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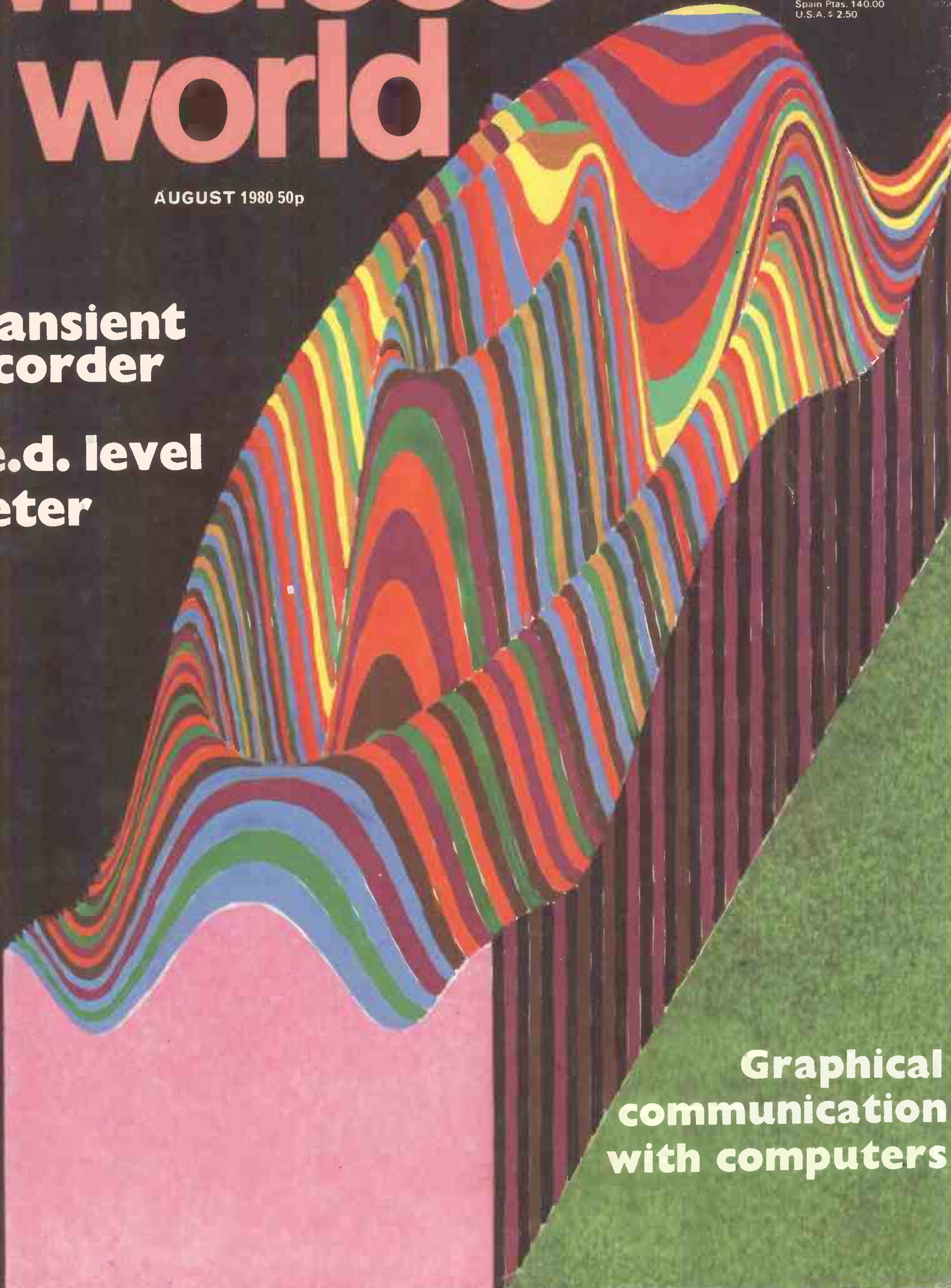
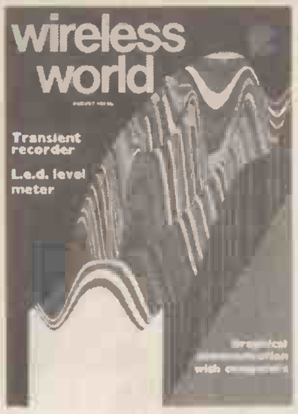


Graphical communication with computers



Front cover is an abstract design by Geoff Harrold, based on an illustration from Ian Witten's article on microcomputers.

IN OUR NEXT ISSUE

Floating-bridge amplifier **is a version of the bridge amplifier, providing 15W from a 12V supply. Article also describes a 200W design.**

Satellite television **reception at 4GHz and 11/12GHz is described by S. J. Birkill. System has worked with Intelsat IVA, Molniya, OTS, etc. and screen photos are included.**

Versatile active filters. **Multichannel tone control, using 'LCR' circuit with synthesized inductance.**

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AUGUST 1980 Vol 86 No 1535

Britain's first com computer kit.

The Sinclair ZX80.

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Price breakdown
ZX80 and manual: £69.52
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Please note: many kit makers quote VAT-exclusive prices.

You've seen the reviews . . . you've heard the excitement . . . now make the kit!

This is the ZX80. 'Personal Computer World' gave it 5 stars for 'excellent value.' Benchmark tests say it's faster than all previous personal computers. And the response from kit enthusiasts has been tremendous.

To help you appreciate its value, the price is shown above with and without VAT. This is so you can compare the ZX80 with competitive kits that don't appear with inclusive prices.

'Excellent value' indeed!

For just £79.95 (*including* VAT and p&p) you get everything you need to build a personal computer at home . . . PCB, with IC sockets for all ICs; case; leads for direct connection to a cassette recorder and television (black and white or colour); *everything*!

Yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers at several times the price.

The ZX80 is programmed in BASIC, and you can use it to do quite literally anything from playing chess to managing a business.

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Your ZX80 kit contains . . .

- Printed circuit board, with IC sockets for all ICs.
- Complete components set, including all ICs – all manufactured by selected world-leading suppliers.
- New rugged Sinclair keyboard, touch-sensitive, wipe-clean.
- Ready-moulded case.
- Leads and plugs for connection to domestic TV and cassette recorder. (Programs can be SAVEd and LOADed on to a portable cassette recorder.)
- FREE course in BASIC programming and user manual.

Optional extras

- Mains adaptor of 600 mA at 9 V DC nominal unregulated (available separately – see coupon).
- Additional memory expansion boards allowing up to 16K bytes RAM. (Extra RAM chips also available – see coupon).

*Use a 600 mA at 9 V DC nominal unregulated mains adaptor. Available from Sinclair if desired (see coupon).

The unique and valuable components of the Sinclair ZX80.

The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter; and the Sinclair teach-yourself BASIC manual.

The unique Sinclair BASIC interpreter offers remarkable programming advantages:

- **Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability – takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input – to request a line of text when necessary. Strings do *not* need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications.
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions, USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

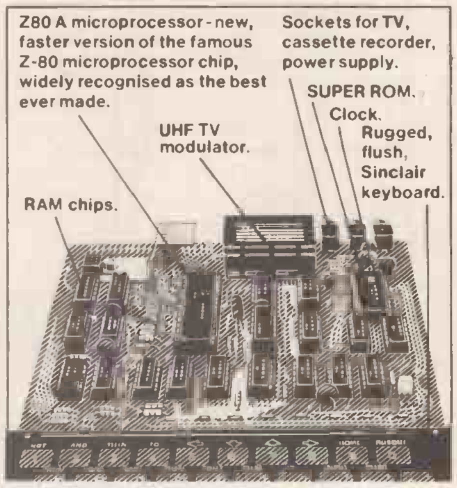
Fewer chips, compact design, volume production – more power per pound!

The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer – typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 lines.

And Benchmark tests show that the ZX80 is faster than all other personal computers.

No other personal computer offers this unique combination of high capability and low price.



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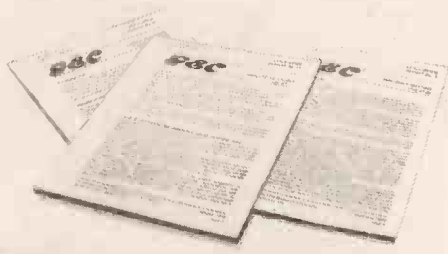

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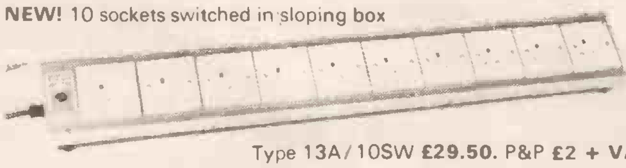

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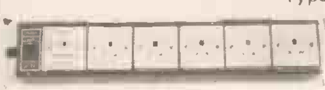

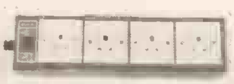

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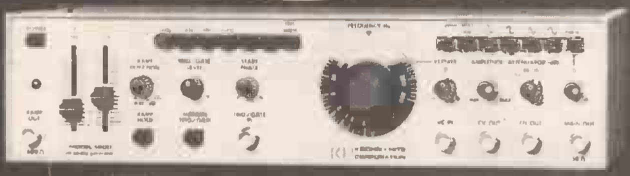

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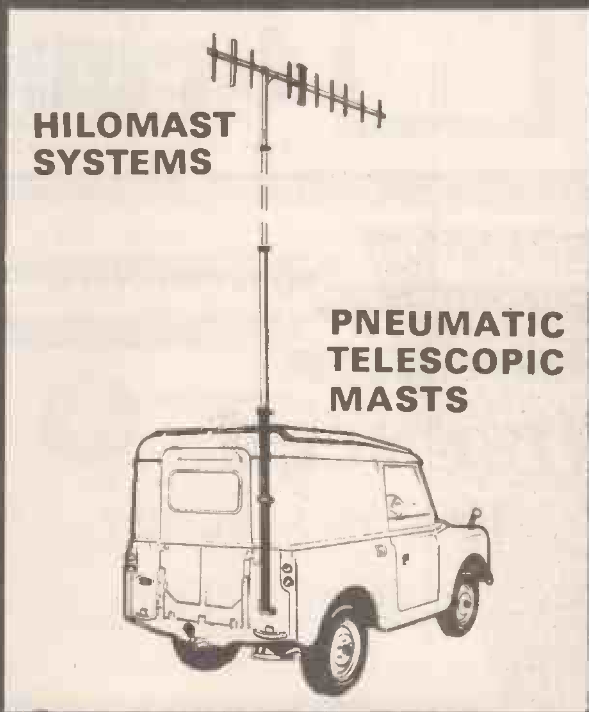

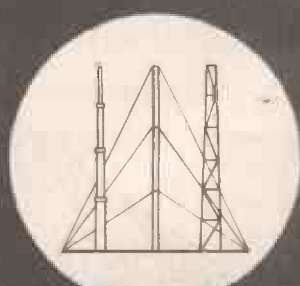

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A40 P.A. CENTRE

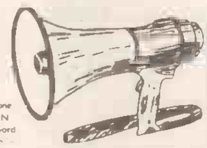
All Solid State
Power: 40W Music
20W RMS
Mono Cassette Deck
Slider Controls
V.U. Meter
Inputs: 2 - Mic (1mV)
1 - Aux (100mV)
1 - Aux (15mV)

£220.80

The "P.A. Centre" has fully comprehensive facilities making it unique equipment for multi-application use in audio, public address, sound and communication systems. Presentation is in a teak sided cabinet, with black/silver deck and control facias, housing the 40W mono amplifier, cassette recorder, internal microphone and speaker. Outputs of 8,16 ohms and 100V line enable a wide range of external loudspeaker systems and P.A. Horns to be used; operation from A.C. mains and 12V car battery further increases the versatility of application, and location possibilities. The "P.A. Centre" can be used as a mixer unit, and the internal condenser microphone or loudspeaker muted as required.

L81 10W MEGAPHONE

Power: 10W
Range: $\frac{1}{4}$ mile
Batteries: 6 - $1\frac{1}{2}$V

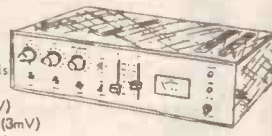


Easy-to-use and hold, this lightweight megaphone has a range approaching a $\frac{1}{4}$ mile. Features ON OFF switch incorporated in pistol grip and forward facing dynamic microphone. Solid-state 5 semi-conductor circuit, powered by 6 x $1\frac{1}{2}$v batteries. Attractive red and white case with carrying strap.

£89.70

A56 50W A.C./D.C.

All Solid State
Power: 50W RMS
S.N.R.: 55dB
Rotary & Slider Controls
V.U. Meter
Inputs: 3 - Mic (0.5mV)
1 - Mag Phono (3mV)
1 - Aux (200mV)



£117.30

The A-56 is a 50W A.C./D.C., all silicon solid state P.A. amplifier. Its outstanding performance and versatile operating features make it ideal for use in a wide range of applications, such as in schools, factories, restaurants and shopping centres. The amplifier is housed in a grey finished metal cabinet, well complimented with a black and silver front fascia panel. 3 low impedance microphone inputs are available. The third of these inputs is an alternative to "auxiliary" or "magnetic phono (R.I.A.A.)" inputs via a selector switch A 3 position switch marked MUSIC, SPEECH is provided to give Bass Cut. The pre-amplifier output is available through a 5-pin DIN socket, rear mounted. Since the "auxiliary" input is through the same socket, it is possible to use a single connector for recording and playback from a tape recorder.

A60 SHOULOER P A SYSTEM

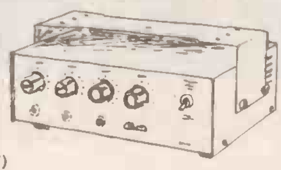
£62.10

Power: 5W RMS, Range $\frac{1}{4}$ mile
Batteries: 6 - $1\frac{1}{2}$V

This is a versatile, complete P.A. system essential for couriers and guides, public speakers, traffic and parking controllers, showground and display attendants and for countless publicity and promotion activities. The neat leather-tone case with adjustable shoulder strap houses a solid-state amplifier, loudspeaker and storage for the "press-to-talk" microphone on self-coiling lead.

A55 MOBILE AMPLIFIER

All Solid State
Power: 20W RMS
S.N.R.: 60dB
Pos. or Neg. Earth
Car Mounting Bracket
Rotary Controls
Inputs: 2 - Mic (3mV)
1 - Aux (40mV)

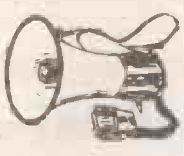


£69.00

Able to operate from both A.C. mains and 12V D.C. this is the ideal solid-state P.A. amplifier for installation in vehicles, caravans, boats, and for exhibitions, demonstration and display purposes. 3 inputs are conveniently front located, individually gain controlled and will accept two microphones plus ceramic or crystal cartridge, radio or tape recorder. Speaker output impedances of 4,8 &16 ohms and 100V line allow for long and complex speaker runs. A two-way chrome mounting bracket stand is provided for easy fitting to dashboards, shelves, panels and control desks. The metal cabinet is finished in grey with black and silver front, incorporating gain controls, tone control and A.C. battery power switch with indicator lamp.

L83 MEGAPHONE (SEP. MIKE)

Power: 16W, Range: $\frac{1}{2}$ mile
Batteries: 8 - $1\frac{1}{2}$V



High powered, yet compact and easy to carry and use, this solid state megaphone has a range of $\frac{1}{2}$ mile. The noise cancelling microphone clips onto the base, has a convenient press-to-talk switch, and volume control and is fitted with a self-coiling lead extending to over $1\frac{1}{2}$ metres. This sturdily constructed megaphone can be operated fitted onto a stand using the tapped hole provided, free standing on table and floor, and portably shoulder slung, or strap carried.

£69.00

A70 PROFESSIONAL

All Solid State
Power: 175W RMS
S.N.R.: 55dB
Rotary and Slider Controls
V.U. Meter
Inputs: 4 - Mic (0.5mV)
1 - Mag Phono (3mV)
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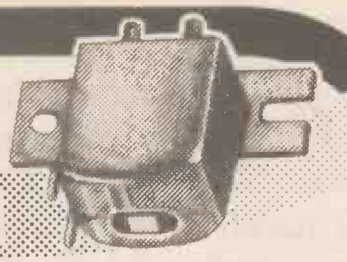

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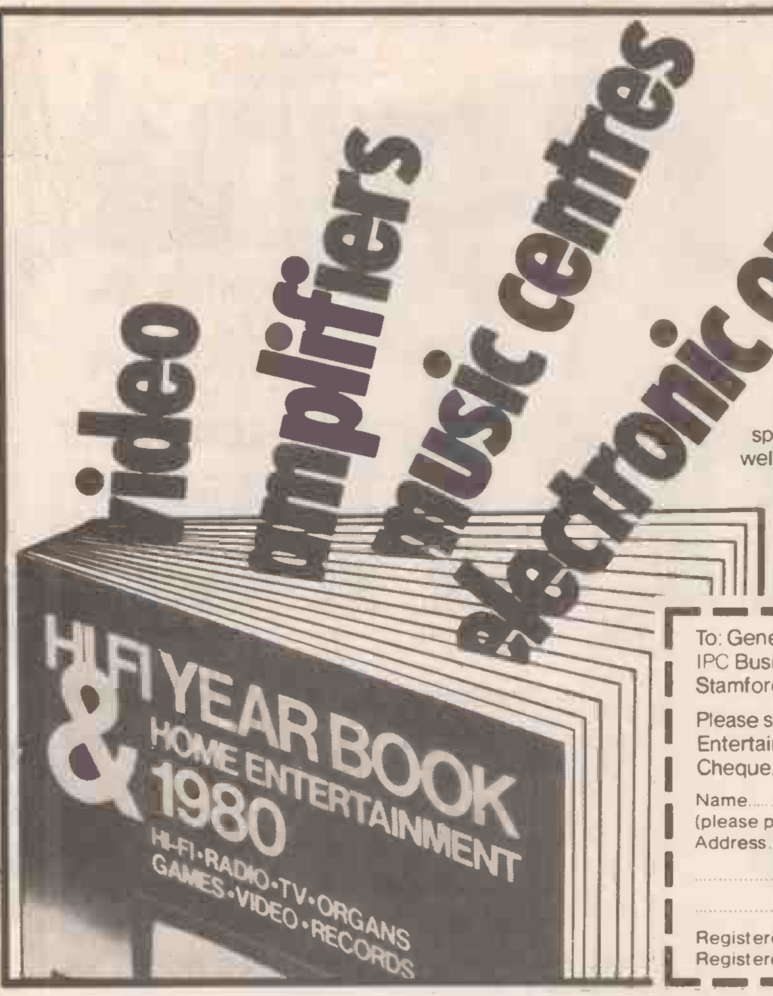

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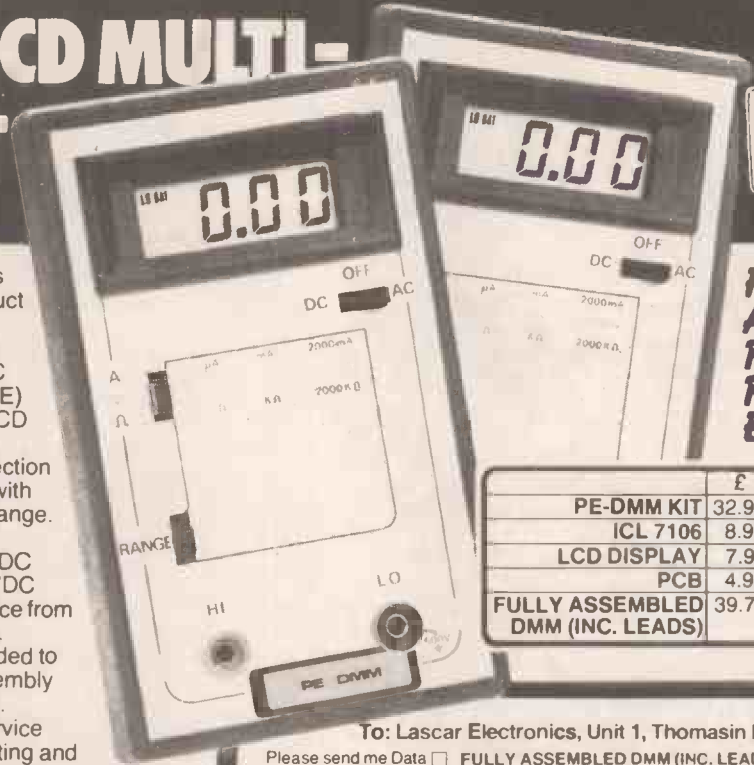

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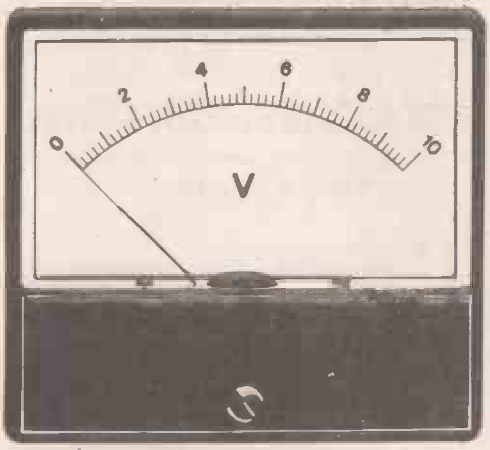

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Are engineering ethics possible?

The title of a recent article in *IEEE Spectrum*, "How to be ethical and survive", says it all. There is the clear implication that you might not in fact survive in engineering if you act according to your ethical principles. Your job may be at risk, as some engineers have already discovered. The "whistle-blower" is not liked by managements and colleagues who do not share his scruples. And by suggesting that ethics really belongs to the individual, to the realm of personal and private convictions, the title raises the question of whether ethics is in fact applicable to such a public and collective activity as engineering.

In the USA they obviously think it is. Over there an attempt is being made to frame a unified code of ethics that will be relevant to all branches of engineering. And for some months 18 teams of engineers and philosophers have been exploring this question under the impressive title of The National Project in Philosophy and Engineering Ethics, apparently believing, in typical American fashion, that truth will be found by sheer application and weight of numbers. If philosophers are anything to go by they will not provide any answers but simply analyse and clarify the questions with finer and finer distinctions – which is what philosophers have been doing ever since Plato.

The practical questions which may force engineers into making ethical judgements range from the clearcut to the hazy. Will this design of bridge carry the intended load or will it collapse and kill people? Will this design of tv set operate safely or will it catch fire in somebody's home? If "commission" is paid to certain people to help along the sale of equipment, is this bribery? If I use somebody else's ideas in my work without permission, is this theft? But even if one succeeds in making a private judgement on such matters, deciding whether to act on it publicly is quite another thing. The act, or lack of it, could be crucial to your material prospects or to your dearly prized image of yourself as a decent human being. Being forced to decide could make you think really hard about whether your first responsibility is to the public or to your employer.

It is to help the individual in such circumstances that the imposed code of ethics is useful. If the code is accepted and has authority he can shelter behind it. It is simply the law, isolated from all those difficult questions of morality. But if the code is derived from what is socially acceptable, rather than what is right, does it have any real worth? Here we encounter the old problem of whether ethics should be descriptive (what people *actually* do) or prescriptive (what they *ought* to do). And there are many others. For example, is morality altruistic, the result of social pressure, or egoistic, arising from individual self-interest? Can there be an objective basis for ethical judgements or must they always be subjective and relative?

One could certainly devise a practical code of engineering ethics based on the criterion of protecting individuals from malpractices. But this would be accepted by engineers' employers only to the extent that it served the purely technical function of satisfying the customer. Ethics are good for business. In other respects it would be treated as just another engineering constraint, to be got around by cleverness. Any genuine effect it might have would depend entirely on those few who saw it as a human claim rather than a technical means or obstacle. For, as the philosopher A. J. Ayer recently admitted in a newspaper interview, "morality is mainly about respect for other people's feelings and interests."

Graphical communication with microcomputers

Input and output of data for interactive graphics

by **I. H. Witten** M.A., M.Sc., Ph.D., M.E.E. Department of Electrical Engineering Science, University of Essex.

This article introduces the techniques of interactive computer graphical input and output, concentrating on the low-cost raster type of display. Input devices described include the light pen and touch tablet, and mention is made of a hand-printing input recognizer. The first part deals with point-plotting and raster-scan displays.

Pictures are a venerable, a natural, and often a most effective way of communicating information, and can greatly enhance a dialogue between man and machine. On the simplest level, functional or empirical relationships can be displayed as a computer-generated plot, and as an example a trend curve for the stock market, together with the individual stock prices on which it is based, is shown in Fig. 1. Rather more exciting is the representation of three-dimensional surfaces like the one in Fig. 2 of a mathematical function. Notice that "hidden lines" have been removed from this picture by the computer — the same function could be plotted with all lines visible. Figure 3 shows an electrical circuit diagram. Here, the computer can perform analysis of the circuit as well as simply drawing it, probably presenting the results of this as electrical waveforms expected at key test points. Since circuits are often etched directly on the surface of a printed circuit board using a photographic process, this too can be automated.

The display of text itself is a most important application of computer graphics, and Fig. 4 shows a typical v.d.u. (visual display unit) computer terminal. Text can be presented in new ways which are impossible on paper, for parts of the screen may be dynamically overwritten, or highlighted by blinking. Suitable software can restrict any input typed on the keyboard to pre-defined parts of the page, for example to assist with filling in a questionnaire. On the other hand, the v.d.u. can be very constraining — annotating a text or scoring out sections is often much easier on paper. A large variety of type fonts can be accommodated, and Fig. 5 shows Chinese text on a v.d.u. screen.

Limited graphics capability is provided in many microcomputer display system, like that used in the teletext facility of the British television services and also in the viewdata scheme (promoted by the Post Office under the name "Prestel"). This generates low-resolution pictures of the type shown in Fig. 6, which are particularly effective in colour. On home computers, such facilities are usually designed to enhance computer games.

Much more expensive equipment is needed to draw three-dimensional shaded objects, and here the computational burden of hidden-line removal can become very great. The illusion of depth is greatly enhanced by the ability to change the apparent viewing position by rotating the object: this too places heavy demands on both the display hardware and supporting software. Systems exist which provide a cockpit view from a simulated aeroplane, allowing you to bank and loop, swoop low over roads and fields, land, and taxi across the airfield into a hangar!

Graphical input is much more primitive. Of course you can interface a television camera to a computer bus and digitize visual images, but interpreting them with a program is currently a challenging research problem. The effects of lighting and shadow, which at first seem to confound recognition by tarnishing and confusing the objects which are being viewed, are in fact important, but subtle, clues to shape and orientation in real-world scenes. Further complications arise from binocular vision, and motion of the object or observer. Even two-dimensional line drawings present considerable difficulties. The thumbnail sketch which so greatly assists communication between engineers or architects is virtually impossible to interpret automatically. Of course, it is easy to record such pictures by computer, and they can be processed by scale changes or rotation and stored for subsequent output on demand — the difficulty is in deducing facts about the structure of the objects depicted. While recording and replaying pictures can be most useful for communication between one person and another, the emphasis of this article is on man-computer communication, and for this it is necessary for the machine to interpret its input.

The easiest thing to interpret is pointing – and this can be put to extraordinarily good use. It is well suited to the machine's capacity for high-speed display, and to man's potential for rapid assimilation of pictorial information, quick decision-making, but rather restricted output capability. This leads

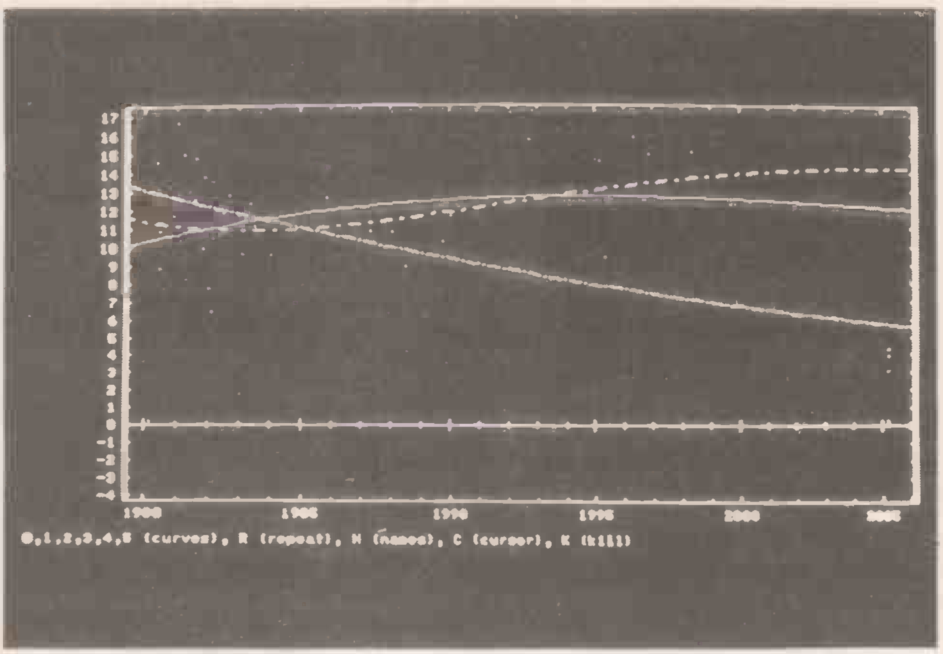


Fig. 1. Stock prices, with a trend curve.

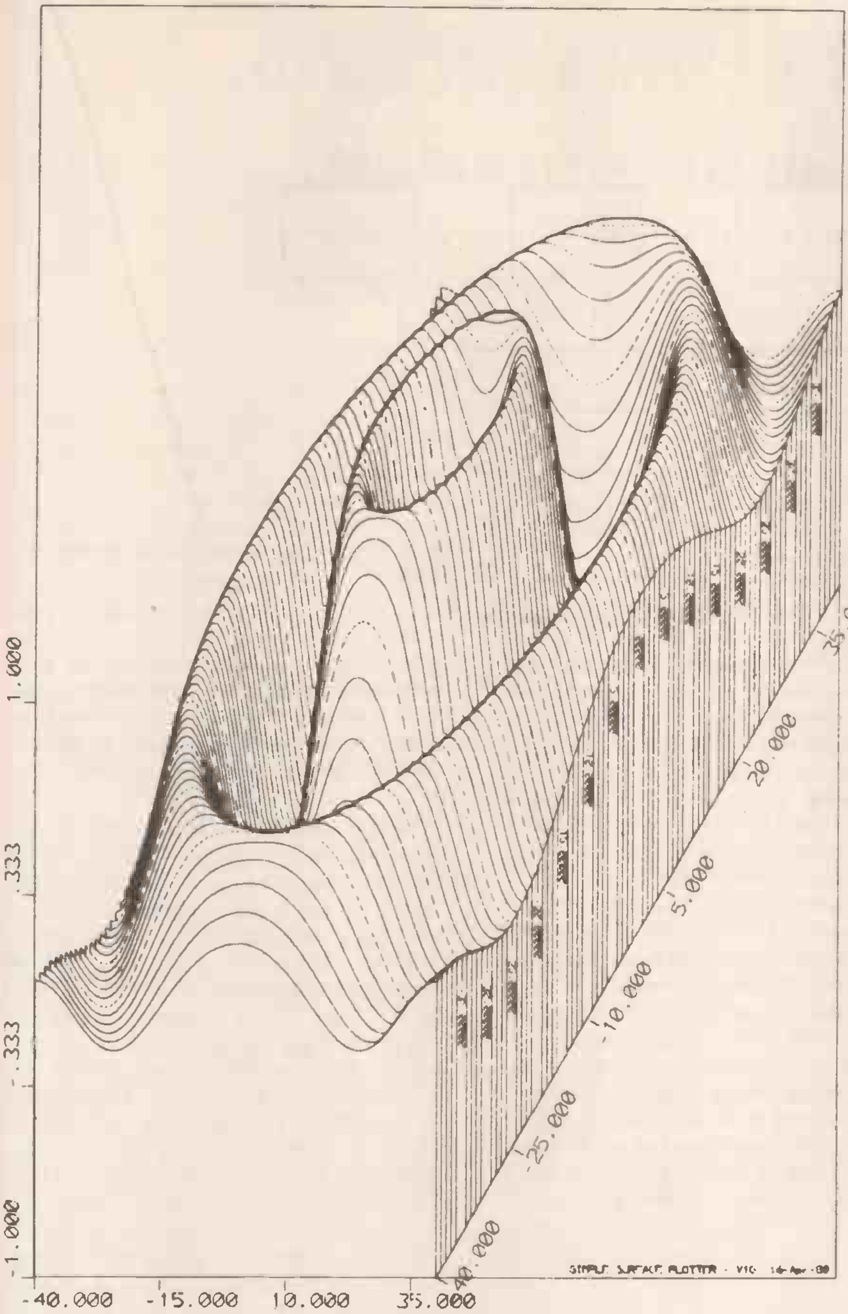


Fig. 2. A three-dimensional surface, with hidden lines removed.

Fig. 4. V.d.u. computer terminal.

Fig. 5. Chinese text.

to the use of a "menu" to show possible options which are selected by pointing; to a stylus which can "pick up" part of a picture and "drag" it around the screen; to "rubber-band lines" which extend from a point on the screen to the stylus tip and move around with it, keeping straight all the time. All these facilities can be provided by a display and suitable software if only the pen coordinates are continually known.

This article introduces the technology of interactive computer graphics. The "interactive" qualifier is important here because it excludes displays which cannot be used for quickly-changing pictures. For example, a plotter which draws lines on paper with a computer-controlled pen is not considered interactive, for it produces pictures slowly, one at a time. In fact, once you appreciate the principles of interactive

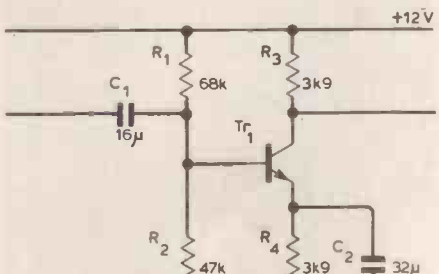


Fig. 3. Electrical circuit diagram.

displays, non-interactive ones are easy to grasp. Two fundamental techniques of random point-plotting and raster-scanning are described first. Although random point-plotting is the oldest and still the dominant technique for high-quality graphics, it is being ousted by raster-scanning, particularly in mass-produced low-cost systems. Hence, we spend rather more time on the latter, discussing the generation of characters, cell-organized raster displays, and related graphics facilities like those of the teletext and viewdata systems. Then, two devices for input are described, one of which is inherently a pointing device while the other is not but can be made so by suitable software. Finally, there is a new input peripheral which recognizes hand-printing, to give a taste of things to come.

Point-plotting displays

The simplest kind of display needs to be able to position a spot on the face of a screen by controlling its x and y coordinates. Think of an oscilloscope, where x and y deflection mechanisms steer the beam of light to any position on application of suitable control voltages. The details of the deflection mechanism itself are not important for an understanding of the potential of the display for man/machine interaction; however, certain properties of it do affect the kind of pictures that can be drawn and the cost of the display, and we will come to these in a moment. In addition to x and y control, a z- or brightness-control is needed to turn the spot on and off.

Figure 7 shows how the display can be connected to the computer bus. Three output ports are provided, one for each of the beam's degrees of freedom. Digital-to-analogue converters change the digital x and y coordinates to voltages which control the deflection mechanism, while since the brightness is either on or off, only a buffer is needed to provide two suitable voltage levels. (This buffer is really a 1-bit d/a converter!) The resolution that is required of the converters depends on the accuracy with which the position has to be specified. Typically, 10-bit converters are used, giving a grid of 1024×1024 points. Notice that this grid contains a total of just over one million points, and if each can be on or off then there are over $2^{1000000}$ possible patterns that can be displayed. This is a truly enormous number, whose decimal representation has around 300,000 digits, and the old adage that a picture is worth a thousand words is clearly an underestimate!

Part of a program for driving the display is shown below. This presents a spot at the point with coordinates (52,716). Can you see why the program manipulates z and does not just leave it at 1 all the time? Physical considerations of the display hardware may dictate some changes in the program: it may be necessary to wait between steps 4 and 5 to give the spot time to brighten up, and between 3 and 4 to allow the position of the beam to settle.

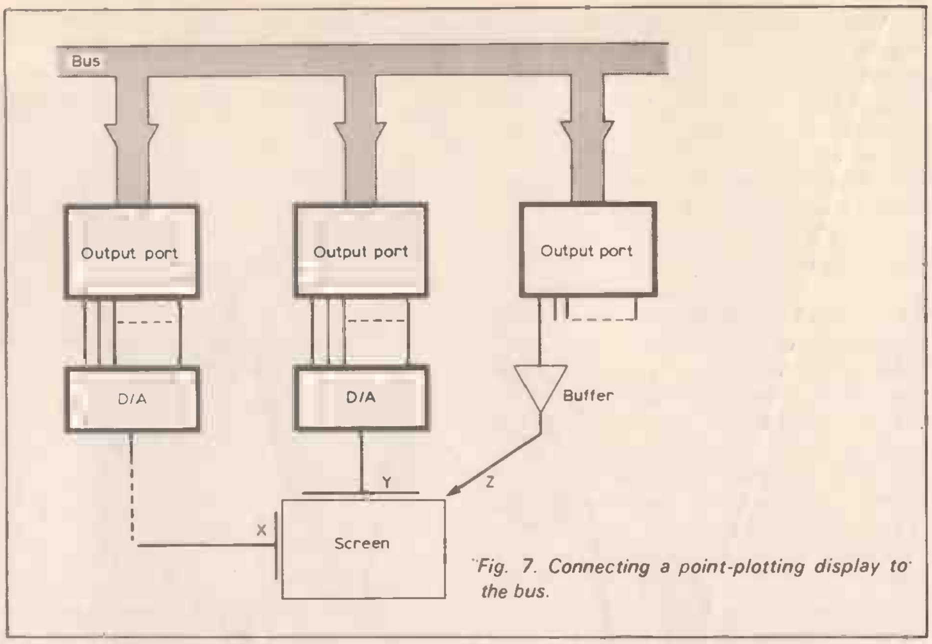


Fig. 7. Connecting a point-plotting display to the bus.

Refresh. What happens when the program is executed once? The spot will move to the specified point, brighten up, and that will be that. If you're lucky you might catch a glimpse of a brief and microscopic flash on the face of the screen. To give an illusion of a sustained point, the display needs to be refreshed periodically, every 20 msec or so.

The refresh rate required depends on the properties of the display itself: usually light is produced by an electron beam striking a phosphor-coated screen and the duration of the spot depends on the "persistence" of the phosphor used. The need to refresh brings many problems in the design and use of computer displays, because if several thousand points are to be refreshed every 20 msec there is not much time for each; for a 1024×1024 display contains over a million points. If the display is not refreshed quickly enough the picture will flicker: this begins to become noticeable at a refresh rate of about 30Hz (33 msec between refreshes).

Timing considerations. Important parameters of a point-plotting system are d/a conversion time, deflection speed of the beam, attack time of the phosphor, persistence of the phosphor, refresh rate and computer speed. A typical settling time for d/a converters is 1 or 2μsec. The currents in the bank of resistors must stabilize and, after the operational amplifier sums these, its output voltage must settle. High-speed d/a converters can be built to stabilize after as short a time as 30nsec. The deflection speed of the beam depends on the deflection system used. There are two important ones, magnetic and electrostatic deflection, the former taking as long as 25μsec for a corner-to-corner movement of the beam and the latter accomplishing even this large movement in 1μsec. Why not always use electrostatic deflection? It costs more! The magnetic scheme is used in television receivers, and these are available very cheaply because of their high sales volumes. The attack time of the phosphor causes no difficulty, being of the order of 50nsec, and its persistence varies depending on the type of phosphor used. While long persistence – and it can be as long as several seconds – means that the refresh rate can be lower, it prevents rapid changing of the display contents because after-images of the old picture remain on the screen. This is quite distracting, and so persistences of around 5 to 10msec are used for interactive displays, allowing a refresh rate of 25-50Hz to be employed without after-images. Finally, if the computer is used in a simple point-plotting mode, as indicated in Figs. 7 and 8, the program execution time to display one point will be 30-100μsec on present-day microprocessors.

Fig. 6. A teletext weather map.

With a refresh rate of 25Hz and a 40μsec point-plotting time, only 1,000 points can be displayed on the screen. This is just 0.1% of the total points, and corresponds to a single full-length line. If characters are to be displayed and each has 20 points, then only 50 of them can be accommodated – less than a line of text. Clearly, computer speed is the big limitation.

From interface to display processor. The scheme of Fig. 7 requires the processor to pick up the coordinates of each point from store and send them along the bus to the display interface. A direct memory access arrangement can substantially increase the speed, with the interface gaining bus mastership and reading the coordinates from store without intervention by the processor. Then, the speed of the bus-mastership protocol becomes the limiting factor, unless the display interface hogs the bus for substantial periods by refusing to relinquish bus mastership once it has been granted. This in turn can prevent the processor from operating at a reasonable speed.

Figure 9 shows a solution which uses a dual-port store. The display interface has private access to the store along a special display bus, and transfers on this do not interfere with the main bus or the processor's operation. Of course, the store must arbitrate between simultaneous read or write requests from the two ports. In general, the processor will have another store on the main bus which it uses unless it specifically requires to update the display: then the processor and the display interface can each work at full speed quite independently.

Now what is the limitation on the display system's performance: Coordinates can be retrieved from the store very quickly – 500nsec is a typical store access time. 1μsec d/a converters will keep up with this, since two coordinates must be read for every point displayed. However, the 25μsec corner-to-corner deflection offered by a typical magnetic system will not, and this will severely restrict the images that can be displayed unless the points are arranged in the store in a way that minimizes large jumps. Furthermore, when large jumps do occur, the display interface must detect them and wait for a suitable period for the beam to settle. An electrostatic display eliminates the need for this and provides a far more satisfactory, but expensive, solution.

More serious limitations are the size of the display store, and the time it takes the processor to write a picture into it. A thousand points need 2,000 coordinate specifications. Thus even a large 64K word store will only accommodate 32 full length lines. And the processor will take a correspondingly long time to change the picture in the display store, so to avoid a muddled display during the change a second 64K store will be needed, with a switching arrangement to allow the display to change over instantaneously from one picture to another (a technique known as "double-buffering").

It is worth considering adding line-generating hardware to compute the intermediate points of a straight line from its beginning and end coordinates. Such hardware interpolates in a straight line from the beginning x voltage to the final one, and similarly for the y voltage. This is not difficult to implement in either analogue or digital hardware, although there are trade-offs between the two that we will not go into.

The display interface must distinguish commands to the line generator from (x,y) coordinate specifications of individual points, and one or more bits must be reserved for this purpose with every data item in the display

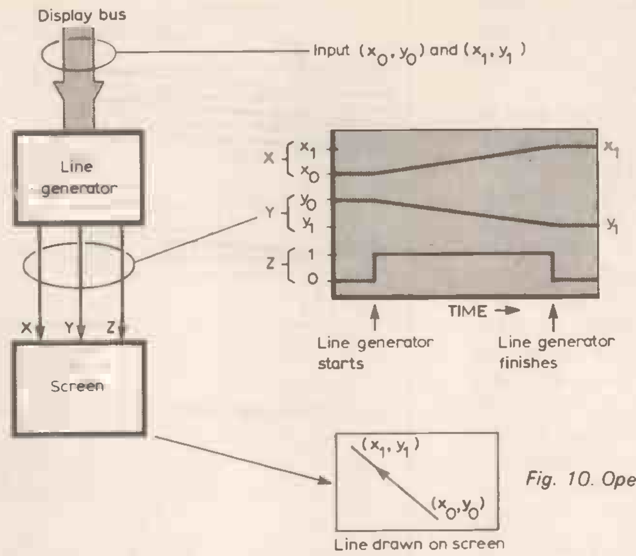


Fig. 10. Operation of a line generator.

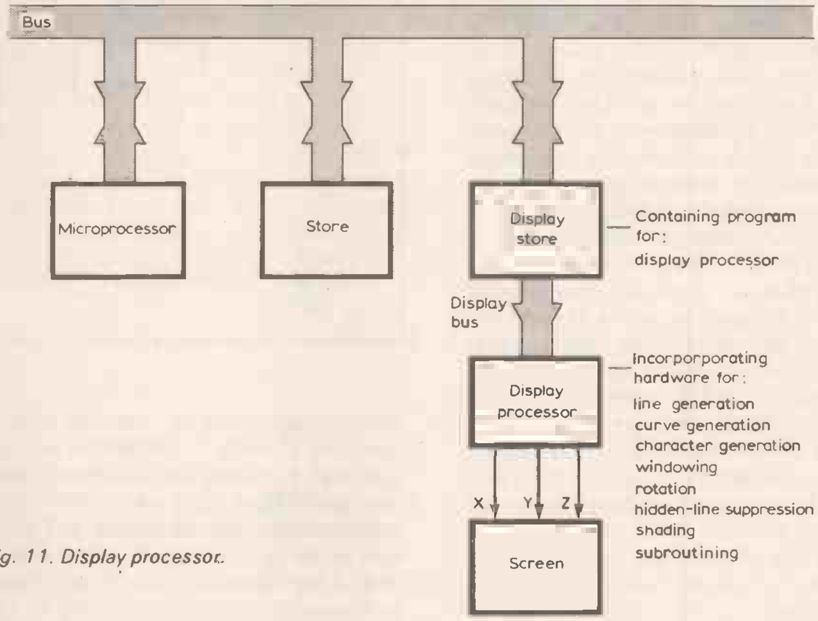


Fig. 11. Display processor.

1. Set z = 0
2. Set x = 52
3 Set y = 716
4. Set z = 1
5. Set z = 0
6. Set x = ...

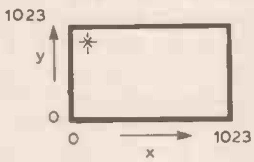


Fig. 8. Part of a program to drive the display.

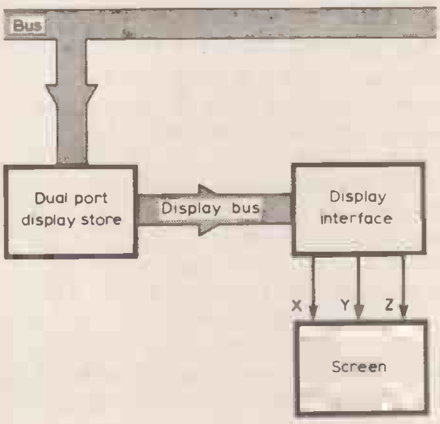


Fig. 9. A display scheme with a dual-port store.

store. Now the display interface becomes more like a processor in its own right, interpreting instructions in the display store, and in fact is usually called a display processor.

What other tasks would it be nice for the display processor to do? It could have circle generators, ellipse generators, and so on. If characters are to be shown then a special hardware character generator is useful, for it is extremely wasteful of store to specify a character as a set of points each time it is to be displayed. We will discuss character generators in another section. It could do windowing of data, allowing the display store to contain a picture larger than that actually drawn on the screen. Rotation of pictures is also possible. Rotation in two dimensions is accomplished by the coordinate change

$$y_K = x \sin \theta - y \cos \theta,$$
$$x_K = x \cos \theta + y \sin \theta$$

where theta is the angle of rotation, and since this transformation needs to be done on all points it is rather slow unless special facilities are provided in hardware. (Note, however, that if a hardware line generator is used the rotation transformation need only be done on the *end-points* of lines.) Three-dimensional rotation is almost as easy, and can be combined with perspective transformations to provide viewing of an object from any position. This brings in hidden-line suppression and shading, which can also be done by the display processor. A subroutining facility is useful too, for it is often convenient to define a component of a picture (like a house) once and regenerate it from the same description at various places on the screen.

Now the display processor, which started as a simple interface, has become quite a sophisticated piece of hardware, much more complicated than the average microprocessor. It needs an expensive electrostatic display screen with an impressive array of intricate supporting hardware. The exploitation of such sophisticated displays for man/machine interaction is a specialist topic in its own right. Let us climb down a little and look at less expensive, and less powerful, display techniques.

Raster-scan displays

The picture on a domestic television is painted by scanning across from left to right on the screen, one line after another, from top to bottom. The technique is known as "raster-scanning". It places relatively light demands on the deflection system of the tube, for the flyback time from the end of each line to begin the next and the frame flyback time across the diagonal of the screen are known, and picture information is not broadcast during these periods. Hence a cheap magnetic deflection mechanism can be used, and this, along with the economies of large-scale production, accounts for the low cost of domestic TV sets. To reduce flicker, two successive rasters are displayed, each one generating alternate lines in an interlaced fashion, as shown in Fig. 12. One raster is transmitted every 20msec and so the complete picture is redrawn in 40msec. This rather low refresh rate of 25Hz does not cause noticeable flicker so long as the pictures on the two rasters are similar – as they always are in TV transmissions.

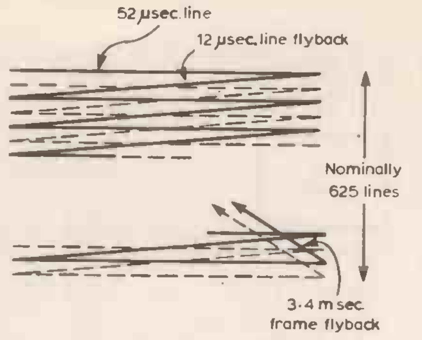


Fig. 12. Television raster-scan, with interlace.

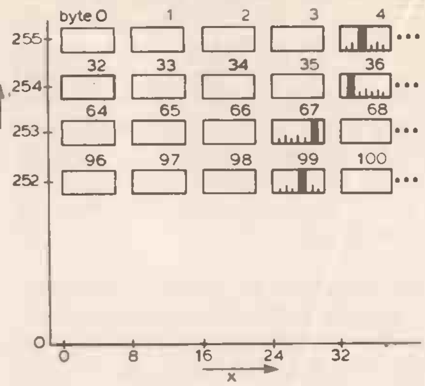


Fig. 13. Memory-mapped bit-per-point display system.

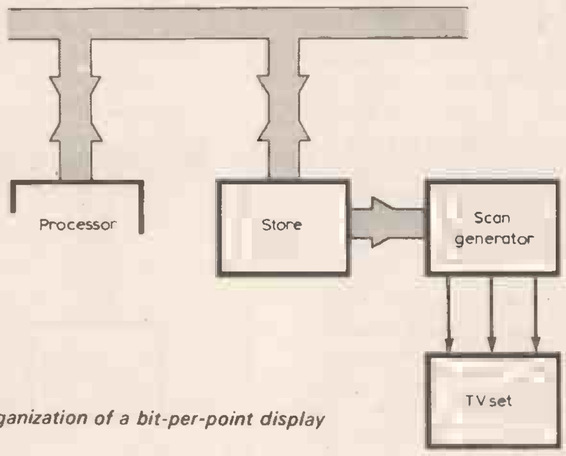


Fig. 14. Organization of a bit-per-point display system.

In Britain, the screen size is nominally 625 lines, some of which are lost in the frame flyback time. If interlace is ignored the number of lines is halved, giving around 290 on the screen. Rounding this down to a power of 2 and assuming a square picture, a screen size of 256×256 is obtained – a quarter the resolution of the high-quality displays described in the previous section. It is possible to double the number of lines on the screen by taking interlace into account, but this may increase flicker to an intolerable level because, unlike the case of normal TV transmission, the interlaced pictures are significantly different.

If a single bit is stored for each point to indicate whether it is bright or not, each line needs 32 bytes of storage and the full screen needs 8K bytes. If this resides in the computer's main store then the result is the memory-mapped bit-per-point display system of Fig. 13. The operation of the scan-generator interface between the store and the TV set is quite simple. Each of the 32 bytes in a line is read in sequence at the appropriate time and its bits used to modulate the beam intensity. Notice that the store is a dual-port one, but the line and frame flybacks provide periods when the processor can access it without contention. In contrast with the point-plotting display, it is easy to brighten up whole areas of the screen, for a point occupies the same fraction of the raster whether it is white or black. There is no limitation on the total length of lines which can be drawn.

As always, however, there are problems. For example, to display a line between point (32,255) and point (0,240) you must set bit 4 of word 4, bit 6 of word 36, bit 1 of word 67, bit 3 of word 99, and so on, as shown in the figure. This can take rather a long time to calculate. And characters are just as time-consuming: imagine the bits that would have to be changed in Fig. 14 to move a page of text up one line! So while memory-mapped bit-per-point displays are certainly flexible, they are not at all convenient to use. Furthermore, to take advantage of the grey-scale possibilities afforded by TV, where there are several shades of grey between white and black, several bits must be reserved for each point, multiplying the size of a store needed. This goes for colour as well, of course.

To be continued

Solid-state level indicator

20 l.e.d. circuit gives numerous options

by Quentin Rice

Unlike earlier "bargraph" driver circuits, this one can be used with any mix of l.e.ds. Log, or linear-scale operation is possible, and other options include dot or bar modes, a.c. or d.c. operation, and adjustable decay time.

Bargraphs have been gaining wider acceptance as a rugged alternative to their analogue counterparts either as the victim of hi-fi gimmickry or in professional recording applications. This unit was designed as a clear visual indicator of high quality, low cost, simplicity and compactness. It can be used for a.c. or d.c. measurement, as discussed later. The display uses 20 light-emitting diodes of any colour mix, and functions in two modes: the bar or strip mode and the dot mode where a single l.e.d. is illuminated giving a low overall current consumption of 35mA, making it ideal for battery applications. This mode select can be externally switched, on a bus if required. Provision has been made for on-board regulation. Sensitivity and decay time presets are accessible from the front of the unit. The decay is linear giving a better feel to the display and can be adjusted to suit up to an infinite decay, which is useful for long-term peak analysis of programme. The circuit has three component parts which are discussed individually.

Input level to the precision rectifier is adjusted by R_{19}. The components around IC_1 form a conventional full-wave precision rectifier; R_1 to R_5 should be close tolerance for symmetrical rectification. The overall gain is set by R_6 which has been chosen for a full scale deflection of 0dB and can be altered to suit. Resistors 21 and 22 compensate for offset and C_5 helps stability at low levels.

The peak detector consists of a comparator, steering network and an integrator. The input from the rectifier is compared to the integrator output and the output of the comparator passed through the steering network R_{20}, R_9, R_{10}, D_3 and D_4 to the integrator input. This gives a fast attack and an adjustable decay current. As the input current is constant, changes in the integrator output will be linear. By turning the decay preset full off, D_4 no longer conducts. This gives the infinite hold facility because f.e.t. op-amps have been used, and there should be very little drift (in theory) from the integrator. The circuit has a high loop gain and as one can imagine, ripple on the input causes instability. This has been overcome by series resistors 21 and 22 which should never be less than 1kΩ except in d.c. applications, where they may be omitted. These have been increased to give lower ripple and a reasonable decay. The detector is very stable and does not overshoot. Capacitor C_2 should be a low leakage, polycarbonate type.

The original design used the Siemens UAA180 bargraph driver. These were found to be very troublesome in practice because l.e.d. forward voltage differences affected linearity. The LM3914 from National Semiconductor provided

Continued over page 33

Specification

Dimensions: 133×25×67mm
Current: 35mA dot mode, 220mA bar mode, max.
Supply: 17-35V or 15V
Attack time: 1ms minimum f.s.d.
Decay time: 1ms to infinity (linear and adjustable)
Amplitude response: 3Hz to 100kHz flat (−3dB limits)

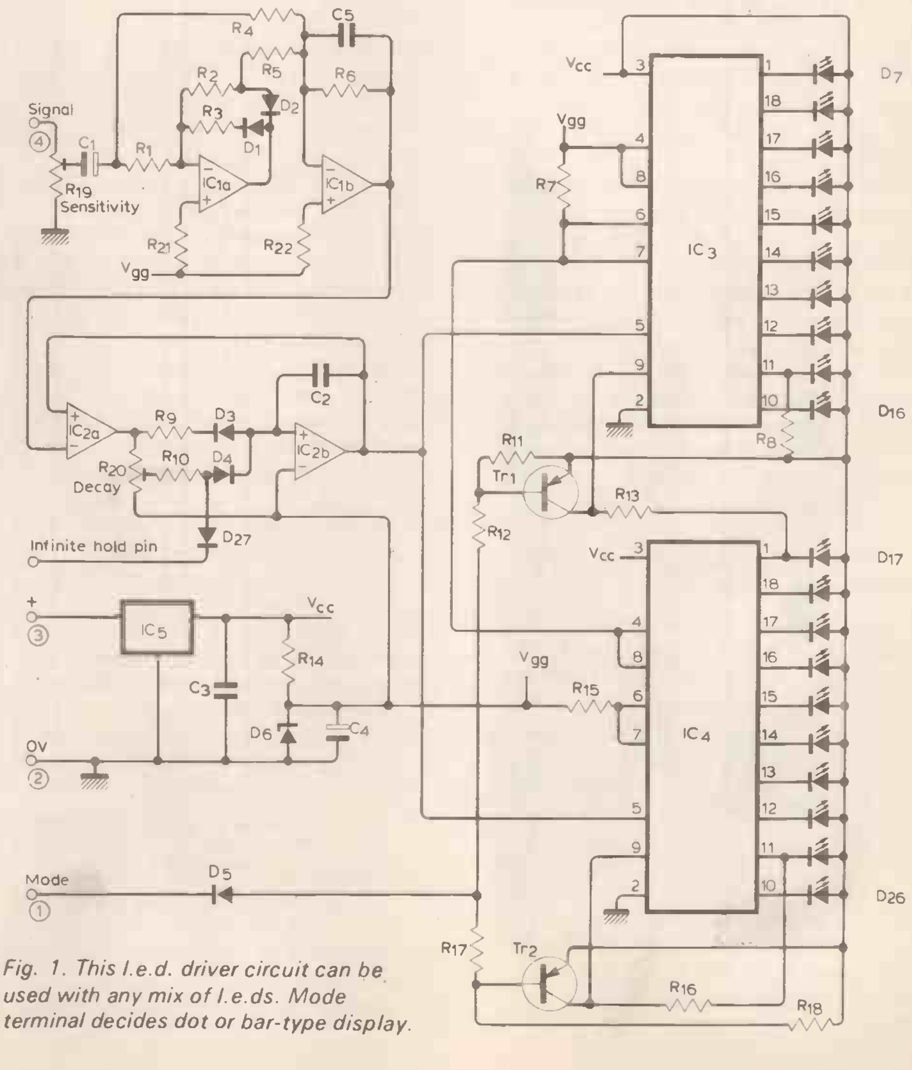
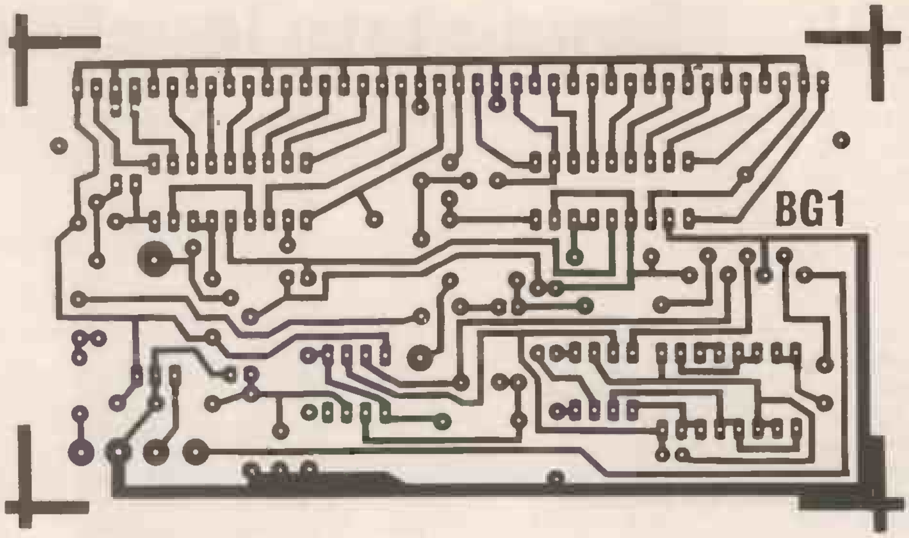
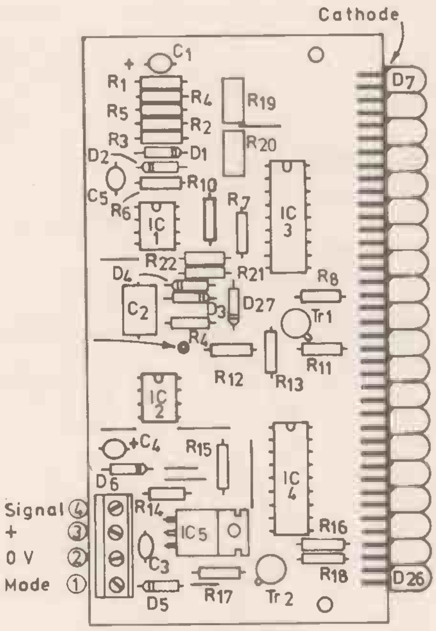
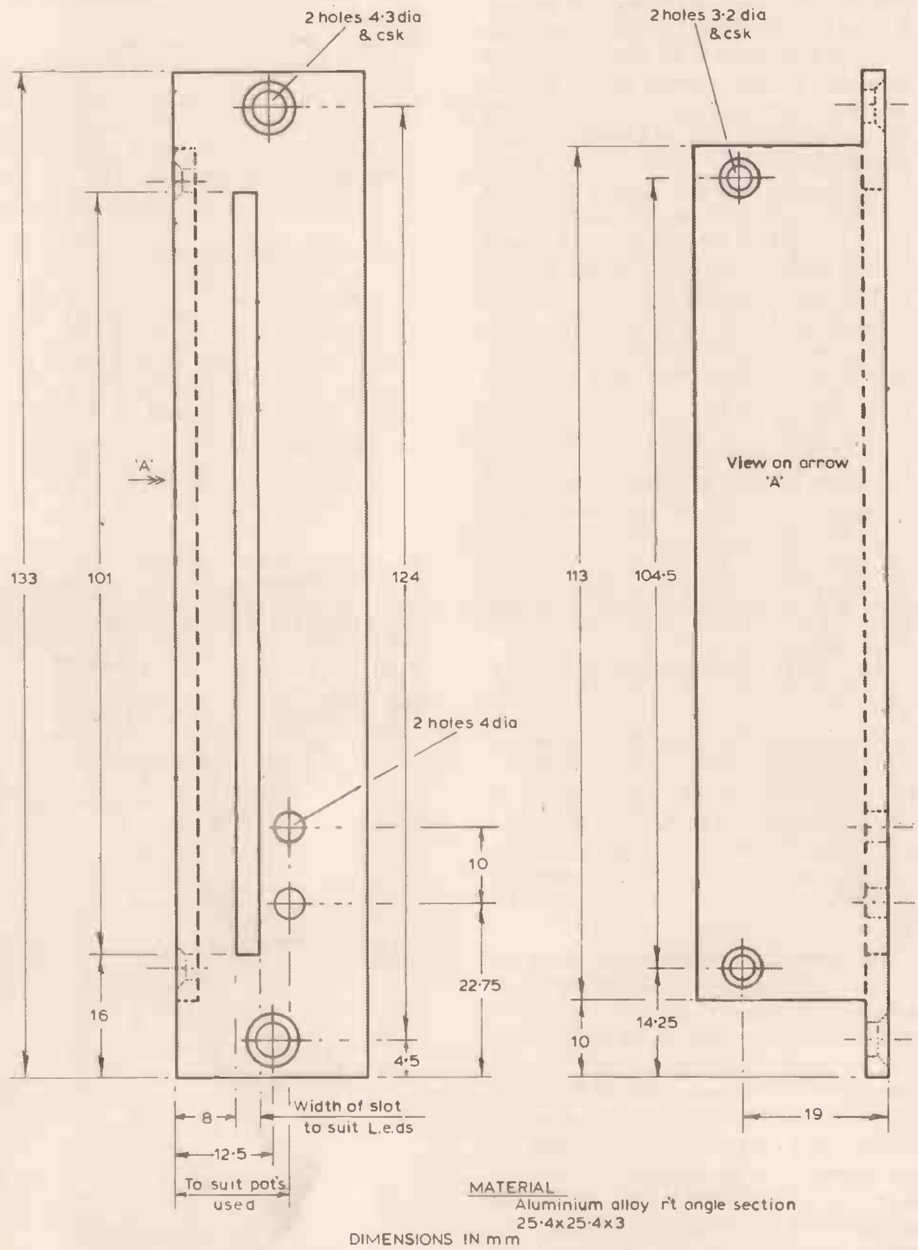


Fig. 1. This l.e.d. driver circuit can be used with any mix of l.e.ds. Mode terminal decides dot or bar-type display.

Panel dimensions are for standard rack fitting. Terminal block is RS type 423-762. A kit of parts costing around £19.55 inclusive is available from Ambit International, 2 Gresham Place, Brentwood, Essex. (Tel: 0277 230909.)







a versatile and easy to use alternative which can be used with any mix of l.e.ds. Each i.c. drives ten l.e.ds at a preset constant current, about 10mA each in this circuit. Up to ten i.cs can be cascaded for greater resolution although only two have been used here. By external switching the dot or bar mode can be selected by the components around Tr1 and Tr2. This is switched by taking the mode pin 1 to 0V; as many units can be switched simultaneously by bussing this pin.

Space for an on-board regulator has been provided, and if this is not required link across the two outside pins. This regulator has no heatsink, and if used in the bar mode from supplies exceeding 24V it gets rather hot. If this is to be used from a higher voltage input, use an external regulator or a dropping resistor. In the dot mode, supplies of up to 35 volts may be used.

Since the introduction of the LM3914, National have introduced two other versions of this chip: the LM3915 and LM3916. The first is a log scale version in ten steps of 2dB, which may be cascaded to give a dynamic range of 60dB, which may be of use for noise analysis. The second is scaled from −20 to +3dB for tape recorders and is not cascadeable.

Good quality l.e.ds were hard to find. Recommended makes are Hewlett Packard, Siemens, Monsanto and AEG, as these gave a consistent brightness and a uniform viewing angle. AEG flat l.e.ds were used in the prototype.

Construction is straightforward. However, take care with the l.e.ds. Preform the leads and tape to the circuit board, making sure they're the right way round. Solder with a low-power iron, as sustained temperature may damage them. The bracket was made from 25mm aluminium angle; with careful drilling and filing this should present no problems. The slot is best milled or punched but can be drilled and filed. Mount the p.c.b. to the bracket using 6BA screws and insulated washers.

There is no alignment to be done. If the sensitivity is too low increase R_6. Check soldering before applying power. The prototype was designed for recording use and has no graduations. The first ten l.e.ds are green for normal recording, the next six yellow for peaks, and the last four red for overload.

For direct-current operation omit all of the components associated with IC_1 and link the wiper of R_{19} to the position of pin 7 of IC_1. Take pin 4 of IC_2 to a −15V supply. Omit R_{14}, D_6 and C_4 and link across D_6. If peak detection is not required, omit IC_2 and its associated components and link the wiper of R_{19} to the position of IC_2 pin 1. This gives a full-scale deflection of 2.4V. If a conventional analogue meter is used, connect this across IC_2 pin 5 and V_{gg}. The meter law can be varied by replacing R_6 with a resistor-diode network.

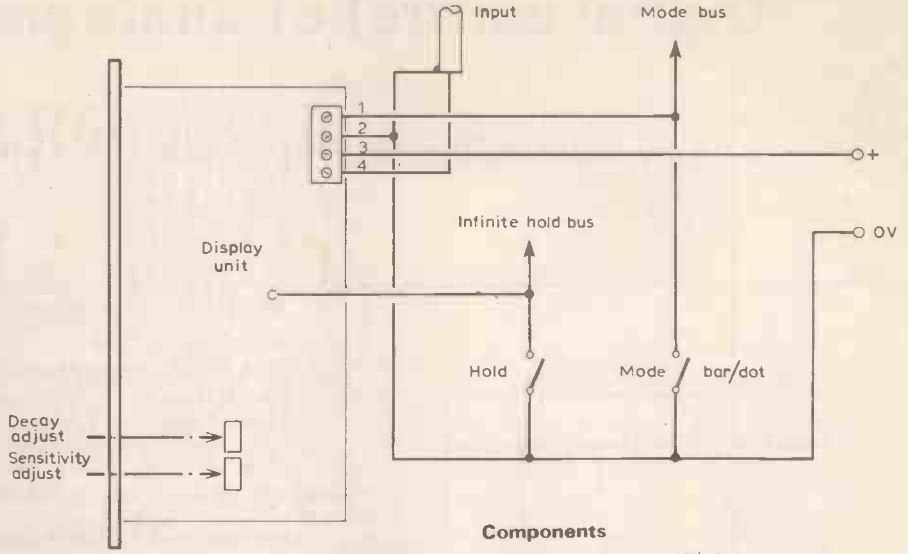


Fig. 2. The decay can be externally switched off into the infinite hold mode by taking the hold terminal to OV. This can be bussed, together with bar/dot mode selection, as shown.

Components

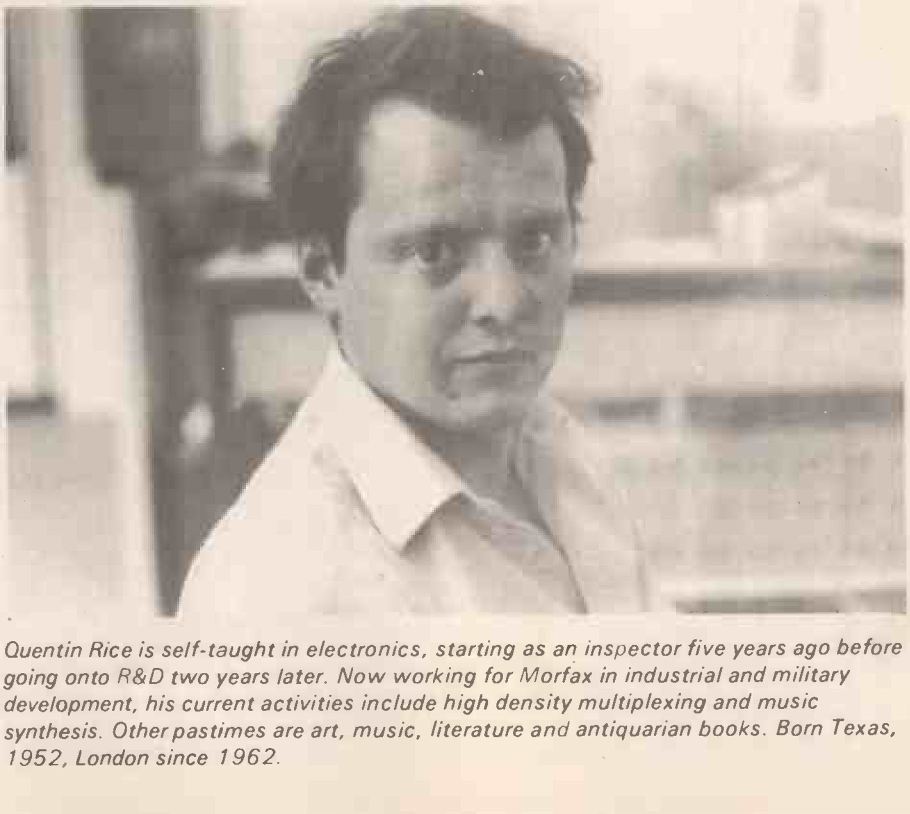
R1, 2, 3	47k 2%
4	22k 2%
5	11k 2%
6	47k
7	1k1 2%
8	20k
9, 14, 12, 17	2k2
10, 11, 18	100k
13, 16	3k3
15	2k4 2%
19, 20	10k (Piher)
21	22k
22	10k
C1, 4	22μ 16V tantalum
2	1μ polycarbonate
3	47n ceramic
5	1n ceramic
D1; 2, 3, 4, 5, 27	1N914, etc
6	BZY88 9V1
7-26	AEG l.e.ds (Ambit)
Tr1, 2	BCY71, 2N4126, etc
IC1, 2	TLO74, TLO84, CA3820, LF353
3, 4	LM3914
5	7815, TO220

Further information

National Semiconductor linear data book 1979.

Peak detector with linear decay, Q. A. Rice, *New Electronics* Nov. 15, 1977.

Wireless World Circards, set 4, card 9. (Also in Circuit Designs–1, IPC Business Press, 1975.)

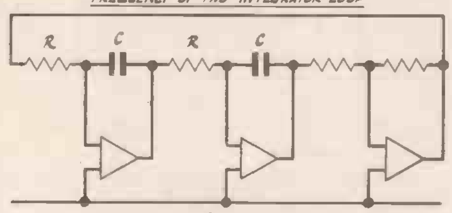


Quentin Rice is self-taught in electronics, starting as an inspector five years ago before going onto R&D two years later. Now working for Morfax in industrial and military development, his current activities include high density multiplexing and music synthesis. Other pastimes are art, music, literature and antiquarian books. Born Texas, 1952, London since 1962.

Digital control of analogue functions

by **Peter Williams,** Ph.D. Paisley College of Technology

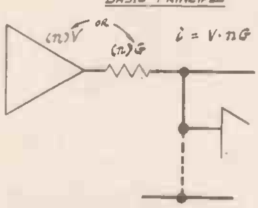
FREQUENCY OF TWO-INTEGRATOR LOOP



$\omega_0 = \frac{1}{RC} = \frac{G}{C}$ Hence if both conductances are varied $\omega_0 \propto G$

The frequency and gain characteristics of circuits are traditionally controlled by means of variable resistors and capacitors. This has two major disadvantages. For many circuits such as RC oscillators and filters two or more components need to be varied simultaneously while retaining an accurate match. This is difficult and costly and because of the mechanical properties of such elements becomes increasingly unacceptable if more than one circuit is to be controlled or if the control is to be achieved remotely. To illustrate some of the alternative techniques a circuit is selected that forms the basis of many oscillators at $\omega_0 = 1/RC = G/C$ assuming equal resistors and capacitors. Dual-gang resistors can be replaced by fixed resistors and dual-ganged potential dividers across the outputs of the two integrators. Any imbalance would in general need a readjustment of one of the other elements to restore the oscillatory conditions. This could be achieved automatically with thermistors, but not with active filters, where the damping would vary as the frequency changed.

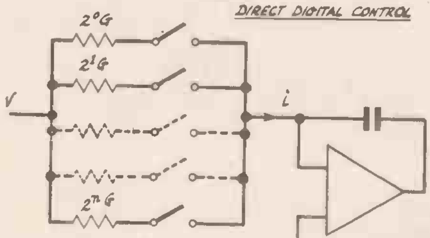
BASIC PRINCIPLE



Add some circuit that varies 'n' according to some analogue or digital control signal

The frequency depends on how rapidly the capacitors charge, i.e. on the current flowing into one as a function of the voltage generated across the other. While the resistance or conductance offers one means of varying that current as above, other possibilities exist. If we take i = nv G then the frequency becomes proportional to n whether that parameter represents a variation in the voltage or the conductance to which it is applied. The variation can be by analogue or digital means, and may be extended to include voltage and current or time division methods as indicated in the following suggestions. In most cases it is desired that the frequency be a linear function of some external variable though other laws, e.g. logarithmic can be accommodated by interposing logarithmic amplifiers. The methods are applied to an oscillator circuit simply as illustrations, but are equally applicable to the remote control of amplifiers, power supplies, control systems.

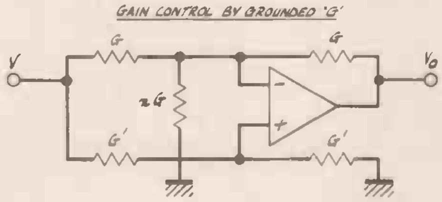
DIRECT DIGITAL CONTROL



$i = V(2^0+2^1+\ldots\ldots)G$

The most obvious digital method corresponds to the weighted resistor d. to a. convertor. Sets of resistors of value 2^0G . . . . 2^nG are placed in series with analogue switches and two (or more) sets inserted in place of the integrator input resistors. The resultant current is then proportional to the set of integers from zero up to $(2^0 + 2^1 + \ldots 2^n)$. The problem is not quite so easy of solution as it might appear. In the first place the switches must have low on-resistance, high off-resistance, must operate with both polarities of input and over the widest possible range of frequencies. The introduction of c.m.o.s. analogue gates allows these conditions to be met economically. The remaining difficulty with this form is that the resistor values spread over perhaps a 1000:1 range making matching more difficult. In addition the need for floating switches can be restrictive since it excludes the use of bipolar transistors, which have particularly low on-resistance. Switches can also be operated sequentially to provide an arbitrary pattern of frequencies via an appropriate set of resistors. This is convenient in automatic test equipment.

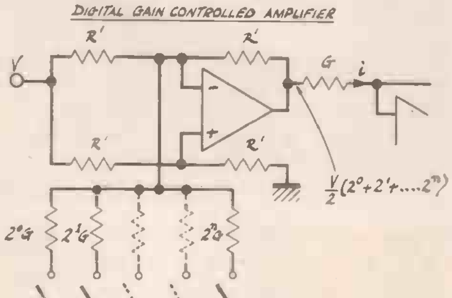
GAIN CONTROL BY GROUNDED 'G'



$V/2 = (V + V_0)/(2+n)$
$nV + 2V = 2V + 2V_0$
$V_0 = (nV)/2$

A neat alternative that uses a grounded variable conductance and hence grounded switches is based on the balanced-bridge amplifier. For n = 0 the gain is zero and with a pair of these amplifiers inserted in the system the frequency of oscillation would tend to zero. The frequency is proportional to n as before. In itself the circuit is already a resist,ance controlled amplifier meeting one of the other common applications of the principle. The amplitude response is limited by the common-mode behaviour of the amplifier and by stray capacitance across the resistors but the circuit has been used successfully up to 50kHz. The variable resistance can be provided by a field-effect transistor with variable gate-source can be provided by a field-effect transistor with variable gate-source voltage provided that the signal level is low enough to avoid distortion caused by device non-linearities. Alternatively temperature or light-dependent resistors may be substituted for direct control of gain.

DIGITAL GAIN CONTROLLED AMPLIFIER



The main advantage of the previous circuit is that it uses grounded elements while permitting the gain to be a linear function of conductance. This can be extended to digital control as shown. All the switches are grounded extending the range of possibilities to include e.g. junction transistors. The weighted resistor method is convenient. If a multiplying d. to a. convertor is available, one in which the output is the product of the digital control word and the analogue input, then it may be substituted entire for the amplifier shown. The proviso is that either the output needs to be buffered before feeding the following virtual earth, or that the convertor retains its control relationship when short-circuited. This is found to be true for one connection of the standard d. to a. ladder network which has a constant output resistance at one port for all switch conditions. In such a circuit a variable attenuator is being substituted for a variable amplifier.

Digital control of analogue functions

THEORY

● Assuming the RC products are the same for the two integrators then the denominator of any transfer function based on the two-integrator loop is of the form

$$S^2 + \frac{\omega_o S}{Q} + \omega_o^2 \quad \text{where}$$

$$\omega_o^2 = \left(\frac{1}{RC}\right)^2 = \left(\frac{G}{C}\right)^2 \text{ i.e. } \omega_o = \frac{G}{C}$$

If both Rs or both Cs are varied simultaneously the frequency shifts without change in Q e.g. if set for $Q \rightarrow \infty$ the circuit is an oscillator whose frequency is varied without loss of oscillation.

● Let the instantaneous voltage at each integrator output be v. Scaling each G by a factor n then changes $\omega_o \rightarrow \omega_o'$, where $\omega_o' = n\omega_o$.

The same effect is achieved by preceeding G by an amplifier of voltage gain n since both cases the current transferred to the following stage is increased by that factor. This can also be expressed in terms of the trans-resistance between the output of a stage and the following integrator summing junction viz $i/v = n\,G$ where n may be raised by any desired means.

● For a set of switched resistors with conductances in the binary steps 2^0G, 2^1, . . . 2^nG the trans-resistance term can range from zero up to

$$\frac{i}{v} = (2^0 + 2^1 + 2^2 + \ldots + 2^n)\,G$$

in steps of G. If these conductances are switched into and out of circuit by external control voltages, direct digital control of frequency is achieved.

● To use grounded switches for the same purpose the modified differential amplifier is used.
Applying Millman's theorems

$$\frac{v\,G + v_o\,G}{(2 + n)G} = \frac{v}{2}$$

$$\therefore\ nv + 2v = 2v + 2v_0$$

$$v_o = n\,\frac{v}{2}$$

i.e. the voltage gain is controlled by the grounded conductance and is proportional to n.

● The single grounded conductance is replaced by a set of weighted reistors as before and the total conductance G_T is again controlled by the switches. Hence the gain is digitally controlled and a pair of such blocks can be inserted in the drive paths to the two integrators.

EXAMPLES

1. Show that the circuit sustains sinusoidal oscillations for equal resistances in the inverter, derive the frequency and evaluate for R 10kΩ, C 10nF.

Break the circuit at any output and show that the loop gain is precisely unity at a single frequency ($\beta A = 1$) the Barkhausen criterion for oscillation.

$$v_o = v\left(\frac{-1/sC}{R}\right)\left(\frac{-1/sC}{R}\right)(-1)$$

$$= -\frac{1}{(sCR)^2}$$

$$\text{For } \frac{v_o}{v} = 1,\ (sC\,R)^2 = -1$$

$$(j\omega CR)^2 = -1$$

$$\omega^2 = (1/CR)^2$$

$$f = \frac{1}{2\pi CR} = \frac{1}{2\pi 10^4.10.10^{-9}} = \frac{10^4}{2\pi} = 1.59\text{kHz}$$

2. Derive the corresponding equations f the integrators have R_1C_1 and R_2C_2, finding the appropriate gain of the inverter.

Let the inverter gain be $-K$.

$$v_0 = v\left(\frac{-1/sC_1}{R_1}\right)\left(\frac{-1/sC_2}{R_2}\right)(-K)$$

$$\text{For } \frac{v_o}{v} = 1,\ \frac{-K}{s^2C_1C_2R_1R_2} = 1$$

$$\therefore\ \frac{\omega^2C_1C_2R_1R_2}{K} = 1$$

$$\omega = \sqrt{\frac{K}{C_1C_2R_1R_2}}$$

This shows that for all values of K there is a corresponding frequency of oscillation. The magnitude of the loop gain increases at higher frequencies but $\beta A = 1$ has to be met identically for oscillation to be sustained.

3. A gain controlled stage has $G = G' = 100\mu s$. If the gain is to be 25 calculate the resistance to be used at nG. It is to be implemented by binary weighted resistors. How many switches are needed? What are the resistor values? Estimate the max switch on-resistance for an error of 1%.
For G 100μs, R 10kΩ
Let the input and output voltages be v, v_0.

$$\frac{v}{2} = \frac{v + v_0}{2 + n}\ \therefore\ v_0 = \frac{nv}{2}$$

$$\therefore\ n/2 = 25 \text{ and } n = 50$$

i.e. the gain increases in 50 increments of 0.5 from 0 to 25 with $50 = 2^5 + 2^4 + 2^1$. Hence three switches are needed, operating conductances of 32.100μs, 16.100μs and 2.100μs respectively ≡ 312.5Ω, 625Ω, and 5kΩ.

The errors are mainly in the low resistance switch where $r_{on} \approx 3\Omega$ would reduce the gain due to this term by ~ 2/3%. Similarly for the next most significant term the contribution would be ½ × 1/3%. This would result in a reduction in the total gain of <1%. □

LETTERS TO THE EDITOR

MULTIPATH DISTORTION

I read with interest the article by Pat Hawker on multipath distortion in your April issue. The author mentions the possibility of using delay lines to reduce ghosting on television and comments that little thought seems to have been given to the use of similar methods in v.h.f./f.m. reception.

Unfortunately, the problem is not so simple. Television signals are amplitude modulated, and the effect of multipath is to add to the wanted carrier envelope a delayed envelope of the same signal. This results in an 'echo' seen on the screen as a displaced image.

In f.m. systems the delayed carrier has a different instantaneous frequency from the desired signal (although its centre frequency is the same). These two frequencies, simultaneously received, will beat in the receiver's mixer stage to produce an i.f. with added a.m. and phase modulation (p.m.) components at an instantaneous frequency of:

$$f_s = 1.41\delta f\ \sqrt{[1-\cos(2\pi Df_m/c)]}[\sin(2\pi f_m t)]$$

where f_s = instantaneous spurious frequency, δf = peak deviation, D = path difference and f_m = modulation frequency.

As can be seen, this is a frequency varying at twice the modulation rate between d.c. and an upper frequency. In the worst case when $D=c/2f_m=\lambda/2$, the upper frequency is $2\delta f$.

This can be considered as a frequency-modulated d.c. 'tone' with a deviation increasing with path difference and frequency, thus producing sidebands within the audio range, and also in the difference channel for stereo broadcasts. Furthermore, there will be one such series for every component of the modulating signal.

Stereo broadcasts are more susceptible because not only are the modulating frequencies involved higher, but every audio note in the difference channel is represented by two frequencies, 'mirrored' either side of 38kHz. Hence, twice as many spurious frequencies are produced by this channel. These signals need not be harmonically related to the audio tone.

For example, a 12kHz tone is represented by a 26kHz signal and a 50kHz signal. The second harmonic of 26kHz occurs at 52kHz which, after decoding, will yield 14kHz. If this tone also exists in the sum channel, side frequencies at 24kHz, 36kHz, and 48kHz will also possibly be produced, yielding 14, 2, and 10kHz respectively. Any attempt to cancel this distortion after demodulation using a delay line is clearly doomed to failure.

The a.m. component of the signal will be removed by amplitude limiting and balancing arrangements. However, the p.m. component is indistinguishable from the wanted signal. Indeed, p.m. is progressively used for frequencies above 3kHz in the broadcast signal as a result of pre-emphasis.

It might be possible to use a delay line to derive an a.f. control voltage for the local oscillator, thus cancelling the phase modulation. However, such an arrangement would be complex, and customer controls would be necessary to balance the system, since path difference is an important factor. Unfortunately, the distortion produced is not as easy to distinguish on normal programme material as is ghosting on television. Could the customer set up such controls?

K. J. Petrie
Romford
Essex

STORECASTING FOR SCHOOLS PROGRAMMES?

I would like to make a tentative suggestion regarding the use of v.h.f. by the BBC for school broadcasts, and this especially in view of Mr D. P. Leggatt's letter in the February issue.

School installations are normally somewhat more sophisticated than the simpler domestic set-up. This is especially true of the antenna connected to the receiver. Normally an excellent signal can be expected to reach the receiver terminals.

Such a situation ought to allow the use of 'storecasting' as permitted in the USA (FCC Rules and Regulations, para. 73.319 of 1964) for school broadcasts which would be inaudible to the normal listener. This subsidiary channel would be multiplexed on the main channel by the frequency modulation of a subcarrier in the 53-75 kHz range and be demodulated by a small addition to the school receiver. The fidelity and signal-to-noise ratio achievable ought to satisfy the requirements and all this at very little cost.

My suggestion is only tentative since I can hardly believe that the BBC did not investigate this way of achieving extra channels without disturbing the general listening public. It would be interesting to hear, at least, why this system is not being considered.

P. Hirschmann
Haifa
Israel

The BBC comments

Mr Hirschmann makes a sensible and well-informed suggestion. He is good enough to acknowledge that the BBC has probably investigated the possibility of 'storecasting' and such is indeed the case. We conducted a series of broadcast trials about five years ago, using some specially-produced 'storecasting' receivers and also assessing compatibility with a range of standard v.h.f. receivers.

The conclusions were clear. With any usable load of injection of the subsidiary channel (on a 67kHz subcarrier), impairment of monophonic programme on the main channel was just acceptable; but impairment of a stereophonic main channel programme could be grossly unacceptable. Furthermore, if impairment of a stereo main channel is to be minimised, the achievable quality of the subsidiary channel must be severely limited.

V.h.f. stereo receivers could, perhaps, be designed to avoid or reduce this incompatibility. Provision of a 'storecasting trap' is of little benefit, and it is such things as i.f. phase response, limiter and discriminator performance or symmetrical decoder switching which would need careful attention.

Summing up then, we could not adopt 'storecasting' without rendering many current v.h.f. receivers unusable, and the achievable quality of the subsidiary channel would be hardly adequate for educational broadcasting.

D. P. Leggatt
Head of Engineering Information
BBC, London W1

OSCILLATING CRYSTALS

I am pleased to see that 'Sixty Years Ago' is with us still, (May issue, p.60), especially as it drew my attention to an article I was unaware of. Ditcham's oscillating crystals seem to have been a flash in the pan, though attracting the interest of the famous H. J. Round (*Wireless World* 19 Aug 1925, p.217) and J. Scott-Taggart (*Wireless Weekly* 2 July 1924, p.280.) And by 1928 one could even buy a Russell's Wonder Oscillating Detector for two shillings (call it £2 in today's Mickey Mouse money) as advertised in *Wireless World*, 1 Feb 1928, p.28. Published static negative resistance characteristics seem to have been similar to those of a modern u.j.t. rather than a tunnel diode; and I lack any theoretical explanation of how this could arise in an essentially two-electrode device. Perhaps other readers can enlighten me.

Although Eccles worked on galena, and silicon was also used, the recommended material in the twenties was apparently a synthetic zinc oxide crystal, Arzinite. This was honey coloured, or perhaps pale yellow, and Captain Round found that his 'dealers will not give the source away'. The method of manufacture was an equally well-kept secret, though Nesper does say 'in elektrischen Lichtbogen gewonnen' (Der Radio Amateur 'Broadcasting', Springer, 1923).

I would be pleased to hear from someone who can throw further light on Arzinite or the Russell's Wonder, even though neither succeeded in fulfilling the prophesies of Ditcham quite as well as silicon has done.

Desmond Thackeray
University of Surrey
Guildford

ELECTRONIC IGNITION PROBLEMS

I read with interest the letter of Mr D. J. Bruyns in the March issue concerning the problems he has experienced with electronic ignition units.

I have also experienced many such problems with a homemade c-d ignition unit which I had fitted to my Fiat 127. The circuit I used was published many years ago in one of the popular electronics monthlies. This circuit uses a simple d.c.-d.c. converter and a resistor-capacitor-diode network to trigger the thyristor and to suppress contact bounce.

The original unit I had constructed worked first time with no problems until I made a mistake during testing in the car that caused the failure of the thyristor. This was replaced with a new identical unit but, alas, the ignition circuit simply was not the same again. It became almost impossible to start the engine and when successful it would misfire badly and run very roughly. I changed the thyristor again but no significant improvement was evident. After many efforts on the test bench I realised that the thyristor would latch on occasionally when triggered. Checks with an oscilloscope revealed that when the thyristor fired it would short effectively the inverter, causing it to oscillate at 25kHz with an output of a few volts instead of the usual 400 volts at 1kHz. Moreover the output waveform had rather sharp loading and trailing edges of short rise and fall times. A check on the gate with the 'scope indicated that there was enough of this waveform, normally present at the anode only, to trigger the thyristor.

I concluded therefore that this triggering signal leaked through from the anode to the gate via their internal leakage capacitance. A 0.01μF, 1000V capacitor from the anode to ground almost completely bypassed this waveform and cured the latching problem. Tests in the car showed much improvement but there was still a certain amount of misfiring which was objectionable especially at high speed. After more tests I realised that the 1kΩ resistor from the gate to ground in the original circuit was too large, permitting inherent electrical noise from the car to fire the thyristor at random. Replacing this resistor with 100Ω completely cured the problem and after the timing was adjusted the car ran perfectly.

I hope this letter will be of some help to Mr Bruyns.

N. Kyriazis
Limassol
Cyprus

DISPLACEMENT CURRENT

In their reply to my criticism in the April issue, p.77, Messrs Catt and Davidson and Dr Walton are challenging me to a defence. They mysteriously read out nonexistent statements from my letter. As an example, I never implied that D is displacement current. Nor did I state that there is an E-field in a perfect conductor. And my illustration clearly shows two different forms of displacement current, one in a capacitor and the other in a conducting wire.

The worst misconception by the authors occurs with reference to their meaningless derivation, eq. (1) to eq. (8). They invent a "world devoid of displacement current", but with a TEM wave. Indeed, freedom from displacement current is their postulate for the derivation. After a number of mathematical manipulations, they arrive at the striking result: "See, no displacement current". How *could* there be any when the postulating statement forbids it? Worse, right under their final equation, they claim no displacement current, not realizing that the r.h.s. i.e. $\epsilon(dE/dt)$ *is* displacement current. The authors perform the amazing feat of having and not having displacement current at one and the same time. They borrowed my eq. (1) to provide the starting point for their derivation, but the net result is that my equation remains correct.

The disturbing fact about the authors' reply is that they picked out various minor details for scrutinization, carefully staying away from any comments on the main message of my letter, which was that as a means for elimination of displacement current, *the author's contraption of a transmission line model is a failure!* Remember the title of the original paper in *Wireless World*, December 1978, p.81, "Displacement Current – and how to get rid of it". The message of my letter was that they failed to get rid of it. Their transmission-line model contraption just does not work, since the displacement current now appears in the model. The authors seem to agree about the failure of their model, because in the third paragraph of their reply they admit to the existence of dD/dt in a transmission line, with reference to the one shown in their Fig. 3. Twice, they back up their derivation by references to the July 1979 issue of *Wireless World*. Anyone still not convinced of the faiure of the attempt by Catt, Davidson, and Walton to get rid of displacement current would do well to read Dr Lago's excellent letter in that issue.

H. E. Stockman
Sercolab
Arlington,
Mass., USA.

For almost thirty years I have reluctantly accepted the concept of displacement current. When your contributors Catt, Davidson and Walton proposed an alternative theory I was impressed. Here at last was a concept that was intuitively acceptable. It did not occur to me then that this would cause controversy. It seemed that those who wished to stick to the displacement current theory could do so without dissent. It was after all only an idea thought up to explain a paradox, and the paradox most satisfactorily disappears if we accept the idea of energy current and treat the capacitor as a transmission line (I. Catt *et al*). The fierce defence of the displacement current concept has however convinced me of the importance of establishing a sound fundamental theory. The fact that so much energy is being expended in trying to prove the unprovable, with such scant regard for logic, is in itself thought-provoking.

One recent attempt in your journal to justify displacement current (August 1979) beats all. After a page of general discussion Professor Bell says in effect that if *Wireless World* readers believe in the existence of electromagnetic waves then Maxwell's equations must be true! Then, after stating Maxwell's equations, he says that the right-hand side of the fourth equation would be zero without displacement current. He carefully shuns the heresy that the current implicit in the term dE/dt could be something other than that exactly defined by the Great Prophet.

But I have now fallen into the trap of nit-picking about Professor Bell's interpretation of Maxwell's theories and this can only lead to fruitless argument. Let me end with a question. Who would ever invent such a contrived and artificial concept as displacement current if it were not a necessity? Thanks to Catt, Davidson and Walton it is no longer a necessity.

K. E. Wilkinson
Hertford
Herts

The author replies:

The first point to dispose of is Dr Walton's red herring of Aristotelian philosophers and *linear* motion (November letters). I mentioned early speculation about the planets because Newton's theory of gravitation was that the same force accounted for objects "falling" to earth (the notorious apple!) and for planets describing *closed orbits* about the sun. The theory of gravitation then involves the conceptual difficulty of action at a distance, unless one prefers to postulate fields of force or the "curved space" of general relativity. Incidentally Newton was *not* the first to suggest that a body in motion would so continue if undisturbed: Hobbes in his book *The Leviathan* mentions that it was a subject for discussion whether this be so or not, and himself unhesitatingly chose Newton's answer. The difference between them is that Newton formulated the precise law and "proved" it by incorporating it in his complete system of mechanics which was supported by experimental evidence.

Everyone tends to believe what he wants to believe (Mr Wilkinson refers to "a concept that was intuitively acceptable"), but scientists accept the *discipline* of two tests of new concepts:

(1) A theory should be consistent with all the known evidence.

(2) It should need the minimum number of supplementary hypotheses.

I do not believe that Maxwell's electromagnetic theory has ever been faulted on experimental evidence: the point at issue is that the concept of displacement current is so intellectually repugnant to some people that they refuse to accept it. Some other ideas of modern physics are also difficult: for example, "tunneling" as in the Josephson junction and the representation of the electron as a packet of waves which may extend over a considerable space.

Are all such theories of modern physics to be rejected because they are not "intuitively acceptable"? The second test must then be applied to whatever theory is proposed as an alternative to Maxwell's. Now I do not know what the "energy current" proposed as an alternative is (it surely cannot be defined by Poynting's vector, since that relies on Maxwell's theory of electromagnetism) but it would require some supplementary hypotheses to explain the electric and magnetic phenomena which accompany the supposed energy current. The most spectacular phenomenon is the production of an electric spark in air by a focused laser beam. Coming nearer home, the advantage of a loop aerial in the presence of some types of local interference (*Wireless World* July 1979) is predicted by the solution of Maxwell's equations. It is not an obvious result of a theory of energy current.

Turning to the issue of displacement current in capacitors (as distinct from radiation), the article by Joan Blomberg to which Dr Walton referred in his November letter is concerned with Maxwell's difficulties in arriving at a satisfactory definition of displacement current in *electrostatics* (without reference to electromagnetic radiation); and so it confirms my statement that displacement current was an inherent part of Maxwell's theory of electricity, not merely a device to complete a differential equation. As I stated in my article, others since have found it convenient or even essential in electrostatics.

Messrs Catt, Davidson and Walton stated that no-one had ever measured the inductance of a capacitor. Why, then, did we have non-inductive capacitors? There cannot be a magic dividing line in either frequency or electrode geometry between low-frequency capacitors which may be inductive and high-frequency capacitors which never have inductance. The use of a transmission line representation changes nothing because the equations for a transmission line are based on distributed *inductance* and *capacitance*. This approach has served very well, taking account of the dielectric, of electrode geometry, of losses in both and application to non-uniform transmission lines. There is no justification for departing from it.

To summarise, displacement current is not the only physical concept which is difficult to accept. Before logically rejecting it and everything that has been built upon it one would need a fully defined and comprehensive theory which had passed the two tests of scientific discipline.

Dr Walton commented that much of the content of my article can be found in any elementary text book on electromagnetism. Of course it can. The article was written on the supposition that there are many readers of Wireless World who have not studied such a book.

D. A. Bell

PROGRAMMABLE NOTES FOR KEYBOARD INSTRUMENTS

I was interested to see P. A. Tipping's suggestion (Letters, April 1980) for an interval keyboard. In the early sixties, with the help of a colleague (M. Bennett), I constructed a simple, experimental, electronic musical instrument using such a keyboard. Rather than providing a natural scale with full modulation capability, our aim was to provide a keyboard which reflected my belief that musicians play by intervals and not by notes. The design was, however, simplified by using a diatonic (7-note) scale, with stop switches to provide key changes, rather than to provide a full chromatic (12-note) scale.

The accompanying diagram shows the general arrangement of the initial design The organ proper consists of an emitter-coupled astable multivibrator tone generator, with the tuning capacitors switched by bipolar transistors used as bidirectional switches. (No doubt f.e.ts would be used today but we had to make do with OC71s). Dividers with switchable feedback provide true fourths and a two-octave range. The output amplifier is a simple Darlington-pair pulse amplifier (i.e. single-ended class-B, using an OC16). Attack and decay circuits, associated with the output gates, provide organ or piano-like (?) sounds.

The note emitted is determined by the state of the store/counter. This is driven by the pulser which uses a monostable controlled astable circuit to provide from 0 to 7 pulses, on depression of a key, in order to increment the counter by the desired number of notes to give the required interval. Negative intervals are provided by triggering the 'octave bistable' to give an octave drop in pitch, followed by incrementing the counter as required.

The astable keyer, provided to eliminate the effects of contact bounce, gives a semi-automatic action. Notes are of preset duration and intervals may be preselected by pressing a key any time during the preceding note. (Holding the +2nd key down produces a diatonic scale automatically.) This keyer proved troublesome and confused judgement of the interval keying system. It was replaced by a simple time-constant bounce suppressor.

The final design worked quite well but key contacts were not 100% reliable (as they have to be) and the need to release a key fully before depression of the next was a serious disadvantage. Further development aimed at eliminating these defects was never completed due to lack of spare time.

An incidental advantage of the interval keyboard is the ability to use a short keyboard to cover a wide pitch range. This was not exploited in our prototype, which used a two-octave keyboard to control a two-octave instrument, but consideration was given to providing a pseudo endless range by suitable harmonic mixing. (An interesting audio illusion.)

Some thought was given to the possible nature of a polyphonic instrument using an interval keyboard. One possibility is to relate all notes to the highest one being played. This, however, assumes that the top line always carries the melody: not always true in practice. A separate manual for each hand may be desirable. When the multiphonic organ design appeared (*W.W.* June 1973 and February 1980), it seemed to offer some potential for tackling the problem.

Returning to Mr Tipping's proposal, I wonder how his instrument would know which major second (or other ambiguous interval of the natural scale) to apply (see table). With this in mind, could it be that

	C	D	E	F	G	A	B	C
Freq. ratio		$\frac{9}{8}$	$\frac{10}{9}$	$\frac{16}{15}$	$\frac{9}{8}$	$\frac{10}{9}$	$\frac{9}{8}$	$\frac{16}{15}$
Reltve freq.	1	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{15}{8}$	2

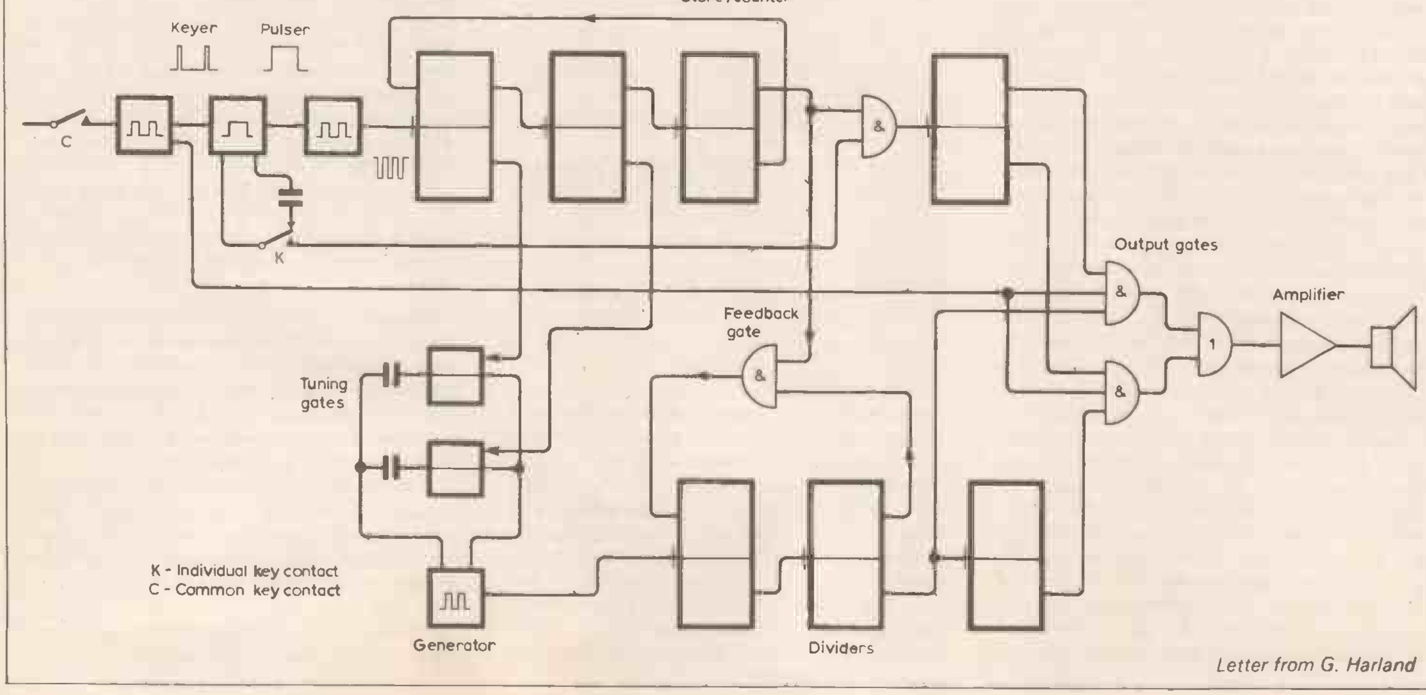
Messrs Robins (Letters, November 1979 and March 1980) and Tipping are attempting to solve the wrong problem or, at least, an intractable one? Perhaps what is needed is equal temperament for successive notes but just (natural) temperament of chords. This would give smooth harmonies, without difficulties in modulation from key to key. Maybe the multiphonic organ principle could also help with this problem. All tone generators could be pulled into exact harmonic synchronism with, say, the highest frequency one.

G. Harland
Barnet
Herts

DISTRESS FREQUENCY AT SEA

A. K. Tunnah, in letters, May issue, asks: "Is 500 kHz a suitable frequency for distress traffic at sea?" The answer to this question is yes, it is the *only* universally suitable frequency because it is the *only* frequency offering reliable ground wave transmission over a radius of several hundred miles 24 hours per day, yet still permitting the erection of reasonably efficient antennas in the space available onboard ship. Higher frequencies, even 2182kHz, are plagued by unpredictable problems of 'skip', particularly at dawn and dusk. It is not for nothing 500kHz was originally chosen.

On the coast of Mr Tunnah's Australia there is in operation a supplementary distress watch network on frequencies in the 4 and 6 MHz r/t service. It works in Australia, a special case, because skip or no skip, the



Letter from G. Harland

signal will be heard at *some* point on the coast and there is an efficient internal telex network, an organisation involving air and naval forces, the people speak one language If the vessel in distress, in the Third World for example, has only the nearest ship to rely on, then only 500kHz offers 24 hours per day reliable communication.

The Admiralty Handbook of Wireless Telegraphy, pre-war editions, has quite a lot to say about 500kHz antennas. It points out that (a) an aerial of small capacitance will operate at higher peak voltage, $V=I\sqrt{(L/C)}$ and (b) equivalent series leakage resistance $= 1/\omega^2C^2R$ approx., so that attenuation due to insulator leakage is *inversely* proportional to *frequency squared*, which explains why wet insulators cause worse problems at low frequencies than at high. There is the further complication that a wet insulator behaves not as a simple resistance, but as resistance and capacitance in series. (See my letter in the June/July issue.)

The fallacy, so popular with modern shipowners, that higher power will compensate for a poor antenna is at the root of many of the modern 'failure of distress signal' problems. The antenna of small capacitance has *less tolerance* to leakage.

Assuming insulator leakage of 100,000 ohms, then series equivalent leakage will be 4.05 ohms for a 500pF antenna, 16.2 ohms for a 250pF antenna and 45 ohms for a 150pF antenna, at 500kHz.

Shifting to some other distress frequency will simply mean exchanging one set of problems for another. The solution to the problems at 500kHz is to be found with more thoughtful aerial design, fewer insulators, better shielding, more antenna capacitance. All that is necessary to know can be found in old text books, as far back as the first world war. The origins of good antenna design have simply been forgotten.

John Wiseman
London E3

I read with interest the letters published on this subject, starting with that in June 1978 by J. Wiseman, followed by R. Philpot in November 1978, P.C. Gregory in March 1979 and A. K. Tunnah in May 1980.

By summarizing the problems of the aerial system in use on ships for the 500kHz distress frequency, I came to the conclusion that it could be that the wrong aerial system is used. During severe gale conditions at sea, the ship, the feed-through insulator and the aerial are coated with a film of salt water, representing a low impedanced short circuit for the transmitter and pi-coupler system. In such conditions the atmosphere surrounding the vessel and its antenna represents a poor dielectric. The antenna, much shorter than a quarter wavelength, acts as a high impedance capacitive load and even the feed-through insulator has to be a high impedance point in the circuit. Due to the contradiction between the low impedance gale conditions and the high impedance optimal circuit conditions, millions of tonnage is lost while no radio calls are heard.

The solution to the problem in my opinion is to use a low impedance inductive small loop antenna for the 410-516 kHz band. No dielectric losses or low impedance short circuit effect will appear, due to the very low loop impedance. By using a 90° phase network and two loop aerials an almost circular radiation pattern can be obtained.

Last year I did some research on these unshielded small loops, and although the radiation resistance is very low it ought to be possible with proper engineering to design a matching network and antenna construction.

R. R. Venekamp
Eindhoven
Holland

SCIENTIFIC COMPUTER NEWSLETTER

I should like to take the opportunity of thanking *Wireless World* and, in particular Mr Mike Sagin, for the assistance in publicising the newsletter on the Scientific Computer and for the helpful advice on setting it up (see May issue, p.40).

I should also like to thank John Adams for his splendid effort in virtually filling the first edition with three articles – on future developments, a 32K r.a.m., line printer, etc. The second article deals with some of the various problems which have cropped up from time to time during the building and use of the Comp 80 and suggests remedies. The third article is the first of a series on the Mark III firmware. The first part of the article deals with the specification; later articles will deal with this firmware in detail together with more information on the computer itself.

Should any readers wish to receive copies of this newsletter, which is issued monthly, please send a remittance of £5 (one year's subscription) to the editor of the newsletter, P. L. Probetts, 50 Cromwell Road, Wimbledon, London SW19 8LZ, England.

Philip L. Probetts
London SW19

WHAT'S SO NATURAL ABOUT e?

One appearance of e, as the logarithm, which Mr Finlay (December, February, April) does not mention, and which I have not seen mentioned elsewhere, is of some topical interest. The analysis was carried out some time ago, in more stable times, but the conclusions are probably still valid.

If we take the income statistics, which are published annually, and plot the number of people in a unit income band against the logarithm of income we find that we have a normal distribution. In practice the statistics are presented in such a way that we must plot percentage of population below *I* against log *I*. The result, on probability paper, is a surprising fit to a straight line.

What are the conclusions which we can draw?

The first arises from the appearance of the logarithm of e. We *feel* our pay packet. We perceive it as we perceive brightness, loudness, even age. There is a limen for an increase, there is a ratio judgement against our fellows: I am worth 10% more than you, but I agree he is 15% better than me. The absolute difference, so forcibly peddled by some populists, is nonsense.

Just as interesting is the appearance of the probability functions. In statistical quality control we know that this implies a number of independent random causes. There is no one reason why you do your job for your pay. One colleague of mine, in an important research unit, once said we were there because we could not afford labs of our own. I did not know how to do anything else: X and Y were there because father put them there. A multiplicity of random causes.

Politicians, usually innumerate and often illiterate, have yet to realize that, in the words of a Greiter axiom: If things are found to be functionally related, there is probably a functional relation between them.

O. Greiter
London W8

My attention has been drawn by Mr Dennis Lovely to the books by Martin Gardner, culled from *Scientific American*. Like *Wireless World*, this magazine has a very lively, intelligent and well-informed readership, so that when a problem is presented to them they will respond, more often than not, with interesting, diverse and sometimes unexpected answers.

In 'Mathematical Puzzles and Diversions' (originally published by Penguin) there are recorded several mnemonics for expressing the value of 'e', contributed by various readers:

(1) To express e remember to memorize a sentence to simplify this.
(2) To disrupt a playroom is commonly a practice of children.
(3) By omnibus I travelled to Brooklyn.
(4) It enables a numskull to memorize a quantity of numerals.

Noting that the value of 'e' to 11 figures is 2.7182818284, it is easy to see how the above sentences help out. *Wireless World* unfortunately does not fit into the pattern but here is a sentence that does:

(5) In Britain a football is circular, a snowball is anyshape.

I am sure that *W.W.* readers will not be outdone in improving upon these gems.

John C. Finlay
Sunderland
Tyne & Wear

LIQUID-STATE AMPLIFIER

The letter from B. Whatcott in your March issue prompts me to ask what became of Solions? If I remember correctly, these had some publicity in the early 1960s and were a kind of electrolytic triode.

I kept an eye open for further information and possible applications for Solions, but they seemed to fade away. Maybe my reading was not consistent or wide enough and I missed later news of them.

I would be grateful if any of your readers could give me references to or recent information on Solions.

W. J. Grant
"Fairlands", Finchmead Lane
Stroud
Petersfield, Hants

GENERATING THREE PHASES

It would be a pity if the cheapness and availability of i.cs meant that older, simpler and efficient circuits were forgotten.

A three stage RC-coupled amplifier with identical stages, back coupled to its input, produces a very good sinusoidal three-phase output. Even if only one phase is required it is still a useful circuit for the generation of very low frequences.

F. M. Colebrook describes such a circuit due to Van der Pol in *Wireless World* February 8th 1935.

E. V. Hurran
Margate
Kent

WORLD OF AMATEUR RADIO

Broadband solid-state transmitters

Recent contacts with K6PWP Los Angeles, JA6JYM Fukuoka, JG1YLX Tokyo, SP9ATE Skawina, LA20D Oslo, OH6GN Finland and several other stations have underlined what looks like becoming the trend of the early 'eighties: all were using Japanese h.f. transceivers of 'all-solid-state' design such as the FT301, FT7, TS120V, TS120S etc, with input powers from about 10 to 100 watts.

The h.f. transmitter/transceiver has been the last item of amateur equipment (apart from the add-on high-power 'linear') to adopt the solid-state approach. It was only in 1974-75 that Heath marketed the SB104, the first medium-power h.f. transceiver to feature a broad-band, transistor output stage. Yet today one senses that the long popular 'hybrid' designs are already in retreat.

Several factors are encouraging this trend (though the vast majority of amateur transmissions continue to come from thermionic power amplifiers): the taming of bipolar r.f. bipolar power transistors by the use of emitter resistors; the recent development of 100-watt broad-band amplifiers using push-pull v-m.o.s. power f.e.ts (not yet in commercial designs); and especially the broadband facility to change band without having to re-tune the final amplifier. A recent poll of users of one of the most popular hybrid transceivers listed the "tune up time and use of valve final amplifier" as the "worst feature" in the eyes of 23.4 per cent of users, even though "ease of operation" (in other respects) was regarded as the "best feature" by 27.9 per cent of users.

Another reason why r.f. power transistors, once regarded as the world's fastest "fuse", are becoming the popular choice is the increasing worry of purchasers about the future availability of valve replacements at reasonable prices. The long lifetimes of much existing equipment is under threat less from reasons of performance than from this form of scarcity obsolesence.

E-m-e and satellite news

Although terrestrial distances have little significance in comparison with the total earth-moon-earth path lengths, the Banningham E-M-E Group (operators include James Keeler, G4EZN, Nick Whyborn, G4JNX and Richard Newstead, G3CWI) believe that a new "world record" for moonbounce was established on April 18 when their 30ft dish aerial (illuminated at 16ft to provide maximum gain) located near Aylsham, Norfolk made contact on 432MHz with Graham Alderson, ZL3AAD at Christchurch, New Zealand.

The group has so far been unable to obtain a 1kW permit for experimental work and power was limited to 150 watts d.c. input. Front-end receiver amplifier uses a Gasfet (Alpha 1000) with a noise factor less than 0.5dB. The aerial at ZL3AAD consists of 16 WoEYE-type Yagi arrays with 1kW transmitter input. Contact was made at the first attempt (ZL3AAD's signals peaking 4-5dB above noise) during a period of closest approach of the moon. The group made e-m-e contacts with all continents in two nights of operation.

The present aerial was erected primarily for reception with initial sun tests measuring about 15dB. A larger aerial, with diameter approaching 50ft, is planned at the same site.

The write-off of the first, German-built, Phase 3A Oscar satellite in the abortive Ariane LO-2 launch on May 23 has underlined the financial problems in maintaining from voluntary contributions the ambitious Amsat programme. Dr Karl Meinzer, DJ4ZC, initiator of the Phase 3A project, is reported by Amsat-UK as saying: "The project has suffered a great set-back but is not dead. The knowledge learned during the development work can be applied unaltered to further satellites. The material is partly to hand, our present problem is to find a suitable starting possibility." The various national Amsat organisations have launched an appeal on behalf of an Amsat-International fund.

Band scan

The first two-way 50MHz contact between amateurs in Europe and Japan is believed to have taken place on April 10 at 0012GMT between ZB2BL in Gibraltar and JA1BK with propagation over the "long-path" across South America, representing a great-circle distance of some 17,000 miles. Subsequently, the Gibraltar station contacted several other Japanese 50MHz stations during a 30-minute opening. Although the level of sunspot activity has declined fairly sharply and is now below predictions, the 50MHz north-south path remained open at least until mid-April, with South African beacon stations heard in the south of England almost daily.

A 144.830MHz beacon station, 9H1VHF, has been installed at Rabat, Malta with continuous operation (1.5 watts to an omnidirectional aerial). A 28MHz beacon transmitter has now reached the British Antarctic Survey Headquarters and is currently being tested. The 3B8MS beacon on Mauritius has been re-activated on 28.210MHz. A 28.280MHz beacon, YV5AYV, located at Caracas, Venezuela has been built and supplied by the German society DARC.

Amateurs have learned with regret of the death of Dr John Saxton, the only person in the post-war period to have been twice elected president of the RSGB.

GA8AAA proposal dropped

One of the minor tragedies of amateur radio in recent years has been the breaching of the conventions surrounding international prefixes, etc. — notably by the American FCC which has largely destroyed the "district" identification feature of American call-signs as well as confusing the position in US overseas territories.

In the UK for many years distinctive prefixes have been available for Scotland (GM), Wales (GW), etc. but leaving all British amateurs with their own "figure-letters" callsign. This convenient system was not followed by the Home Office for "special" exhibition, repeater calls with the prefix GB which is used anywhere in the British Isles with 'call-letters' already issued to other amateurs.

The Home Office appears to have come very close to abandoning the traditional system altogether in initially proposing to use the sequence GA8AAA when, shortly, the Class B licences reach G8ZZZ.

However, fortunately, this plan has been changed and callsigns for Class B licences will soon be in the G6AAA series, permitting the retention of the traditional country prefixes.

The total of UK amateur licences now exceeds 28,000 representing a doubling of the number in the past 12 years.

In brief

Solar activity rose to a peak on May 25 exceeded in Cycle 21 only in November 1979 which now clearly appears to represent sunspot maximum . . . The West German national society, DARC, has awarded Roy Stevens, G2BVN their "Goldene Ehrennaded" award for outstanding services to amateur radio . . . Miss Diane Parker, G8VVV, recently became the 25,000th current member of the RSGB . . . King Juan Carlos of Spain holds the amateur callsign EAoJC . . . Arthur Collins, WoCXX, founder of Collins Radio at Cedar Rapids in the early 1930s is to receive an Electronic Industries Association (USA) "Medal of Honour".

PAT HAWKER, G3VA

Miniature, ten-line telephone exchange

Small relays give low power, quietness and secrecy

by L. D. Gunn

With the better availability of dial telephones now on the market several articles have been published in various magazines with the object of improving their utility. Some articles have given circuitry which uses uniselectors to establish connexions between up to 23 telephones, and others have used integrated-circuit modules for selective ringing systems. The disadvantages of using uniselectors are the high power requirement and the mechanical noise, while designs using integrated circuits use a common speech path, which does not give secrecy to the established conversation. The system described overcomes these objections by using miniature relays, which are fairly easily obtainable from surplus stores at reasonable prices.

There are four elements to the system. The Call Sensor identifies the calling line and provides for it a discrete circuit to the Transmission Feed, which supplies the telephones with power for their microphones. It also monitors the progress of a call and relays information to the Control, which sequences the system according to information received from the transmission feed. The fourth element is the Binary Counter, which consists of a group of relays which count the dialled pulses from the caller to select the wanted line, and provide a discrete path from it to the transmission feed, which also supplies ringing current for the a.c. bell until the handset is lifted.

When the system is in the normal state all the lines are connected to the call sensor via the contacts of two relays in the control. When a call is originated, the call sensor identifies the calling line and provides a discrete connexion from it to the transmission feed, which then tells the control that a call is about to mature. The control disconnects all the lines from the call sensor and prepares a path for the dial pulses to be transferred from the transmission feed to the binary counter. When dialling is completed, the control connects ringing current to the wanted line, via the transmission feed and the appropriate contacts of the binary counter relays. The ringing current is interrupted periodically by a transistorized timing circuit in the control, since continuous ringing would be very irritating. When the called telephone is answered, the transmission feed signals to the control that the ringing current can be disconnected. The speech path is then established. The control holds all the appropriate relays operated until both telephones are replaced on their rests.

Circuit operation

Originating calls sensor. The circuit consists of six relays and twenty-one diodes. Two of the relays, BC and BD connect the four sensing relays, CA, CB, CC and CC, to the lines via diodes which are coded so that different combinations of the sensing relays operate when a telephone is lifted to make a call. The relays are operated in accordance with Table 1 and their contacts are arranged to provide a path for one line to connect with the transmission feed relay A. One contact on each of the sensing relays is used to hold the relay operated under the control of the transmission feed and control elements.

Transmission feed. This comprises the three relays, A, D and FC. Relay A supplies current to the calling telephone and responds to the pulses generated by the dial of the telephone. D provides current to the called telephone, in addition to controlling the disconnexion of the ringing current when it is answered. Relay A operates when the circuit of the telephone is extended to the transmission feed on the path set up by the call sensor. The make contact of A1 operates relay B in the control. Soon afterwards (about 20 milliseconds) the caller will hear dialling tone and may commence dialling. Relay A responds to the pulses from the dial, its break contact sending pulses to the control to indicate that dialling is in progress, and via the control to the binary counter to select the wanted line. At the make contact of A1, pulses are sent to the B relay to hold it operated (it is slow to release by virtue of the shunt capacitor) whilst dialling is taking place.

Control. This is a group of four relays B, ON, C and BB and, as mentioned above, relay B operates when a call is detected and the calling line is connected to the transmission feed. Contact B1 provides a holding path for the call sensor relays, operates relay C via contact ON1 normal and energizes relay BB. Contact B2 prepares a path for the operation of relay ON when the first dial pulse is received and also prepares a path for passing the dialled pulses to the binary counter. Relay C operating at contact C1 completes the path for passing the dialled pulses to the binary counter and for holding relay C operated during the dial pulsing. Con-

Fig. 2 (over page). Complete circuit diagram of the exchange. Resistors of 200Ω in series with A and D relays are 1W; 100Ω resistors across B and C relays are ½W; all rest are ¼ types.

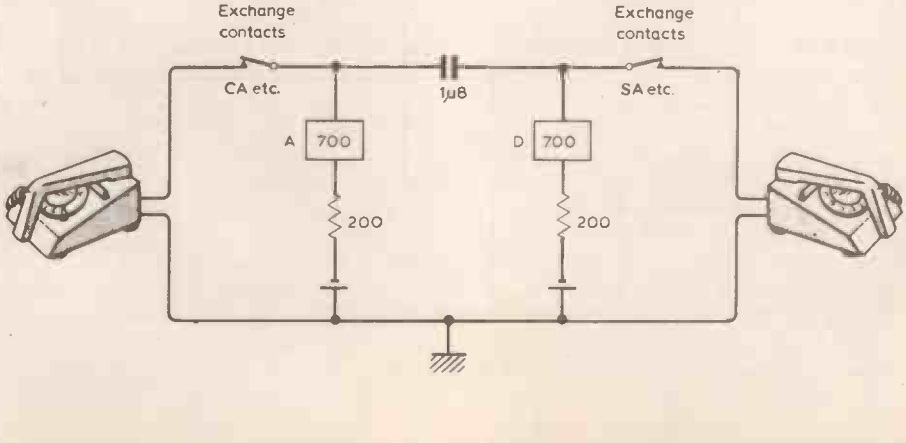
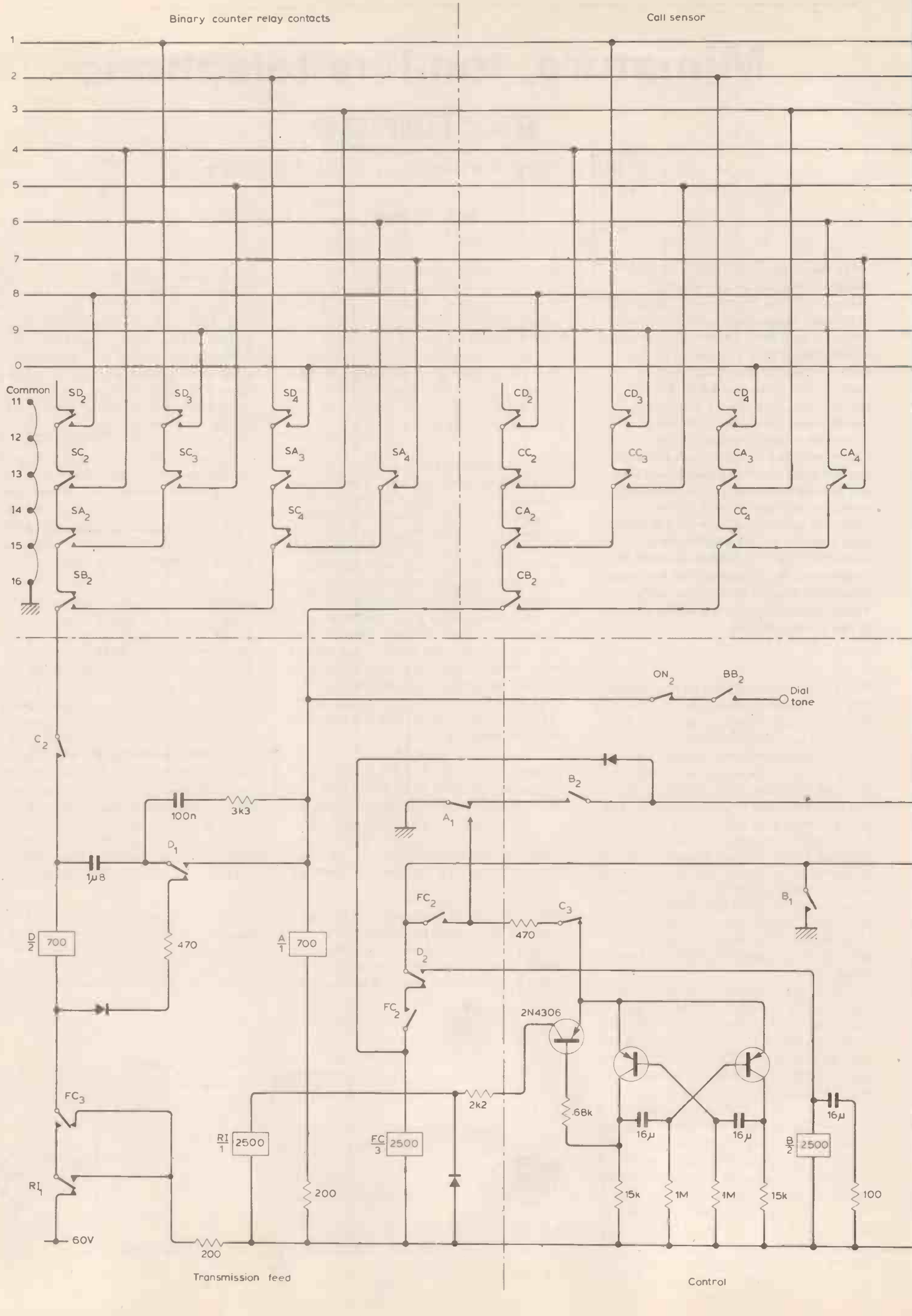
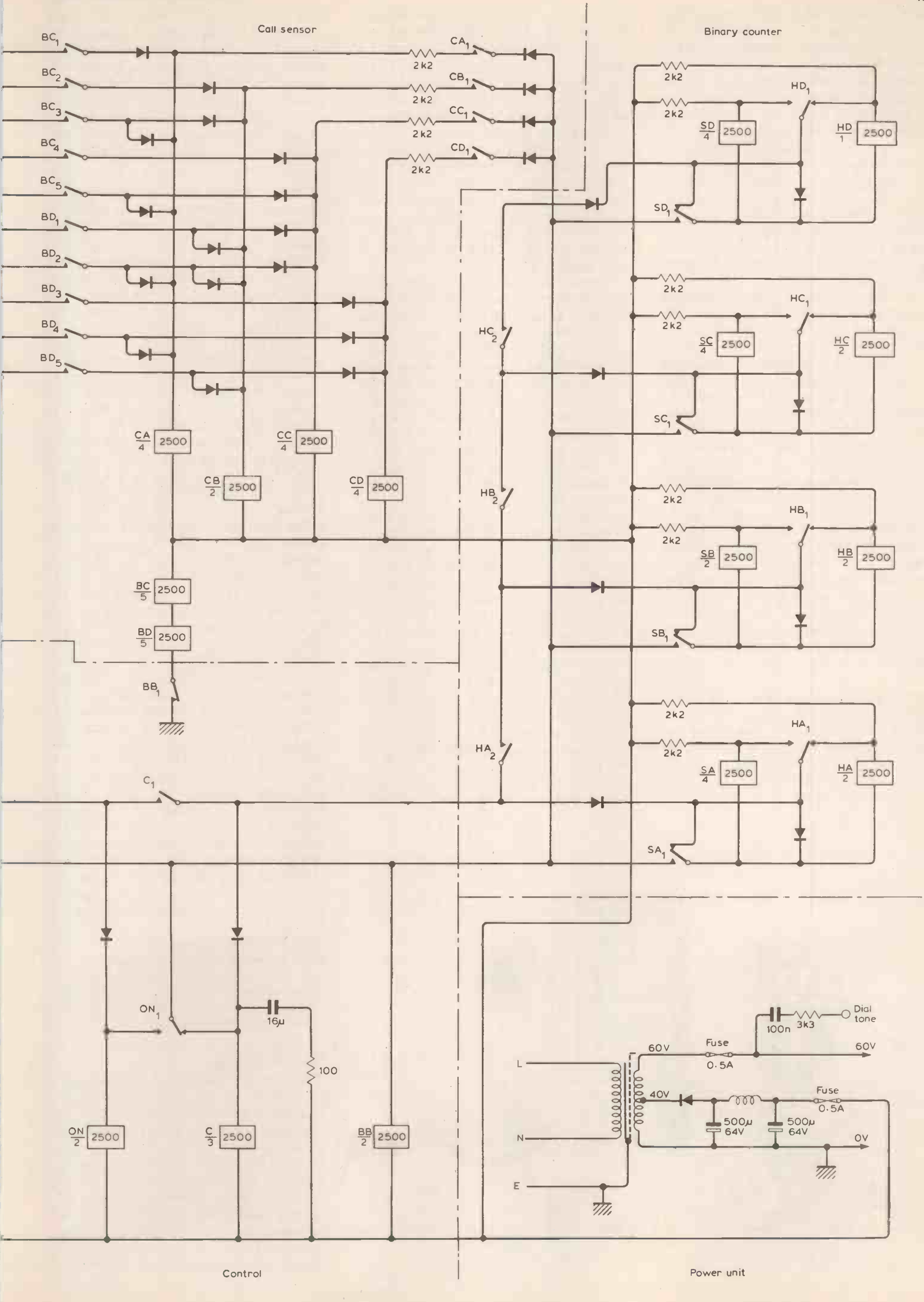


Fig. 1. Divided-feed transmission dridge. Power is fed separately to each telephone, thus eliminating problems which arise with a single-feed system when long and short lines are connected.


Binary counter relay contacts
Call sensor
1
2
3
4
5
6
7
8
9
0
Common
11
12
13
14
15
16
SD2
SC2
SA2
SB2
SD3
SC3
SD4
SA3
SC4
SA4
CD2
CC2
CA2
CB2
CD3
CC3
CD4
CA3
CC4
CA4
ON2
BB2
Dial tone
C2
100n
3k3
D1
1µ8
B2
A1
B1
FC2
C3
470
D/2 700
470
A/1 700
D2
FC2
2N4306
68k
16µ
16µ
16µ
FC3
RI1
2k2
RI/1 2500
FC/3 2500
B/2 2500
200
15k
1M
1M
15k
100
60V
200
Transmission feed
Control


Call sensor
Binary counter
Control
Power unit
2k2
2500
Dial tone
100n
3k3
60V
Fuse
0.5A
40V
500μ 64V
0V
16μ
100
L
N
E

tact C2 disconnects the transmission feed from the binary counter contact 'tree' to prevent bells tinkling whilst the counter is selecting the wanted line. Contact C3 delays the start of the ringing interrupter circuit until dialling is completed. Relay BB, operating at contact BB1, disconnects the operating path for relays BC and BD in the originating call sensor, thus causing them to release and disconnect all the lines from that element to prevent interruption by another telephone. Contact BB2 connects the ringing supply to the calling line through a leak path consisting of a resistor and capacitor to provide the 'dialling tone'.

At this stage dialling takes place and pulses are sent from the A1 break contact to contact B2 and via contact C1 to the binary counter. The first pulse operates relay ON in the control and relay FC in the transmission feed. Relay ON operating at contact ON1 breaks the original operating path for the C relay, which still holds due to the resistive/capacitive shunt and the pulses via contacts B2 and C1. Contact ON1 holds relay ON operated via contact B1. Contact ON2 disconnects the dialling tone.

At the end of dialling, relay A in the transmission feed remains operated and holds the B relay operated via the make contact of A1. The break contact of A1 remains open and after a short time (about 150 milliseconds) relay C releases. Contact C1 disconnects the holding path for relay C and the path for extending the pulses into the binary counter. Any further pulsing cannot then affect the setting of the counter. Contact C2 connects the selected line to the transmission feed D relay coil which, by the operation of contact FC3 has been connected to ringing current via the ringing interrupter RI1; the bell of the wanted line is now rung. Contact C3 completes the circuit for the ringing interrupter which uses three transistors and relay RI in a resistive/capacitive timing circuit, the time constant of which can be made to suit the constructor's preference. (The circuitry shown gives a ringing pulse of about two seconds and a silent period of about four seconds.)

The first dial pulse received energizes relay FC in the transmission feed, which provides a holding path for itself via contact FC1 to the break contact D2. Contact FC2 completes the circuit for the operation of the ringing interrupter unit, and FC3 disconnects the d.c. supply from the D relay coil, providing a circuit to contact RI1 which controls the ringing and silent periods. The coil of relay D in the transmission feed is shunted by a diode, in series with a resistor and a capacitor, whilst the ringing current is sent to line. This arrangement prevents the D relay from being energized by the ringing current, but permits its operation through the d.c. path via the called telephone when it is answered. When the call is answered, relay D operates: contact D1 disconnects the shunt from the D coil and completes the speech path between the two telephones. Contact D2 releases relay FC and completes a holding path for relay B. Contact FC1 disconnects the holding path of relay FC and prevents it from re-operating during the call. Contact FC3 restores the d.c. supply to the D relay coil and contact FC2 disconnects the ringing interrupter circuit.

When a call is finished, both telephones are replaced on their rests and relays A and D release. In turn, relay B releases and contact B1 releases relays ON and BB in addition to all the relays which were operated in the originating call sensor and the binary counter. Contact BB1 completes a circuit for relays BC and BD, which operate and re-connect the lines to the originating call sensor in readiness for the next call.

Photograph shows one form of the exchange, built in case measuring 10×4½×3in. Order of relays shown: top pair — D,A; second row — B,C,ON,FC,RI; third row — BB,HD,HC,HB,HA; fourth row — BC,SD,SC,SB,SA; — bottom row — BD,CD,CC,CB,CA.

Binary counter. Four pairs of relays are wired as flip-flops. The left-hand, or 'S' relay of each pair operates at the beginning of a pulse and the 'H' relays operate at the end. Contact B1 in the control provides a holding path for all the relays once they are operated. Diodes are used to mask the transients of the change-over contacts.

The start of the first pulse is caused by the release of the A relay in the transmission feed. The earth potential from contact A1 normal is connected, via contacts B2 and C1 operated and SA1 normal, to the coil of relay SA, which operates. The breaking of contact SA1 is masked by the diode D. The make contact of SA1 connects relay SA to the main earth via contact B1 in the control. During this time the coil of relay HA is short-circuited via contact HA1, thus preventing relay HA from operating whilst the pulse persists. The diode D prevents this short-circuit from being maintained from the holding path of relay SA when the pulse ends. When the A relay re-operates at the end of the pulse, the short-circuit is removed from the relay HA coil by the opening of the A1 contact, and relay HA operates. Contact HA2 connects the pulse to the next pair of relays, SB and HB. Contact HA1 switches the circuit so that the next pulse not only operates SB of the next pair of relays but short-circuits relay SA which releases, whilst a holding path, initially via diode D, is maintained to hold relay HA operated until the end of the pulse. At the end of the pulse, the holding path for relay HA is disconnected at contact A1 and relay HA releases. At the same time, relay HB operates, since the coil is no longer short-circuited when the pulse finishes. Relay HA releasing disconnects the pulse from relays SB and HB so that the third pulse is effective only upon the pair of relays SA and HA. The fourth pulse operates relays SC and HC and releases SA, HA, SB and HB. The full sequence is set out in Table 2.

Power supply

The power requirement depends entirely upon the relays used for the system, bearing in mind that the line current for a telephone should lie between the limits of 30-100 mA. In the systems made by the writer, a mains transformer was used which gives a secondary output tapped at 0-24-30-40-48-60 V. The 0V tag is grounded and the 40V tap is taken to a silicon diode of 1A rating to give the d.c. supply which is smoothed conventionally with two capacitors, 500μF, 64V,

Table 1 — Relay combinations in line sensor

Calling line	Relays operated	Calling line	Relays operated
1	CA	6	CB, CC
2	CB	7	CA, CB, CC
3	CA, CB	8	CD
4	CC	9	CA, CD
5	CA, CC	0	CB, CD

Table 2 — Relay combinations in binary counter

Called line	Relays operated	Called line	Relays operated
1	SA,HA	6	SB,HB,SC,HC
2	SB,HC	7	SA,HA,SB,HB,SC,HC
3	SA,HA,SB,HB	8	SD,HD
4	SC,HC	9	SA,HA,SD,HD
5	SA,HA,DC,HC	0	SB,HB,SD,HD

wkg., and an inductor of around 150 ohms d.c. resistance. The 60V tap is used for the ringing current supply: 75V would be preferable for ringing normal telephone bells and it may be found necessary to adjust some bells to perform adequately on 60V, 50Hz.

With the system as described, working on approximately 50V, the maximum current drawn from the power supply is just over 250mA. The highest value will be drawn when a call is made from a line operating two of the call sensor relays on line 7, which requires the operation of three pairs of relays in the binary counter.

The system should operate satisfactorily with lines up to 600 ohms loop resistance and is ideal therefore for use on large estates or farms.

The capacitors shunting the B and C relay coils and those in the ringing interrupter circuit are electrolytic, 64V working. It is important that those shunting the relay coils do so in series with 100 ohm resistors in order to prevent heavy sparking at the A1 relay contacts. All other capacitors must be non-electrolytic.

The relays BC and BD are permanently operated when the system is not in use in order that there is a small load on the power supply which prevents peak voltages from damaging the smoothing capacitors in the power supply. The current drain is only about 10 mA.

With different relays, the system can be adapted to operate on 24V, but this would reduce the line length over which transmission would be satisfactory. However, at least 60V a.c. is required for ringing nevertheless.

Installation

In the original models made by the author, a sixteen-way terminal strip was used for terminating the leads from the call sensor and binary counter relays. The first ten connexions were used for the lines and the remaining six were used as a 'ground' common. One wire from each telephone is connected to the appropriate numbered terminal and the other is connected to one of the 'ground' terminals. It is preferable to use two wires from each telephone back to the exchange, particularly if the lines are long. Overhearing and noise is likely to arise if a single wire is used with a ground return via a water pipe. Under no circumstances should a 'mains' earth be used.

Components list

Relays:	18, 2500Ω, 4 changeover	all relays other than those below.
	2, 2500Ω, 6 make	relays BC and BD.
	2, 700Ω, 2 change-over	relays A and D.

Suitable types are made by Plessey, Thorn, Varley and Siemens-Halske.

Capacitors:	2 0.1μ non-electrolytic	250V dial and ringing tones.
	1 1.8μ non-electrolytic	250V speech path.
	2 16.0μ electrolytic	64V shunts for relays B and C to give slow release feature.
	2 500.0μ electrolytic	64V smoothing — power supply.
	2 16.0μ electrolytic	50V ringing interrupter circuit.
Resistors:	12 2200 ¼W	call sensor and binary counter.
	2 3300 ¼W	dial and ringing tones.
	2 470 ¼W	D relay shunt. Feed to ringing interrupter circuit.
	2 15k ¼W	ringing interrupter circuit.
	2 1M ¼W	ringing interrupter circuit.
	1 68k ¼W	ringing interrupter circuit.
	2 200 1W	series with A and D relays
	2 100½W	shunts of B and C relays.
Diodes:	42 30mA, 100V	any fast switching silicon type.
	1 1000mA 150V	ITT BY135 or similar.

Mains transformer: 1 Type 124 Barrie Electronics, London EC3N 1BJ.
Coke: small output transformer — use primary winding not more than 200 ohms resistance.
Transistors: 3 2N4036 p-n-p silicon, ringing interrupter timer and relay driver.
Terminal strip: 16 way; any type available to the constructor which will provide for ten lines and adequate capacity for the common leads.
Case: The aluminium case used in the example shown in the photograph is 10×4.5×3in, but other examples have been constructed to fit into cases 8×6×2.5in. □

Literature Received

Technical information booklet from Mullard is entitled "Applications of **field-effect transistors**". Use of f.e.ts in several roles is discussed, from d.c. amplifiers to f.m. front ends, with practical circuit details. Publication is obtainable from Mullard Ltd, Mullard House, Torrington Place, London WC1E 7HD. WW 401

Leaflet giving a quick look at Newmarket's capabilities in **thick-film modules** can be had from Newmarket Transistors Ltd, Exning Road, Newmarket, Suffolk CB8 0AU. WW 402

Switching regulator design, with particular reference to filter design, is discussed in Application Note 349 from Fairchild Camera and Instrument Ltd, 230 High Street, Potter's Bar, Herts. EN6 5BU. WW 403

Lead-oxide **camera tubes** (Leddicons) made by EEV are listed and tabulated in a brochure, which recommends tubes for every known colour camera in all applications. It is produced by English Electric Valve Company Ltd, Waterhouse Lane, Chelmsford, Essex CM1 2QU. WW 404

Vero have published a catalogue containing descriptions (but no prices) of their range of **cases, wiring systems and hardware** accessories for the amateur. The S100 bus system is included. The catalogue can be obtained from Vero Electronics Ltd, Industrial Estate, Chandler's Ford, Eastleigh, Hants, SO5 3ZR at 50p.

A range of low-frequency (up to 2MHz) digital **storage oscilloscopes** made by the American firm Nicolet is described in a booklet, which can be obtained from Nicolet Instruments Ltd, Budbrooke Road, Warwick CV34 5XH. WW 405

Catalogue of components, accessories and systems from Transam, the Triton **microcomputer** people, is obtainable at 50p from Transam, 12 Chapel Street, London NW1 5DH.

Wire-wound **precision resistors** are listed in several ways by Hamlin in a new selection chart, which can be had from Hamlin Electronics Europe Ltd, Diss, Norfolk IP22 3AY. WW 406

Instrument cases and accessories, tools, components and instruments for the amateur are fully described in a new cataloque from West Hyde Developments Ltd, Unit 9, Park Street Industrial Estate, Aylesbury, Bucks, HP20 1ET. WW 407

CIRCUIT IDEAS

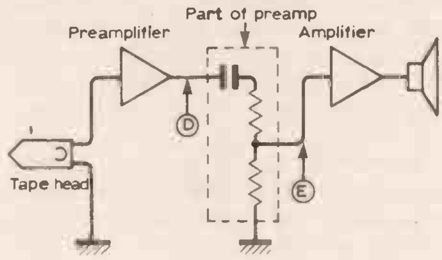
Automatic turn-off for cassette motor

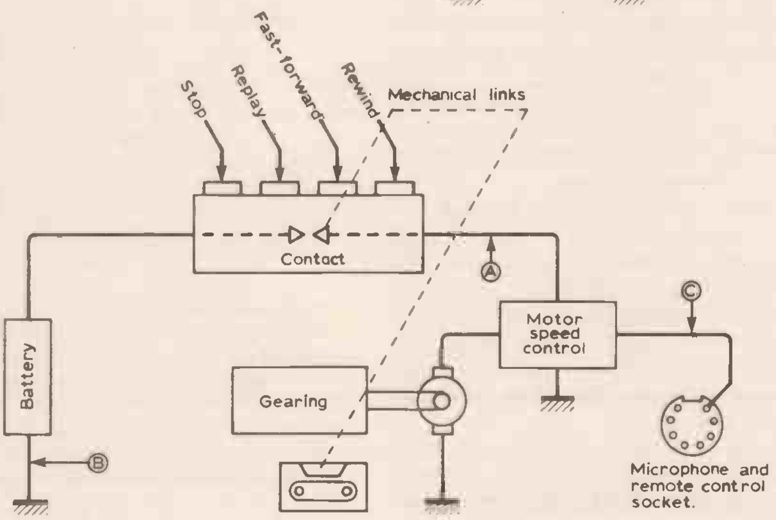
Many domestic cassette recorders do not have an automatic stop mechanism on replay, but use a friction clutch so that the motor can keep running at the end of a tape without causing damage to the motor or drive mechanism. However, this system does not protect the tape because the revolving capstan wears the tape at each end.

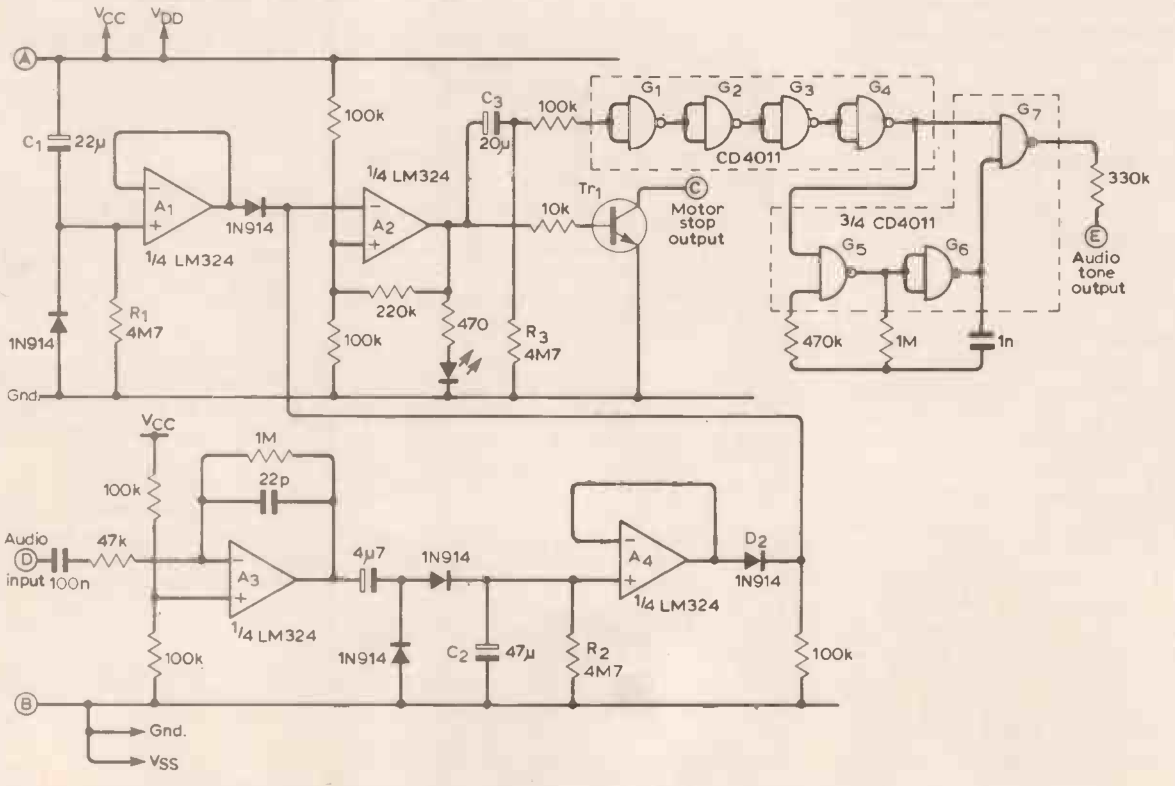
This circuit is easy to fit because, apart from an optional l.e.d., there are no mechanical changes, additions or modifications, and connexion is via five wires with T joins, so that no breaks have to be made. Points A and B supply power to the tape-end circuit only when required, and point A also detects a positive edge when the motor starts. Connexion C is the output from the tape-end circuit which connects to the remote motor-stop line, and point D feeds an audio signal to the circuit when the tape is playing. The final connexion at E feeds an audio tone to the cassette recorder and must be placed after D. There must be no feedback from E to D because this could cause the tape-end circuit to be activated by its own audio signal.

When the motor starts, the positive edge at A is differentiated by C_1R_1 and the signal from A_1 holds the output of A_2 at 0V, which turns Tr_1 off and allows the motor to remain running. The time constant maintains this state for 80s, which allows the tape to completely wind or rewind and, when replay is selected, the delay ensures that the motor runs for long enough to produce an audio input at D. When this input occurs, the output of A_3 is rectified, buffered and ORed with the decaying output from A_1. Therefore, the motor will run provided an audio signal is present at D. Short breaks in the audio are ignored because the time constant C_2R_2 prevents the voltage at A_2 from falling below the threshold for approximately 60s. When this period elapses after the end of a tape, the l.e.d. and Tr_1 are turned on and the motor stops. The output of A_2 also triggers a one-minute monostable formed by C_3R_3 and a 4011 whose output turns on an audio oscillator and gates the output to point E. This tone sounds for one minute and is then turned off by C_3R_3.

M. Holmes
Newbury
Berks



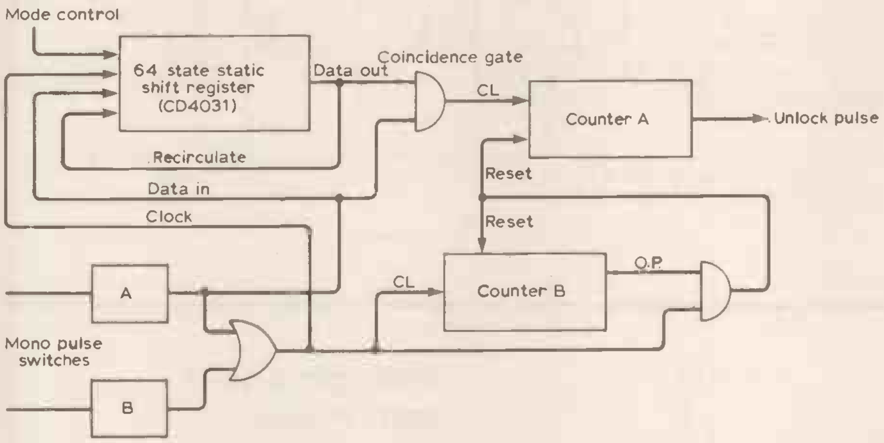




Economic electronic lock

Electronic locks generally compromise between complexity and security. This simple design does not require a keyboard and offers high security. A 64-stage static shift-register stores a code by switching the mode-control input low and feeding 1s and 0s to the shift register via switches A and B respectively. To produce an unlock-pulse, this code has to be repeated. The coincidence gate clocks counter A provided that the unlocking code agrees with the stored code, and counter B is simultaneously clocked by the switches. Counter B resets itself and resets counter A after the 65th clock pulse so, if the code is incorrectly entered, counter A is reset before an unlocking pulse is produced, and the code has to be repeated. If a complex code is not required, different counters and a shorter shift register can be used.

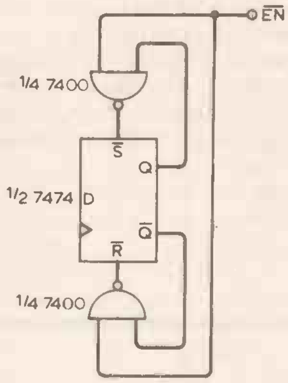
K. R. Srinivasa Murthy
Bangalore
India



D-type with enable

If a D-type flip-flop with enable is required, it is cheaper and often more convenient to use the circuit shown. When the $\overline{EN}$ line is high, the flip-flop is held in one state by the asynchronous $\overline{S}$, $\overline{R}$ line, and clock transitions have no effect. When the $\overline{EN}$ line is low, the flip-flop operates normally.

T. Clark
Trinity College
Cambridge



Accurate motor speed control

In this design the motor voltage-drop is the sum of the back e.m.f., V_b, and the voltage dropped across the internal armature resistance R_a. If the armature current is I_a,

$$V_x = I_a R_a + V_b$$

and

$$V_y = \frac{R_2}{R_2 + R_3} \cdot V_c + \frac{R_3}{R_2 + R_3} [V_b + I_a (R_a + R_1)]$$

Because

$$V_x = V_y, \; V_b = V_c + I_a [(R_a + R_1) R_3 - (R_2 + R_3) R_a]$$

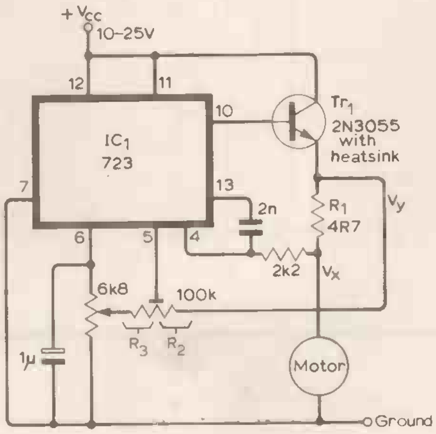
Therefore, if

$$\frac{R_2}{R_3} = \frac{R_1}{R_a}$$

$V_b = V_c$, so the back e.m.f. is always equal to the control voltage V_c, and the motor speed can be regulated with the potentiometer. The preset control is adjusted until the motor speed remains constant with different loads.

The circuit has been used with a domestic cassette recorder and has improved the motor performance with C120 tapes. Note that motor speed is not dependent on the supply voltage.

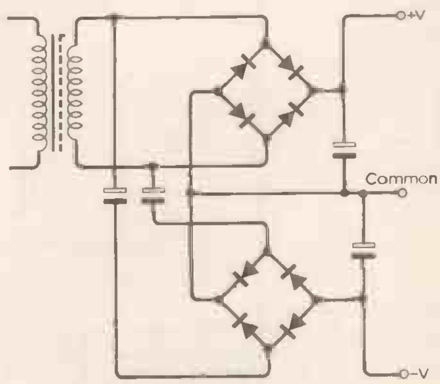
H. S. Malvar
University of Brazil



Dual supply

If a negative supply is required from a transformer which only has one secondary winding, a capacitor coupled bridge-rectifier provides a simple solution.

A. J. Strike
Norwich
Norfolk

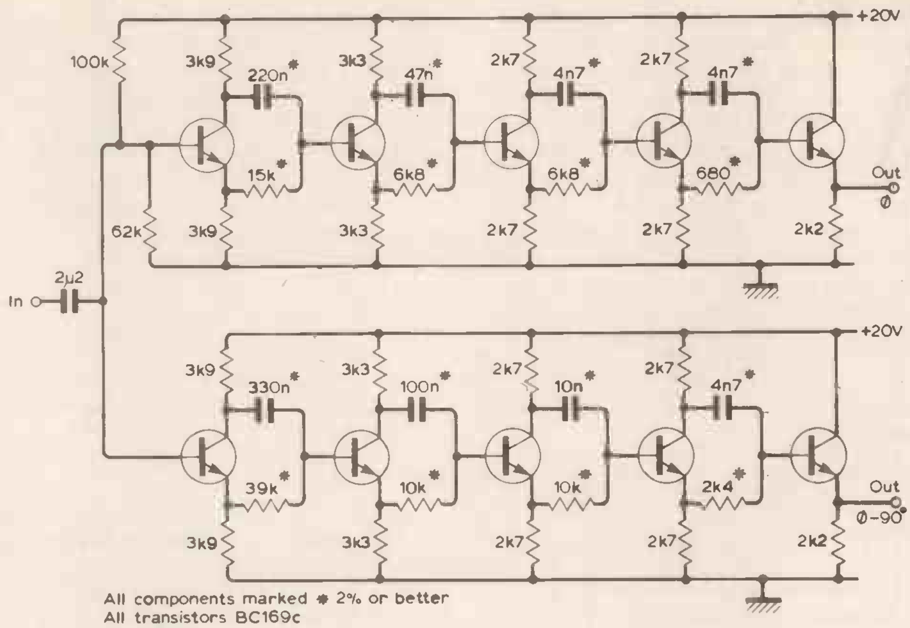


Wide band phase-shift network

When generating two signals in quadrature, most 90° phase-shift circuits produce errors of up to 10° and operate only over a limited audio bandwidth. The simplest phase-changing circuit is an all-pass filter. By connecting four all-pass filters in series, a linear phase-frequency relationship can be achieved over several octaves. Two such circuits connected in parallel and fed from a common source can produce a constant phase difference which is independent of frequency.

The circuit shown provides a phase-shift of 90° ± 5° from 23 Hz to 24 kHz. The critical components, denoted by asterisks, should be 2% or better and the transistors should have a h_{fe} of at least 400 to prevent loading. Overall gain of the circuit is unity, but the power supply must be adequately decoupled because the gain-bandwidth product is high.

C. J. Gibbins
Sunningdale
Berkshire

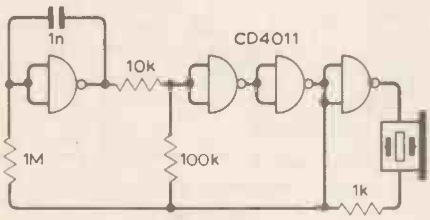


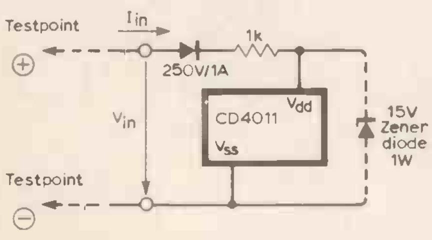
Acoustic level-indicator

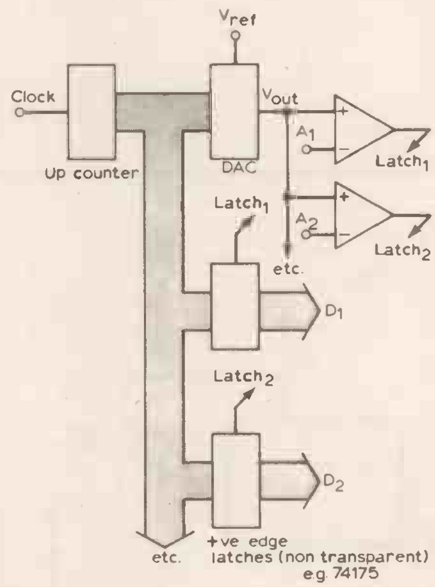
If the voltage at the testpoints exceeds 2.5V, the indicator oscillates at approximately 2kHz and drives a sounder. The indicator can be connected to the testpoint and positive rail for a logic high, or to the testpoint and negative rail for a logic low. The circuit will operate with input frequencies up to 10kHz, although the output signal is reduced with an input above 2kHz.

The current drawn by the circuit increases with voltage, but at 5V only 500 μA is required.

J. W. Richter
Backnang
W. Germany







Multiple a-to-d conversion

A single d-to-a converter can be used with several independent a-to-d converters as shown. The d.a.c. is continuously ramped upwards through its entire range and, when the output exceeds the input to a comparator, the associated digital word is stored in a latch. The number of comparators and latches is only limited by the drive capability of the converter and counter.

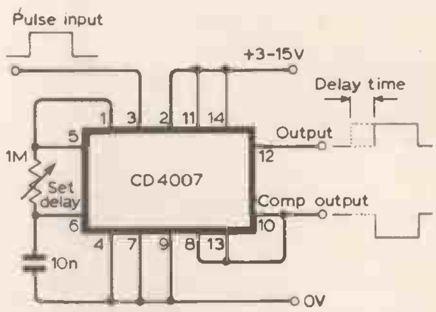
Gain and level shifting can be applied to the analogue inputs to provide a.d.cs with different ranges. Also, the comparator latch commands can operate sample-and-hold circuits at the inputs to signal Data Ready, and to inhibit further latching.

J. W. Rimmer
London

Pulse delay

Pulse delays from milliseconds to several seconds can be achieved with one i.c. provided that the delay time is less than the duration of the pulse.

M. Miller
Reading
Berks



Designing with microprocessors

3 — Microprocessor addressing modes

by D. Zissos and Laurelle Valân Department of Computer Science, University of Calgary, Canada

The previous two articles described the basic components of the microprocessor chip and the internal functioning of the device from the designer's point of view. The authors now continue with a concise description of the most commonly used microprocessor addressing modes, from the points of view of both the designer and the user.

In the previous article (June/July issue) we saw that the microprocessor operation consists of repeating cycles during which each instruction in a program is fetched from memory, executed, and succeeded. Clearly, the process of pulling out each byte of our instruction from memory and loading it into the microprocessor chip slows down considerably the execution of programs — the main drawback of microprocessor-based systems.

Different actions to speed up the response time of microprocessor-based systems have been taken by manufacturers, system designers and, to a lesser degree, by programmers.

In the case of manufacturers their main response has been to produce microprocessor chips, which, (a) can address external memory and peripherals more effectively, (b) can transfer more data between the microprocessor chip and the external circuitry (example: 16-bit machines), and (c) include more internal circuitry, such as registers, which reduces the need to access external memory.

The system designer can increase the response of microprocessor-based systems by imaginative use of present-day technology and design methods[2]. At this level the problem is one of effective management of the available resources, rather than detailed technical knowledge. This aspect is the main theme of these articles.

In the case of programmers, it is encouraging to detect an increasing level of awareness of the interplay that exists between hardware and software. For example, more programmers are now able to generate vectoring addresses in interrupt-driven systems using standard i.c. chips (priority encoders), instead of using the very slow and highly inefficient method of polling-and-testing each interrupt flag in turn[2].

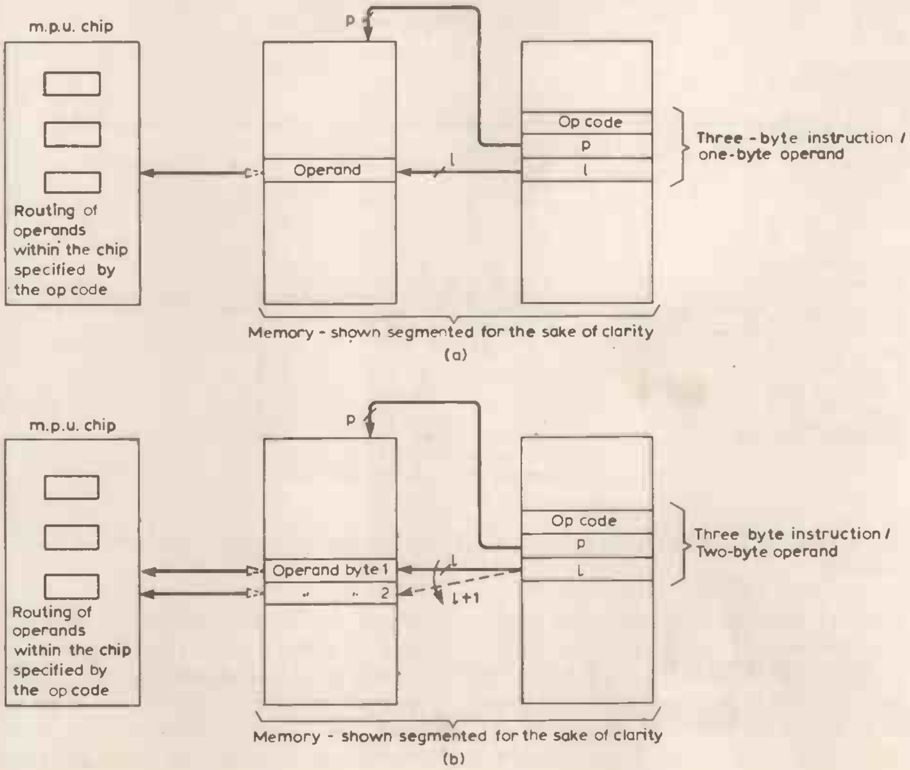


Fig. 1. Process of direct addressing, (a) for one-byte operand and (b) for a two-byte operand.

Addressing modes

Addressing modes in microprocessor-based systems refer to the methods used to generate the address signals for routing data within the microprocessor chip and through the system itself.

Because each microprocessor chip has its own set of addressing modes, in this article we shall describe the most commonly-used modes, which are

- Direct addressing,
- Indirect addressing,
- Indexed addressing,
- Relative addressing,
- Immediate addressing,
- Inherent addressing, and
- Implied addressing.

For the sake of simplicity we shall use eight-bit microprocessors with sixteen-bit address lines when describing the addressing modes.

Different manufacturers may use different terms to describe the same addressing mode. For example, what most manufacturers refer to as direct addressing is called extended addressing by Motorola.

Direct addressing

In **direct addressing** the memory of i/o is said to be directly addressed, which implies that the address of the operand is part of the instruction (bytes p and l), and appears explicity in written form, as shown in Figure 1(a). The reader will recall from the previous article that during machine cycle 1 the op code is pulled out of memory and loaded into the instruction register (i.r.) in the microprocessor chip. During machine cycle 2 the page number (upper half of the sixteen-bit address) is loaded into the appropriate section of the addressing register (r), also in the microprocessor chip. The line number is loaded similarly into the other section of register r during machine cycle 3. In machine cycle 4 the address of the operand, held in register r, is output on the system's address bus, and the operand is moved in the other direction.

In the case of a two-byte operand the value of l held in addressing register r is automatically incremented after byte 1 of the operand has been transferred.

A special form of direct addressing is provided on the 6800 microprocessor in addition to the normal type we described. In this mode, an address on page 0 is **privileged** in the sense that op codes are provided which load automatically '0' in the upper half of the addressing register (r), leaving only the l byte to be written explicitly. For example, the contents of accumulator A in the 6800 may be copied into memory location 0034_{hex} using one of the following two instructions.

- B7 00 34 — ordinary direct addressing, called **extended addressing** by the manufacturer.
- 97 34 — privileged direct addressing, called **direct addressing** by the manufacturer[1,3].

Indirect addressing

In **indirect addressing** the address of the operand (p and l) has to be taken either from a memory location (p_1 and l_1 in Fig. 2) defined in the instruction, or from an addressing register in the microprocessor specified in the op code as shown in Fig 3(a) and 3(b). The first mode is referred to as **memory indirect addressing** and the second mode as **register indirect addressing.**

In the case of two-byte operands the value of variable l (defining the line number of the operand) is automatically incremented after byte 1 of the operand has been transferred in or out of the microprocessor chip.

Indexed addressing

In **indexed addressing** the address of the operand, denoted by variables p and l, is generated by adding a number D, which follows the op code, to an index register, and outputting the sum onto the address bus, as shown in Fig. 4. That is, in indexed addressing the location of the operand is IX + D. Variable D, which can be either a positive or a negative number, expressed in twos complement (see Appendix), is referred to as **offset** or **displacement.** Note that the index register (i.x.), which is an addressing register* that can be incremented or decremented by software, is not affected by this operation.

Indexed instructions are particularly useful when we need to access consecutive locations in memory, for such operations as block transfers.

Relative addressing

In **relative addressing** the current value of the program counter, PC + 2, is incremented by the byte that follows the op code, denoted by variable R in Fig. 5. This clearly allows the program to jump from PC + 2 to PC + 2 + R. Variable R, as in the case of indexed addressing, can be either a positive or a negative number, expressed in two's complement (see Appendix).

The value of relative addressing is that it allows jumps to nearby locations to be implemented with two-byte instructions. For most programs, relative jumps are by far the most prevalent type of jump due to the proximity of related program segments. Thus, these instructions can significantly reduce memory space requirements. The signed displacement can range between

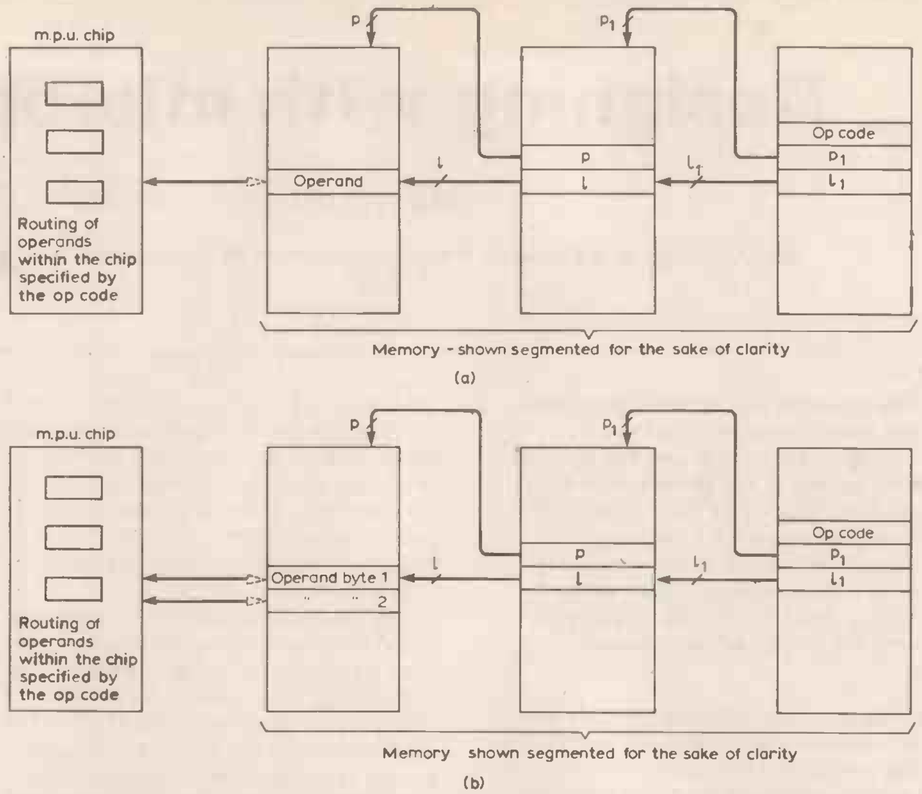


Fig. 2. Memory indirect addressing, (a) for a one-byte operand and (b) for two-byte operand.

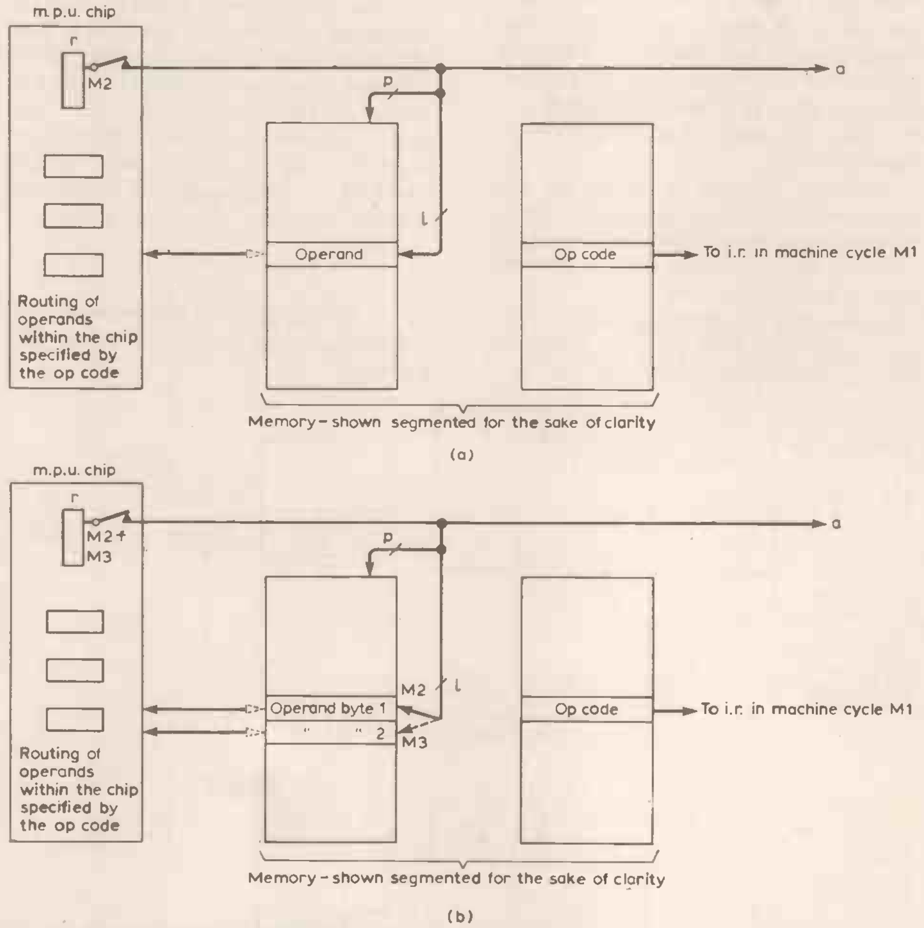


Fig. 3. Register indirect addressing, (a) for a one-byte operand and (b) for a two-byte operand.

*An internal register that can be connected to the address bus.

+127 and −128 from the jump relative op code address.

Immediate addressing

In **immediate addressing** the byte following the op code in memory contains the actual operand, as shown in Fig. 6(a). An application of this type of instruction would be to preset an internal register to a given value, where the value is the byte following the op code.

The operand in immediate addressing may contain two bytes, as shown in Fig. 6(b).

Inherent addressing

In **inherent addressing** the operand is embedded in the op code, as shown in Fig. 7. For example, in the 6800 microprocessor

01 $\boxed{00}$ 1111 (4F) increments accumulator A, whereas

01 $\boxed{01}$ 1111 (5F) increments accumulator B.

Instructions involving inherent addressing define operations that take place within the microprocessor chip, and are always single-byte instructions.

Implied addressing

Implied addressing refers to operations where the op code automatically implies one or more internal registers as containing the operands. An example of implied addressing is the set of arithmetic and logic operations in the Intel 8080, where the accumulator is always implied to be the destination of results.

Appendix: twos complement

The **twos complement** is a method of representing negative binary numbers. The twos complement of a binary number can be formed either by inverting each binary bit and adding 1 to it, or by using a scanning process as follows. Starting from the least significant digit, we copy each digit as it is up to and including the first '1' digit. The remainder digits are inverted.

The most significant (left-most) digit is a sign digit — '0' for positive and '1' for negative.

Examples

+5	0000 0101
−5	1111 1011
+84	0101 0100
−84	1010 1100

References

1. Duncan, F. G., "Microprocessor programming and software development," Prentice Hall, 1979.
2. Zissos, D., "System design with microprocessors," Academic Press, 1978.
3. M6800 microprocessor system design data, Motorola, 1976.

The next article will deal with the synchronization problem.

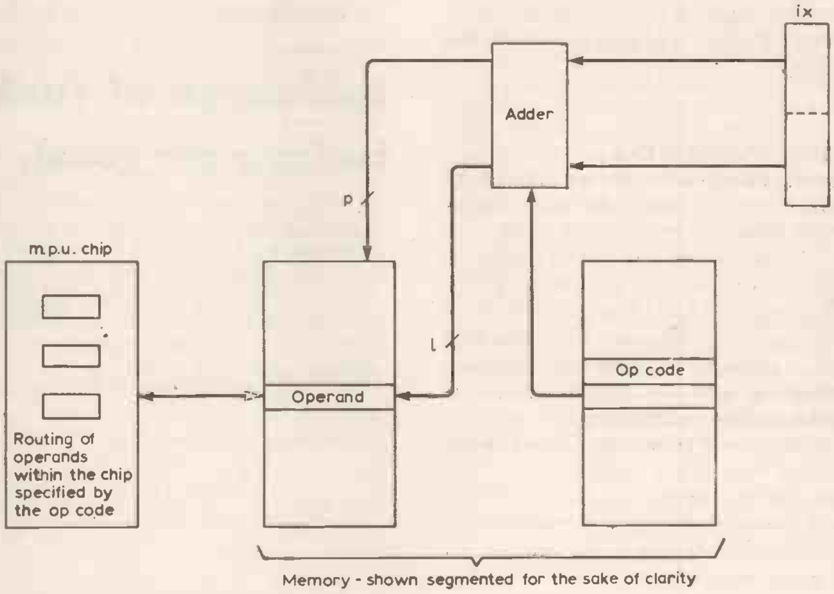


Fig. 4. Indexed addressing.

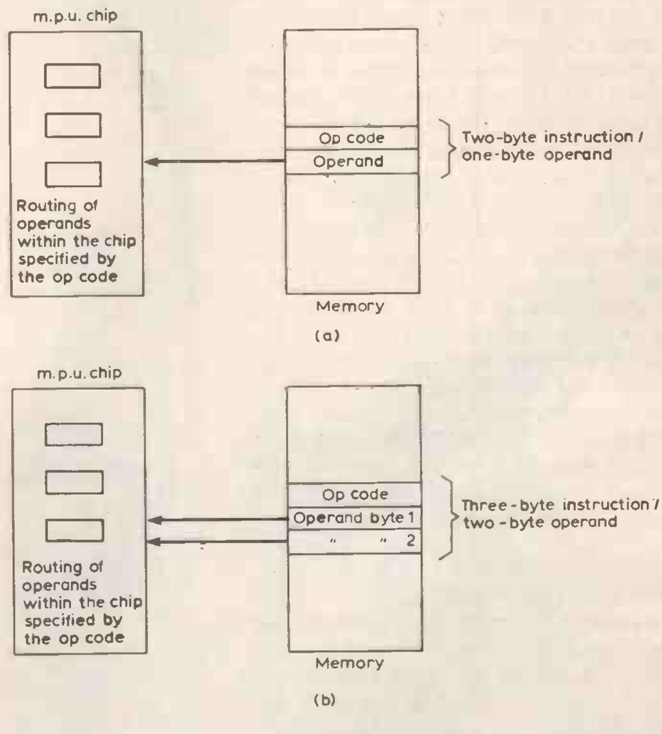


Fig. 6. Immediate addressing for (a) a one-byte operand and (b) for a two-byte operand.

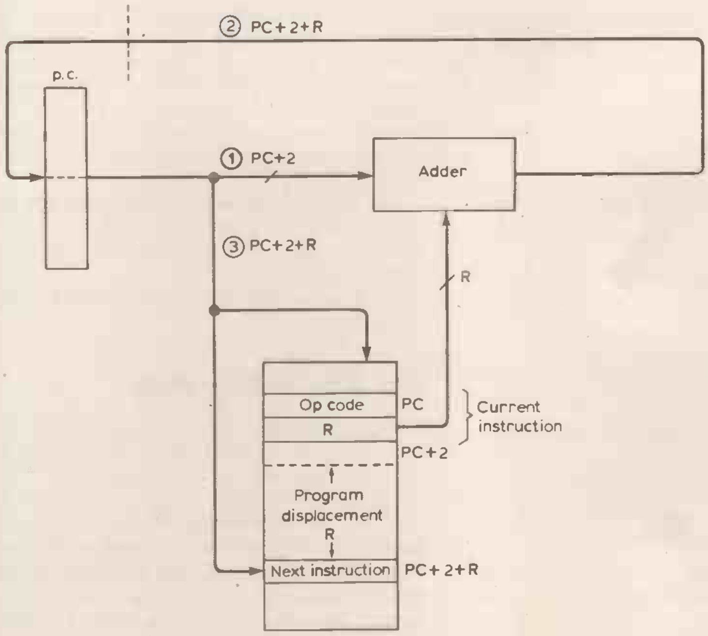


Fig. 5. Relative addressing.

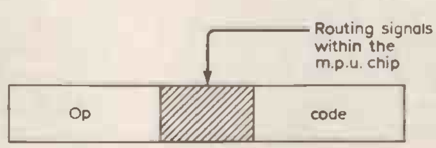


Fig. 7. Inherent addressing.

Largest slice of CAA's radar renewal contract goes to Dutch

A Dutch company, Hollandse Signaal Apparaten (HSA) has won a £10 million order from the Civil Aviation Authority to supply primary radars as a part of the authority's radar replacement programme, brought about by the need for compatibility with radar data processing systems, and systems currently being developed at the London Air Traffic Control centre.

The total cost of the programme is around £25 million, of which 30% will be met by the Ministry of Defence. A £2.5 million contract was placed with AEG Telefunken in 1979 for some of the required primary radars, the remainder (about 50% of the total workload) going to British companies, with a £1.1 million contract going to Cossor for secondary radars in 1979 and a £1.2 million contract for remote control and monitoring equipment going to Marconi Radar Systems earlier this year. A further £10 million-worth of contracts is still to be let covering buildings, radar towers, etc., and this is expected to be covered mainly by British firms.

The main reason HSA radars were chosen is their "advanced state of development", although the CAA also claims that other important requirements included technical performance and reliability. Similar equipment is already in service in Singapore and with NATO.

Frank Chorley, managing director of Plessey Electronic Systems, in a statement to *The Times* in January 1980, said that "short-term ordering decisions .... may threaten the future export prospects of British electronics companies." He said that the principal danger was that orders might be placed with foreign companies which would offer the cheapest immediate solution but which could damage the credibility of UK companies in export markets generally.

At the time Mr. Chorley made these remarks, the US company Westinghouse was expected to emerge with the contract for the major share of the work. The new primary radars will be sited at Heathrow Airport (to provide services for Airport Approach Control and Terminal Control) and at locations in Yorkshire, Lincolnshire, Essex and Sussex. The radar at the Yorkshire site will have the largest range, at 210 nautical miles and that at the Heathrow site with the smallest, at 80 nautical miles.

Delivery of new radars is expected to begin early in 1981, the replacement programme being scheduled for completion in 1983.

Exchange of radio messages just before air crash

A further statement on the Tenerife air crash of April 25th was made in the House of Commons on June 10 by John Knott, the Secretary of State for Trade. The statement results from meetings between the Accidents Investigation branch of the Department of Trade and the Spanish Commission of investigation, and it reads as follows:

"The Dan-Air accident at Tenerife on 25 April 1980. First radio contact with Tenerife Air Traffic Control was made by DA 1008 when it was 14 nautical miles from the VOR/DME* beacon TFN. The flight was then cleared "to the FP (radio beacon) via TFN, flight level 110, expect runway 12, no delay." Up to this time the flight had been without incident. Some three minutes later it was instructed to descend and maintain flight level 60.

The crew reported "overhead TFN" about 35 seconds after passing the facility — Air Traffic Control then informed them that "the standard holding over FP is inbound, heading 150°, turn to the left." This indicates an anticlockwise pattern. However, **this procedure was not published and was not included in the appropriate radio facility charts carried on the aircraft.** In spite of this, the instruction was accepted by the pilot.

The aircraft did not pass over the FP but flew to the South of the beacon calling "entering the hold" and passing abeam about a minute after the previous transmission. About half a minute later it was cleared to descend to 5,000 feet.

Although he had expressed his intention of entering the holding pattern, the Commander, for reasons which are not clear, turned the aircraft to the left (towards the South-east) into an area of high ground where the sector minimum safe altitude is 14,500 feet.

During the descent to 5,000 feet, the Ground Proximity Warning System operated, and the crew immediately commenced an overshoot procedure. With high engine power being applied, the aircraft was put into a steep turn to the right, but it struck the mountainside before it had climbed above 5,500 feet.

The radio navigational facilities at Tenerife North Airport were checked after the accident and were found to have been operating normally."

*V.h.f. omni-range/distance measuring equipment.

A 2.4 metre dish used by BBC engineers to receive experimental signals from OTS. The BBC hopes to be able to take up two of the five channels allocated for satellite broadcasting in Britain, one for pay television and the other to provide selected "best" programmes from BBC1 and BBC2.

Old firm fading away

Armstrong Audio, the well-known British stalwart of the audio industry (50 years old), is to go into voluntary liquidation. The company's managing director, Alex Grant, said that the availability of 600 series products in this country will not be affected. The 48 hour service and supply of spares for series 400/500 and 600 models will continue to operate from the company's North London premises in Warlters Road.

NEWS OF THE MONTH

Government stalls over Inmos and NEB "plays" with Ferranti

In a Commons statement in reply to questions about the future of Inmos, Industry Secretary Sir Keith Joseph said "I am conscious of public concern on this matter. It presents complex and difficult considerations. Proposals are being considered by the parties concerned but they are commercially confidential and there is nothing I can say about them at the present."

Only a week or so before this statement, Margaret Thatcher had said, referring to the second charge of £25 million due to be released to Inmos, that the Government was "carefully considering" the conditions attached to any money going to the company. The first payment of £25million had been made by the last Labour government as a part of NEB funding.

Sir Keith added to his statement by saying that "it would be imprudent for me to force upon the NEB taxpayers money at the same time as commercial interests are expressing interest in possibly replacing some of that money," clearly indicating that the government's stance is that of waiting for a positive move (initiated by the NEB) to private ownership of Inmos. Two American firms and a Belgian consortium are said to be interested in buying out the government's 70% holding in the venture.

Tory MP Timothy Renton had asked when Sir Keith proposed to announce his decision and suggested that the delay was causing damage to Inmos, its employees and British microelectronics as a whole.

Referring to a similar situation at Ferranti, Labour MP Robin Cooke urged the Prime Minister to ask the NEB to stop "playing football" with the future of the company. He said the proposal to dispose of the NEB's interest in the company has been rejected by the workforce and condemned by the management as being against the best interests of Ferranti. Cooke asked the question "Why, for the sake of a fast buck is she taking such a gamble with the future of high technology industry in Britain, which we need if we are to survive as a manufacturing nation?"

Mrs Thatcher replied, "The NEB helped Ferranti when it was in need. Ferranti no longer needs help through the NEB. It is for the board to dispose of the shares in the best way possible."

The truth is that in the past 5 years, Ferranti's health has improved out of all proportion. Last year, pre-tax profits were £9.9 million and are this year expected to show an improvement to £11 million. The company is heavily committed through its contracts, to the government's programme of defence spending and the consensus view is that it enjoys a technological lead in a range of defence activities and projects. It certainly has a healthy immediate future if only from the proceeds of equipment it will be supplying for the Tornado aircraft programme.

Workforce and management at Ferranti favour disposal of the NEB holding via the stock market, either as a complete deal or in various stages. However, the more attractive possibility (for the Government) is disposal to a single buyer due to the fact that this would provide an additional premium for the shares as the buyer would have to bid for the balance of the shares. Taking into consideration the bias of the company's military contracts with the government, foreign buyers seem to have been ruled out — the most likely interested party is therefore GEC, which creates a number of possible problems.

Takeover would mean "rationalization" and redundancies, not to mention competition for military contracts between major GEC subsidiaries and Ferranti itself.

The company's financial report, due the last week in June, may well harden some attitudes on both sides.

The 26 inch Philips viewdata receiver now being used by members in the House of Commons library. The set was presented by Mullard Ltd, who are now committed to heavy investment in i.cs for information systems. At the presentation ceremony, Ian Lloyd, MP, chairman of the all-party Information Technology Committee, stressed the need for the government to exploit the opportunities offered by viewdata — a major British invention.

Home Secretary shows more interest in company than person in data privacy exchange

The Data Protection Authority and other recommendations by the Lindop Committee, which finished its work about two years ago, was given only a nodding recognition by the Home Secretary in a recent exchange in the Commons. In written answers to questions, William Whitelaw said that he is still considering the results of consultations (which finished last year) and he asked MPs for instances where firms have encountered problems because of data privacy laws now operating in other countries.

Although Mr. Whitelaw said that he was conscious of the concern in industry, he did not give much attention to the concern of private citizens. The written answers were provided in response to the findings of a questionnaire conducted by the National Computing Centre, which showed that 90% of managers believe some form of regulation is needed to prevent the misuse of personal information held in computer data "banks". They also believe that the Lindop committee's principles and codes of practice form an "acceptable and practical" way of tackling the problem and 75% of managers said a government statement of intent is urgently needed.

There was a 90% majority for voluntary codes of practice if the Government fails to act.

Viewdata standards agreed

THE CCITT (International Consultative Committee on Telephones and Telegraphs) has recognised Prestel, the Post Office's public viewdata service, as meeting the requirements of the recommended international standard for information retrieval systems.

Study groups of the committee, meeting recently in Montreal, also approved Teletel, the French system, and laid down international viewdata standards. British Telecom, the PO organisation set up to market Prestel, has so far exported to four countries — West Germany, the Netherlands, Hong Kong and Switzerland.

One of the two study groups involved dealt with service aspects of each system and the other with technical aspects. Four types of viewdata system were recognised:

1 Alpha-mosaic, which produces characters and pictures from a mosaic of dots. This method is used by both Prestel and Teletel.
2 Alpha-geometric, a method of forming letters and pictures by drawing them geometrically. Canada's Telidon system is an example of this technique.
3 Alpha- d.r.c.s. (dynamically redefinable character set). This is a new British technique, which is also being adopted by France, allowing special purpose characters stored in the viewdata computer to be transferred to a second character generator in the terminal.
4 Alpha-photographic, used in "picture" Prestel to build up full colour photographs as part of the complete page; a wide-band version of this technique is used in Captains, the Japanese viewdata system which generates more than 3,000 Japanese characters in the central computer and then transmits them to the tv receiver over a telephone link.

The CCITT proposal for alpha-mosaic systems recommends two ways of providing control information. In one, the serial attribute technique (used by Prestel) injects information in the appropriate points in the text. In the other, parallel attribute technique, additional information is sent with each character (used in Teletel), adding to the data transmission requirement for a given page of information.

The alpha-mosaic recommendations are based upon the European 625-line standard, which gives a viewdata frame or page of 24 lines, with a maximum of 40 characters per line. The document tentatively suggests a 20-line frame for American 525-line tv, but makes no firm recommendations because of views held in Europe and the USA that a 24-line frame can be created for a 525-line tv system.

Hundreds of viewdata terminals which form a system called Topic by the contracting company C. W. Cameron, are to be installed at the London Stock Exchange and throughout its member firms. The contract is worth £500,000 and as well as being linked to the exchange's computer, the system can also be connected to Prestel. Each terminal will provide instant read-out of current stock fluctuations with blue figures showing an increase and red showing a decrease.

Nascom in danger—or is it?

In an announcement made on 23 May 1980, Nascom Microcomputers revealed that they had requested Grovewood Securities Ltd, to appoint a receiver. This move was taken after Grovewood's decision not to inject further capital into the company and efforts by Nascom's managing director, John Marshall, to secure alternative investment.

Nascom Microcomputers was founded in June 1978 following the launch of the Nascom 1 single board computer but the company is thought to have suffered from cashflow problems associated with the slow recovery of development costs and delays in component supply. An investment of £500,000 was received from Grovebell shortly after the launch of the Nascom-2, the packaged version of the System 80 which appeared in our May 1980 issue.

It was intended that the Nascom 2 would use a new memory chip (the MK4118) and within weeks of the computer's launch the company was advised that supply of the new chip would be seriously delayed. As a result, no Nascom 2s could be shipped even though the company had invested thousands of pounds in advertising and marketing, as well as hundreds of thousands in general stock which was to lie idle.

The situation was partially relieved by the decision to provide a 16K r.a.m. expansion board, thus eliminating the need for the MK4118 and April 1980 saw Nascom's most successful month since formation, with sales on target at £250,000.

More recently, a "rescue team" plan has been put forward by an interested Nascom user, John Margetts. He suggests the sale of 50p shares in blocks of 20 to both users and distributors in an attempt to buy Nascom from the Receiver.

If the company's distributors commit themselves to a large enough stake, it is just possible that the company might be saved, and Margetts is also attempting to mobilise the Nascom Microcomputer Club (based at Interface Components) which comprises about 18,000 members. Interested parties should contact John Margetts on 0242 511472.

Satellites detect vibrating stars

An explosion of a neutron star, occurring billions of miles from earth, was recorded by nine earth satellites, and produced the largest burst of gamma radiation yet observed.

It marked the first time that scientists have been able to trace a gamma ray burst to any known astronomical object and has provided evidence, for the first time, of a vibrating neutron star. Another significant point is that the vibrations could be a source of gravitational radiation previously only a theoretical possibility, mooted by Einstein.

The explosion was measured by devices aboard US, Soviet and US/German spacecraft on March 5 1979 and was reported on during a scientific colloquium at Nasa's Goddard centre on April 24 1980. A scientific paper on the event was also given at the spring meeting of the American Physical Society in Washington in May of this year.

The source of the March event was tracked by timing the triangulation to a decaying star ("supernova"), in the galaxy called the Large Magellanic Cloud. Scientists traced the burst to a supernova remnant identified as N-49 and the source of the gamma radiation is believed to be another neutron star lying inside the debris of N-49. A neutron star is so dense that a spoonful of material from the centre might weigh a billion tons.

Until this event, astronomers had merely speculated that such stars went through gigantic vibration episodes, explosively stretching outwards then just as violently snapping back towards their original shapes through the energy of external forces.

Einstein's theory of Relativity holds that such vibrations should emit gravitational radiation. This part of the theory appears to have been substantiated.

NEWS IN BRIEF

Crellon Electronics Ltd, of Slough, Berks, are now offering the Motorola MCM6665L25 64K dynamic r.a.m. as an off-the-shelf item. This particular device is a 65,536-bit r.a.m. using n-m.o.s. technology, and is supplied in a 16-pin ceramic package. For more information contact Crellon Electronics Ltd, 380, Bath Rd, Slough, Berks, or ring 062864300.

The Department of Industry has established the Technology Advisory Point (TAP), to "assist in making the expertise and facilities available from British R and D establishments more accessible to British industry." A single sheet brochure is available from the department; ring Orpington (0689) 72918 and ask for either Ian Melville or Dick Vance.

"Choosing and using microprocessor development systems" is the title of a two-day seminar being organized jointly by Sira Institute Ltd, and Era Technology Ltd. The aim of the seminar is that of providing information and practical experience on which to base the selection and use of microprocessor development systems. The programme is intended for senior engineers and engineering managers who already have some knowledge of microprocessors. The Seminar will be held at the London Press Centre, EC4 on 1 and 2 October 1980. Further enquiries should be made to Carol Meads, Sira Institute Ltd, South Hill, Chislehurst, Kent BR7 5EH, or telephone 01-467 2636.

The tenth European Microwave conference begins in Warsaw on 8th September 1980 and continues until 12 Sept. Information on hotel bookings and other details of the meeting are available from Promotor Services Ltd, 247, Regent St, London, W1.

An exhibition on Technical Education Methods and Aids is to be held at the West Centre Hotel in South West London between 28 and 30 April 1981. A programme of lectures and seminars, covering the major aspects of the education and training of engineers and technicians in both developing and industrialized countries, will run concurrently with the exhibition of technical teaching equipment, systems and related services. Contact Electrical and Electronic Fairs Lt, Wix Hill House, West Horsley, Surrey, KT24 6DZ.

Japanese set-makers beaten to second place by Thorn

A deal described by Thorn Consumer Electronics as "substantial" has been achieved by them in the face of strong competition from Japanese tv set producers. A Hong-Kong based company, Promoters Ltd, is being licensed by Thorn to assemble the TX9 single-board chassis in a joint venture factory in China. This chassis can be used for screen sizes between 14 and 22 ins and in common with the TX10 (for larger screen models) uses about 30% fewer components than the range of sets it replaced.

Thorn has undergone an extensive modernization programme, bringing it up to the manufacturing capabilities of many Japanese manufacturers. Robot production techniques have been introduced which the company says improve reliability quite dramatically and, coupled with ease of servicing, this factor is expected to give the technology considerable export potential. A manufacturing agreement worth £2.5million has already been finalized with Philco-Italian and a smaller agreement with a Scandinavian company is in the air.

First supplies of the new chassis kits will start from Thorn's Gosport factory in October.

Concept for 50 inch tv display

The basic concept for a 50 inch diagonal colour tv display for wall mounting was presented by RCA laboratories at the Society of Information Display conference in San Diego.

The conceived tv display consists of 40 modules, side by side, each with a height of 30 inches and a width of 1 inch. The three electron beams in each module are directed along "beam guides" until they are electrostatically deflected through 90° onto the red, green and blue phosphors. The point in the length of the module at which deflection occurs is determined by selection from a row of electrodes lying at right angles directly under the beams.

Dr. Tietjen, Staff Vice President at RCA laboratories believes that as far as brightness, energy requirements and manufacturing feasibility are concerned, this is the best approach, but says "While we are optimistic, we are by no means certain as to when all the problems facing us will be overcome. It will probably be closer to 1990 before such a flat-panel display can be manufactured at a price the consumer will be willing to pay."

Among the difficulties already encountered was that of achieving uniform brightness in each of the 40 modules, and circuits are now being developed to over come this problem. But so far, the RCA lab, scientists have only worked with black and white tv pictures with an experimental display consisting of five, one-inch modules, each ten inches high.

The colour technology planned for the flat-panel screen will be similar to that of the shadow-mask system, but the problems concerning the control of electron beams and manufacturing processes must be overcome before the work on the colour system can be realized.

'Colossus' inventor honoured

The first recipient of the new Martlesham Medal, to be presented annually to past and present British Telecom engineers for outstanding contributions to telecommunications, is Dr Tommy Flowers, perhaps best known for his development of Colossus, the computer used in World War II to break the German geheimschreiber cypher.

His work for the Post Office, when he joined in 1926, gave him an insight into electronic switching and formed a sound base for his war work at Dollis Hill, the predecessor to Martlesham, and subsequently at Bletchley Park, where he was involved with the Government Communication Headquarters and the Enigma operation. He developed the equipment needed to break the Enigma cypher quickly enough to be of use and received the M.B.E. for the work. Dr Flowers then went on to produce Colossus, which was certainly the first operational computer in the U.K., and possibly in the world: it was working two years before its American equivalent. The achievement of the Bletchley Park computer is all the more impressive when it is remembered that it was not only the first, with no previous experience to draw on, but that the only switching devices available were valves and neon tubes.

Dr Flowers remained with the G.P.O. until 1964, consolidating and greatly expanding his ideas on computers in communications, later leaving to join S.T.C. to work on switching systems. He is now retired, and is occupied with developing aids for the disabled.

PO opens world's first facsimile service

Intelpost is the name the Post Office has given to the electronic mail service it launched on June 17th. The service enables facsimile copies to be transmitted over vast distances by means of earth satellites, and although the first part of the service is restricted to message flow between London and Toronto, Canada, other links will be established later in the year.

The cost of the new service to the user is high — about £4 for an A4 size message to Toronto against 15 or 20p by traditional postal methods, although this level will clearly fall with increasing use. The central advantage is that of speed, each message taking only a few hours from sender to recipient, against several days by conventional letter post.

Home Office report on WARC '79 published

A report comprising 192 pages dealing in general with the World Administrative Radio Conference in Geneva in 1979 and in particular the revised versions of Article N1 (Terms and Definitions) and Article N7 (International Table of Frequency Allocations), has just been published by the Home Office, price £8.50 net.

Information covering Region 1 (Europe, Scandinavia and Africa) only was published in Wireless World in Feb. and March 1980 but this report provides the remainder of the allocation information covering Region 2 (the Americas and Greenland) and Region 3 (roughly, the USSR, India and Australasia).

The complete Final Acts of the Conference will be obtainable later in the year from the headquarters of the International Telecommunication Union in Geneva at a cost of 360 Swiss Francs.

The instrument being used here is the Redac "Cadet" p.c.b. designer, the complete system having been launched recently by Racal-Redac. It is a microprocessor-based system which the makers say is the first true example of computer-aided design in this field and at a "reasonable" price. This particular system costs £20,000.

Organ-stop control

Further developments

by **A. D. Ryder**, M.A., Ph.D., F.I.E.E.

Convenient and flexible control of stops is musically important to any organ, and electronic devices are increasingly used, particularly for control in groups or combinations. Some circuits and designs are described which may be equally useful for the construction of an electronic organ as published from October 1978 to March 1979, or the modernisation of a pipe organ.

In early organs, power and brilliance were achieved by using several pipes for each note, including pipes of different harmonically-related pitches, all of which sounded together. The idea of stopping-off some ranks seems to have come later. A stop was originally a multi-pole mechanical switch arranged as a sliding piece of wood under the pipes, with holes to block or admit the wind. The wooden switch was extended at one end to be more or less accessible to the player and, in modern mechanical organs, this construction is still used. A slider-type stop action is preferred by many organists, even though the organ may be electrically operated. A stop-switch with push-pull action is called a drawstop and one with an up-down action, as on a theatre organ, is known as a tab. The rank or group of pipes controlled by a stop is also called a stop, although it would be more logical to call it a go. Console switches control further switching within the organ, such as a solenoid-driven slider, or a relay, referred to here as stop-selection switching. Stops are segregated by departments, i.e. keyboards, although there is usually provision for coupling more than one department to one keyboard.

As a piece of music may call for frequent changes of loudness and timbre, which requires rapid manipulation of the stops for one or more departments, most organs of any size are provided with combination pistons at each keyboard. These are buttons for thumb operation, or toe pistons for the pedal department, and also general toe pistons for controlling all departments at once. In operation, each combination piston acts to set, or bring on, all those stops included in its combination, and reset the rest. Usually this is effected by actual movement of the console stop-switches, which are motorised by two electromagnets, set and reset. The abreviation TMS is used here for a motorised tab or drawstop, which are standard components, although they are relatively expensive.

Occasionally the combinations are built-in, but it is better for them to be selectable. A separate matrix of selector switches, p pistons × s stops, may be provided, but the capture method using the stops themselves is more convenient, saves space and, with semiconductor switching, is cheaper. A combination manually set up is allocated to a chosen piston by holding in a separate capture button and momentarily operating the piston. This switches the combination into a memory (originally electromagnetic) at the address determined by the piston and can thereafter be read out at will. One objection to the capture system is that there is no neutral option, as with selector switches with a third position, which allows a stop to be isolated from a combination and controlled independently by the player. This point is considered later.

Stop control can be extended by second-touch contacts which are operated by a heavier than normal finger pressure. On a tab, rather than a draw-stop, such contacts can be arranged to reset all tabs except the one pressed, leaving that stop as a solo, a facility known as second-touch cancelling (STC). On a departmental piston, ST contacts may be used in parallel with the pistons of another department, in particular to change pedal combinations at the same time as those of the great manual.

Other types of piston used with motorised stops are cancel, departmental and general, and reversible (RP) Reversible types have push-on push-off switching and are usually provided for the more important couplers which, although not strictly stops, are treated as such on the console to bring them under thumb or toe control. There are some advantages in including couplers within the combination system, but this is not universal practice.

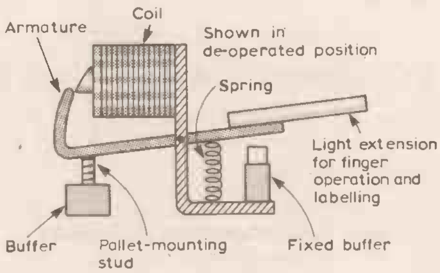


Fig. 1 Pallet-magnet with finger-tab extension. The contacts are not shown.

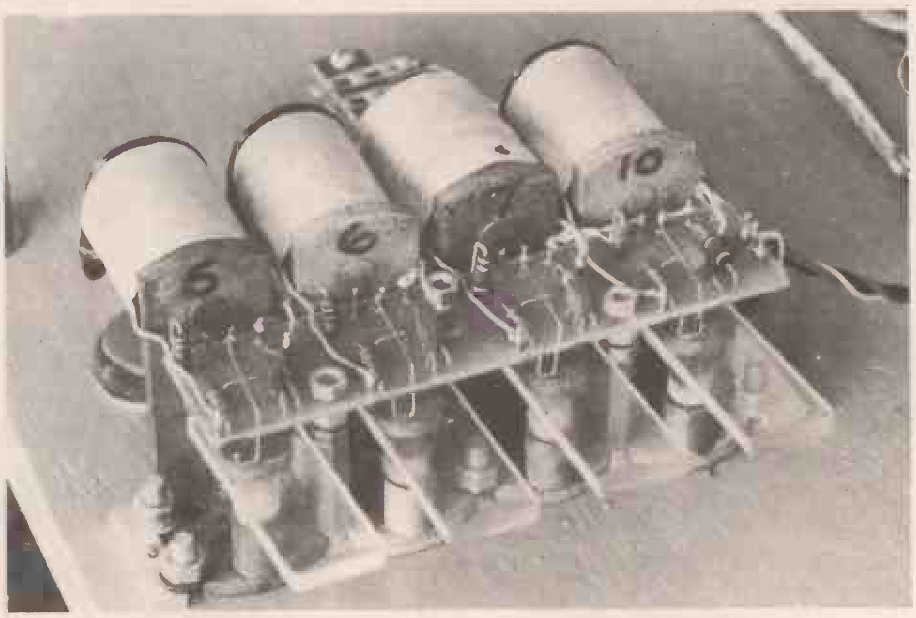


Fig. 2. Prototype assembly of four single-magnet tabs. The p.c.b., type EO3, accommodates 8 circuits, but can be cut down as shown.

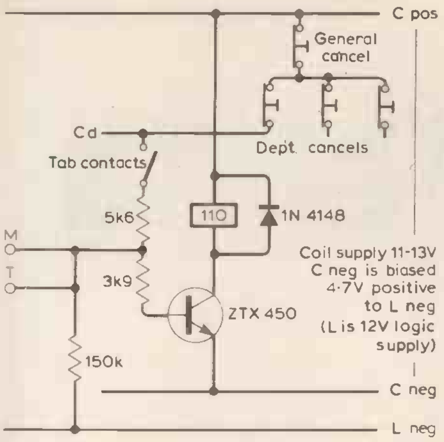


Fig. 3. Drive for single-magnet tab. The memory line M is used to capture the tab position and to supply the drive signal. Cancel line Cd feeds all tabs of one department.

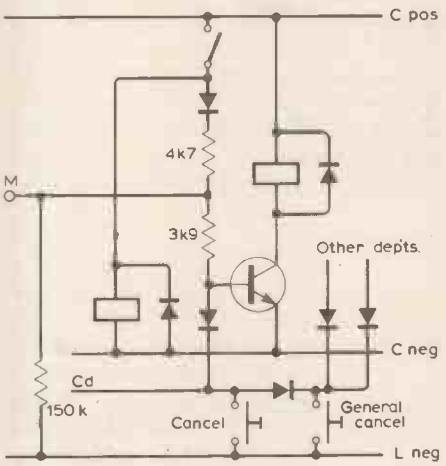


Fig. 4. Single-magnet tab with relay load.

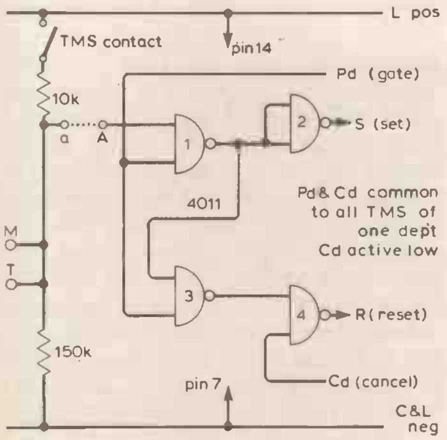


Fig. 5. Gating for one TMS. For signals Pd and Cd, see Fig. 9 and Fig. 15. The L supply can be 7 to 8V.

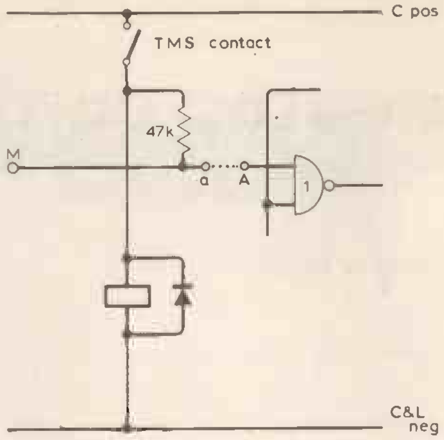


Fig. 6. Use of a relay load.

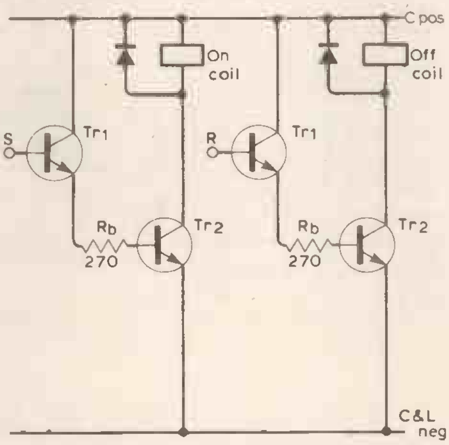


Fig. 7. Coil drivers for one TMS. Resistors R_b are chosen to provide about 20 mA to Tr_2.

Table 1. Component summary

One EO3 board is used for each group of 8 stops, or a board can be cut down to suit other groupings. Normally, one EO4 is used per department, and each board caters for 16 stops. Quantities below refer to fully assembled boards.

EO3 board	
ZTX450	8
1N4148	8
5k6 resistor	8
3k9 or 27k resistor (see Fig. 22)	8
Contact wire	40 cm approx.
EO4 board	
4036	4
4093	2
4539	2
1N4148	12
20-pin connector	1
10-pin connector	1
1 μF tant	1
10n ceramic	3
100p ceramic	1
470k resistor	3
47k resistor	15
470 resistor	1

Printed circuit boards are available from Hiykon Ltd. (W), Woodside Croft, Ladybridge Lane, Bolton, BL1 5ED.

Single-magnet stop

The TMS is an example of a two-way powered actuator, found in many automatic mechanisms, which can often be used instead of a one-way powered device with spring return. In the present application this alternative offers a substantial economy in the stop-unit and the control circuits. Reference 1 suggests that a pipe organ pallet-magnet, Fig. 1, can be adapted as a motorised stop by adding a finger-tab and a light pair of contacts. A prototype assembly is shown in Fig. 2. The drive circuit in Fig. 3 causes the tab to stay up or down as operated by the finger, and the memory line M goes high or low and can be captured by writing into the memory. A subsequent read-out, initiated by a combination piston, drives M high or low and sets or resets the tab irrespective of the contacts. The signal at T switches a 4016, as used for stop-selection in reference 1, and with some re-arrangement other loads may be switched as shown in Fig. 4.

In contrast with the direct switching of Fig. 3, a TMS requires two separate signals which must be momentary, i.e., active only when a piston is operated, a condition introduced by the signal Pd in Fig. 5. The signal at T switches a 4016 and Fig. 6 shows an alternative relay load. The coils are typically 30Ω and may require ½A at 15V. A suitable two-stage driver is shown in Fig. 7.

Capture memory

Table 1, Fig. 8 and Fig. 9 relate to the E04 p.c.b., which uses the circuits given in reference 1. Eight combinations of 16 M lines (stops) are provided, but these can be reduced to 4 × 16 by omitting packages 12 and 22, or to 8 × 8 by omitting 21 and 22. The M lines connect to terminal pins and to a 20-pin socket, which is used when the T outputs are taken from the M connections. By incorporating a small battery in the power supply, combinations are retained when the mains power is off. If this facility is not required, the B pos. terminal is connected to L pos. Normally, one E04 board is used per department, more if there are more than 61 stops, in which case the piston connections are commoned and the Pd signal is taken from only one EO4. Fig. 10 shows each set of eight combinations allocated to four pistons, CP, per department, i.e. 12 in all, wired separately to the 10-pin connectors, and four general pistons, GP, wired to the GP pins of all EO4 boards in parallel. However, any GP input may be used for a CP instead, and GP4 is available at the socket for the alternative of 5 CP or 3 GP. Second-touch contacts on the great CP may be paralleled with the pedal CP, and so on.

Reversible pistons

Each EO4 also carries two independently accessible toggle circuits for RP, Fig. 11, which provide the push-on push-off function from normal single

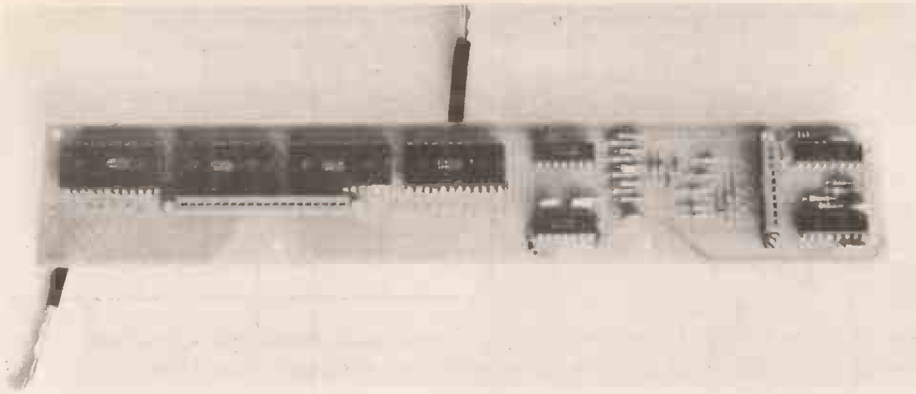


Fig. 8. Memory and logic board, type EO4, has a capacity of 16 stops, 8 combinations, and provision for two reversible pistons.

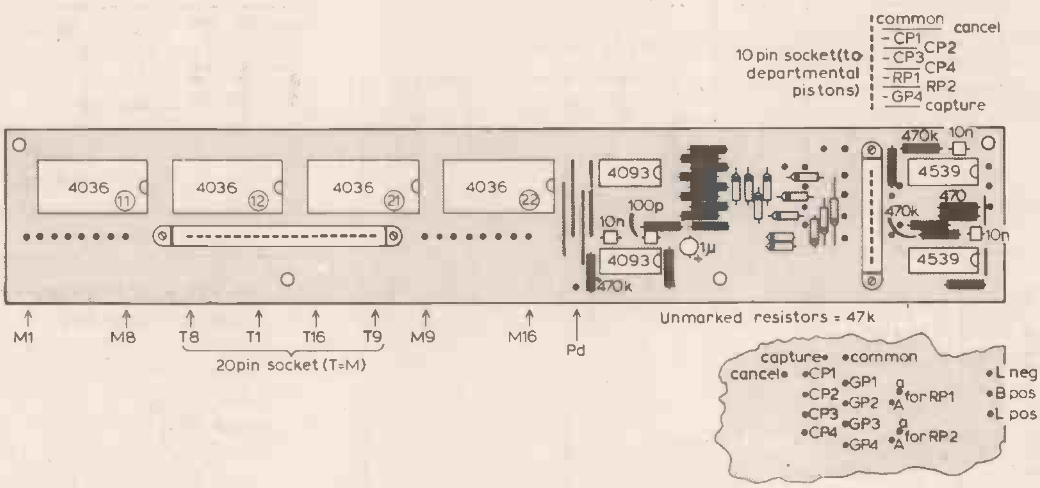


Fig. 9. Component layout and connections for EO4 board.

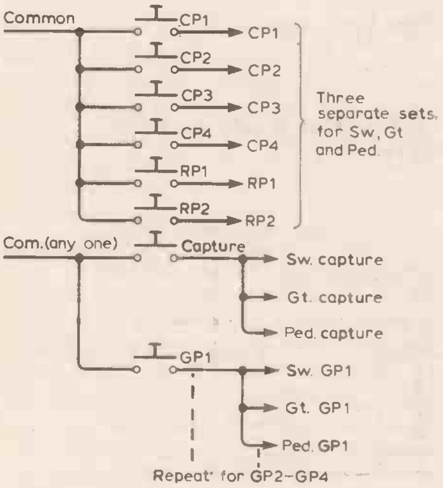


Fig. 10. Example of piston connections for three departments.

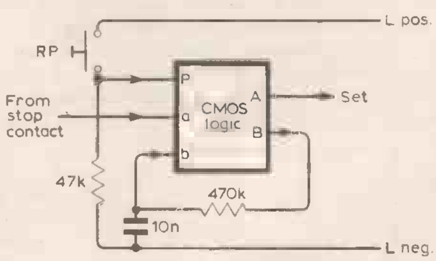


Fig. 11. Toggle circuit. Feedback from A to a is via the stop unit.

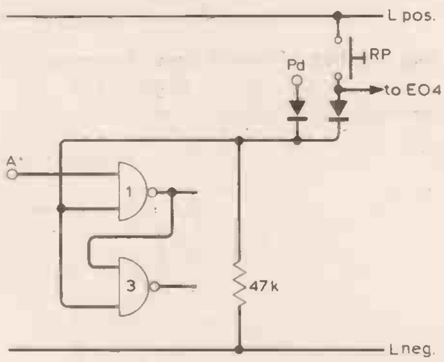


Fig. 12. Gating also from RP signal.

circuit contacts. These are slow-counter cells[2] which have a high immunity to contact bounce. The A signal sets the stop, and the stop-contact signal is fed back to a. For the Fig. 3 circuit this requires the modifications noted in Fig. 22. In Fig. 5 and 6, the connection points are shown as links. If the RP stop is to be captured, an M line connected to a is still required, and with a TMS, the RP signal must be ORed with Pd as shown in Fig. 12. If the RP stop is independent, the RP signal can replace Pd for the TMS concerned. An advantage of the Fig. 11 circuit is that an M signal at a sets or resets the toggle as well as the stop, and a subsequent RP operation produces the result expected.

The single-magnet tab can be particularly quiet in operation if the supply voltage is consistent, and it is worthwhile to use a stabilized C supply. In Fig. 13, the additional diodes postpone 723 dropout by providing a partly independent positive rail. Output voltage is set by R_1, and current limit by R_2, which is adjusted on maximum load so that the output voltage falls slightly. Both settings increase with increasing resistance. The L supply in Fig. 3 and 4 is a separate 12V, and Fig. 14 shows the biasing and battery connections. As noted, TMS usually require higher currents. For example, a piston controlling 48 TMS may momentarily demand 24A because it will energise either the set or reset coil of every stop. Therefore, an unregulated C supply is normally used for economy. The unloaded voltage, which may be controlled by a bleed of about 5%, is limited by the drive transistor ratings, 40V for the BC547 suggested in Fig. 7. Fig. 15 shows a nominal L voltage of 7.5V to reduce the smoothing needed for the C supply. The loaded voltage, including ripple, should not fall below the L supply. The C rails should be low resistance and twisted together to minimise a.f. radiation. If necessary, the di/dt, and hence the radiation, can be reduced by using 4k7 resistors in series with each Tr_1 base in Fig. 7, with 2.2μF from base to C negative.

Second-touch cancelling

The ST movement of a tab is usually obtained by mounting the on-buffer on

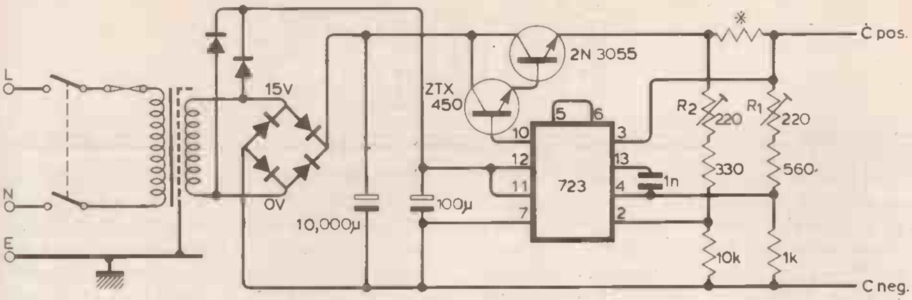


Fig. 13. Coil supply of 11 to 12V for single-magnet tabs. The bridge rectifier and 2N3055 require heatsinks, and the series resistor is selected to drop 1V at maximum current.

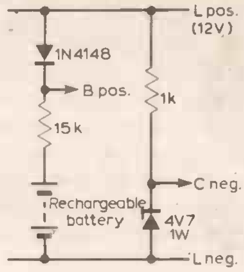


Fig. 14. Biasing for Fig. 13 C supply. The battery can have two or three 90 mAh cells.

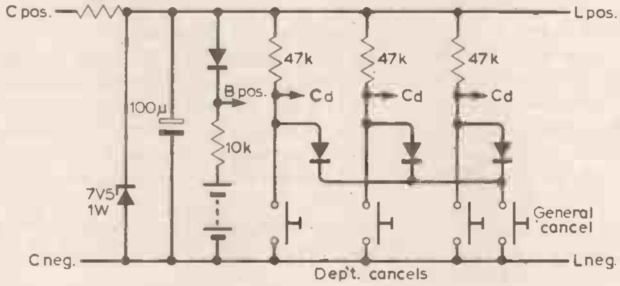


Fig. 15. Nominal L voltage for TMS using Fig. 5, 6 and 7. The series resistor is selected to pass 50mA from a maximum C voltage.

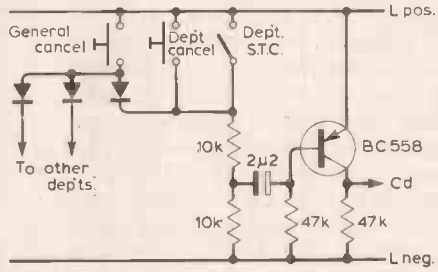


Fig. 16. Pulse timer for use with second-touch cancelling.

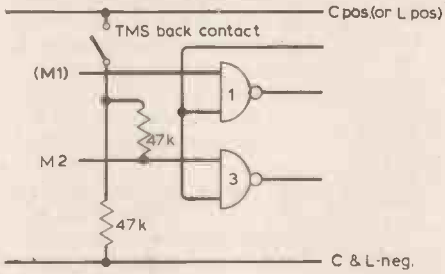


Fig. 17. Use of two M lines. The cross connection from gate 1 to gate 3 is omitted.

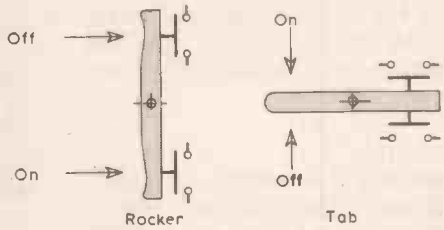


Fig. 18. Two types of spring-centred console switch.

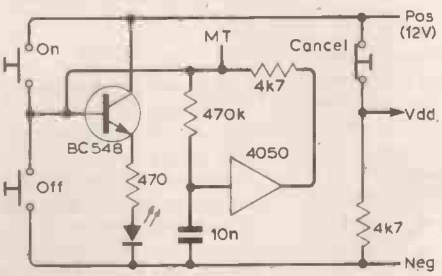


Fig. 19. Latching for spring-centred stop and l.e.d indicator.

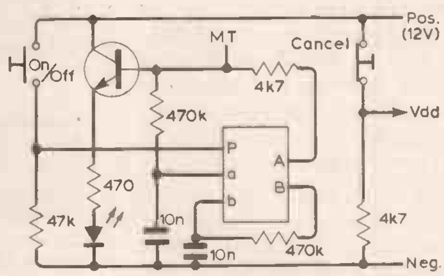


Fig. 20. Single-circuit stop with toggle.

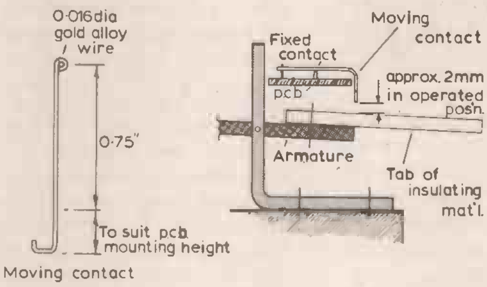


Fig. 21. Contact details for a single-magnet tab. A pin jig should be made for forming the moving contact.

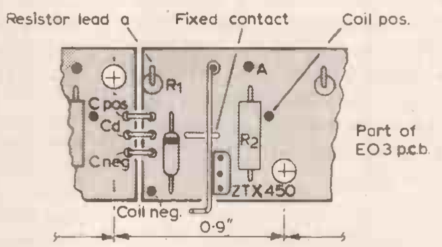


Fig. 22. Component layout and connections for EO3 p.c.b. For a normal tab, R_1 is 5k6, R_2 is 3k9, A = M(T), a is unused. For a tab with RP, R_1 is 27k, R_2 is 5k6, a = M(T) = toggle input, A = toggle output. Cut track Aa below.

a stiff spring which can be deflected by extra finger pressure to close auxiliary STC contacts. All STC contacts for one department are paralleled, and it is preferable that the cancel signal terminates before the finger is removed. Fig. 16 shows a method appropriate to a TMS driven as shown in Fig. 5, and a similar circuit may be used with Fig. 3. The function of a departmental cancel piston is mainly superseded by STC.

Neutral option

When playing requirements are analyzed, sometimes only two or three stops need the option of being within or isolated from the capture system. One simple method is to provide each stop with a conventional switch to disconnect the M line when required. Another solution is to provide duplicate stop-switches outside the combination system (except for cancelling). When TMS are used, a more elegant method is to provide each with an additional back contact in the off position, and a stable mid-position used for capture only where neither contact is made. An additional M line is then allocated to the back contact, see Fig. 17, so that two M lines are used for each TMS having a neutral option, which is exercised by selecting the mid-position before capturing. The action should be light and not interfere with normal motorised operation.

Indication

The main cost of a motorised combination system is the stop-unit, even if single-magnet tabs are used. Non-motorised stops with indicator lamps, although not universally accepted, can be cheaper and combinations are selected silently. The contacts must have momentary action, and Fig. 18 shows two types of spring-centred console switch which may be used in a latching circuit such as Fig. 19. However, the simplest console-switch with momentary action is a single-pole push button, and Fig. 20 shows a circuit using a toggle which makes each button a RP with indicator. In Fig. 19 and Fig. 20, the cancel button may be replaced by Fig. 16 to provide STC from additional contacts. Fig. 21 and 22 show the detail of Fig. 2, and table 1 lists the components for the EO3 and EO4 p.c.bs. The fixed contact is set about 1.5 mm above the p.c.b. using a temporary spacer, and contact pressure is applied by bending the terminal pin carrying the moving contact. A 0.9in. spacing allows the screws for the p.c.b. pillars to pass between the magnet feet, which may be clamped by the pillars.

References

1. A. D. Ryder. "Electronic organ tone system", *Wireless World*, March 1979.
2. A. D. Ryder. "Slow counters", *Wireless World*, November 1979.

BOOKS

Hi-Fi Choice No 17 is a new edition of the cassette decks and tapes review by Angus McKenzie, this time including a short section on open-reel decks and tapes. The familiar format is retained, since it has been found to present the maximum amount of information most economically and in a form which is easy to assimilate. The reviews are prefaced by two introductory chapters for both non-technical and technical readers, and each instrument is described in a qualitative manner as well as in a more factual, quantitative way. A later section on the types of tape available is extremely well and thoroughly done — a collection of information which is possibly worth the price of the book in itself. The book is published in paperback at £2.00 by Sportscene Publishers Ltd, 14 Rathbone Place, London W1.

Introductory Circuit Theory, by J. K. Fidler, is intended for first-year students in electrical degree or diploma courses who are also engaged in circuit design and mathematical studies. The mathematical level is such that differential equations, complex numbers and matrices are needed, though they are dealt with in the text. The range of the book is from an understanding of basic electrical quantities and concepts in Chapter 1 to Fourier analysis of complex waveforms in Chapter 8, with frequency and time-domain analysis and non-linear circuits covered on the way. The book is a good example of the better style of teaching, in that the writing is clear and purged of any intent to demonstrate the author's cleverness at the expense of lucidity. Examples and problems are provided in each chapter, with answers. Mr Fidler is a Senior Lecturer at the University of Essex. The book is in paperback, contains 214 pages and is published at £5.95 by McGraw-Hill Book Company (UK) Ltd, Shoppenhangers Road, Maidenhead, Berks.

Choosing and Using Your Hi-Fi, by Maurice L. Jay, is one of the vast series of Babani books for the enthusiast who may not want to approach the more advanced texts. There are many books on this subject which are claimed to be for the non-technical, but which often lose sight of their function and use terms with which the layman cannot be expected to be familiar. The author of this book does not succumb to that temptation, keeping the treatment to a practical and easily-understood level throughout, while not compromising on accuracy. For example, the subject of amplifier output specification is well explained, the "watts r.m.s." fallacy being discussed at length — no mean achievement in this type of basic book. For the complete newcomer to audio who may easily be baffled by some of the more spectacular advertising copy, this little book can be recommended. It is published at £1.65 by Bernard Babani (Publishing) Ltd, The Grampians, Shepherds Bush Road, London W6 7NF.

'Consumer electronics' is an expression of the 1970s. Ten years ago, the amount of electronics in the average home amounted to a radiogram and a television set (probably monochrome). Since then, of course, all manner of entertaining and useful devices have emerged, largely as a result of the extreme speed of i.c. development, and this book, **From Television to Home Computer,** is one attempt to survey the whole field. Most of the latest developments are reviewed, with comments, by several prominent writers, the whole being co-ordinated by Angus Robertson, who dealt with some of the video-based chapters.

The book is not for engineers, the language being non-technical, but does afford an overall understanding of the equipment now appearing in the shops for the interested layman. A rather surprising omission is a section on the radio control of models — a rapidly increasing interest — but the rest are well described in readable language. The Publishers are Blandford Press Ltd, Link House, West Street, Poole Dorset BH15 1LL, and the 323 page book costs £8.95 in hard back.

Discover Data Communications was written by Brian Warrington, managing director of a data communications company, because he found from experience in searching for staff that there was inadequate literature on this subject at the technician level. The 128-page, well-illustrated book begins by discussing basic communication techniques and modes, covering general development and defining terms on the way. Hardware of terminals, media devices and interface circuits is described, together with standards, PTT regulations and communications protocols which the terminals may use. Also included are the four character code sets most widely used today, one appendix comparing six character codes for translation and another consisting of a comprehensive glossary of terms. Northwood Books, 93-99 Goswell Road, London EC1V 7QA. Price £4.50 from bookshops or £5.00 inclusive from the publishers.

Computer programming in BASIC by I. Williamson, R. Dale and T. Eiloart is a self-instruction course supplied in four volumes. Part one, predictably called "Basic Basics", comprises 17 lessons which initially describe a computer and explain popular jargon. Subsequent lessons cover simple maths and give programme examples in Q and A form. Part 2, Introducing Basic, takes the student through high- and low-level languages, flow charts, trigonometry, and a more detailed explanation of Basic statements. Applying Basic is discussed in **Part 3**, with lessons covering compilers, interpreters, loops, and more about statements, followed by debugging, arrays, computer games and more problems. The last volume deals with advanced Basic and covers subroutines, string variables, recursion, integration, matrices, files, with supplementary lessons covering series expansion, and numerical integration. Again, the book is well provided with problems and answers. The complete course does not require the use of a computer and each volume has cartoons to break up the text. The course is priced at £7.50 and is available from Cambridge Learning Enterprises, Rivermill Lodge, St Ives, Cambs.

Colour tv receiver design

2 — The r.f., i.f. and colour decoder sections

by **R. Wilkinson,** B.Sc. (Hons), M.I.E.E. Decca Radio & Television Ltd

The tuner

Fig. 4 is the circuit diagram of the Mullard U321 u.h.f. tuner for the British market, covering the range 470 to 860 MHz (channels E21 to E68). Three factors combine in this tuner to give improved signal to noise ratio and signal handling characteristic: they are a p-i-n diode attenuator, an r.f. amplifier which always operates at high currents, and a Schottky diode mixer.

The p-i-n diode attenuator (BA 379's) is controlled by a.g.c. current from the i.f. sub-panel. Maximum tuner gain is obtainable when the a.g.c. circuit is sinking the maximum current of 9mA from pin 3 of the tuner.

The r.f. amplifier Tr_{701}, a BF480 high current low noise transistor, is d.c. coupled to the p-i-n diode attenuator to optimise the a.g.c. characteristic. The tuning of the double-tuned bandpass circuit in the collector is varied by applying a variable d.c. to the varicap diodes.

The BA280 Schottky diode mixer is driven by the local oscillator Tr_{702} (a BF480) whose tuning is varied by a varicap diode.

The final r.f. amplifier Tr_{703} (a BF324) compensates for the conversion losses of the diode mixer.

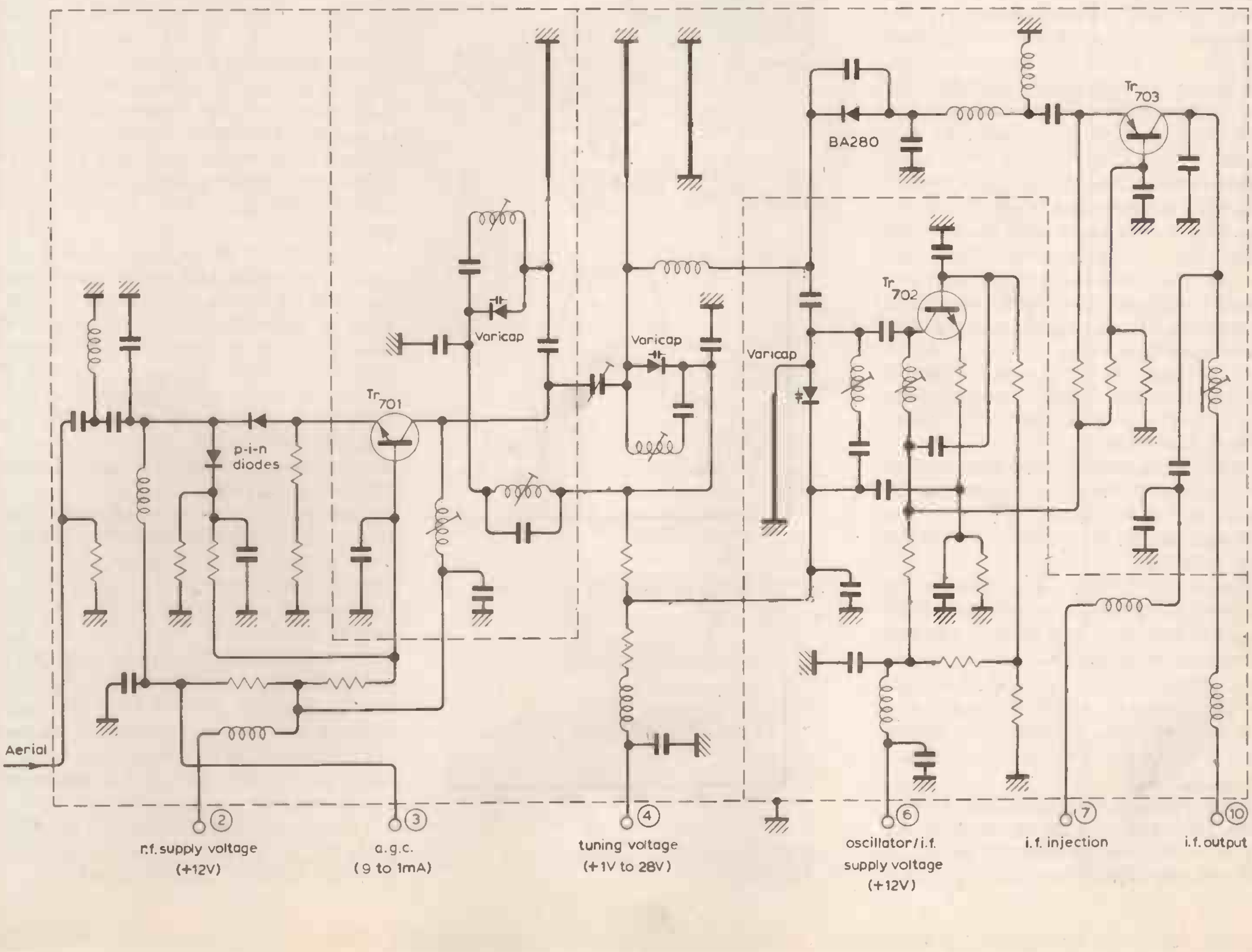
When both the v.h.f. and u.h.f. tuners are used (for export markets), band-switching is easily effected by switching the 12V supply line to whichever tuner is required.

Vision i.f.

The vision i.f. section (Fig. 5) is centred on the TDA2540 i.c., which provides i.f. amplification and demodulation, a.g.c., a.f.c. and noise inversion. The use of a single i.c. to provide all these functions results in a great reduction in components and the circuitry within the i.c. for each function is much more advanced, and hence the performance much improved, relative to discrete circuits.

Most of the band-pass shaping and the traps are provided by a surface acoustic wave (s.a.w.) filter. The mode of operation and construction of these components have been described in detail elsewhere but, briefly, the i.f. signal is converted by transducers to an acoustic wave which travels over the surface of the substrate (Fig. 6) to be

Fig. 4. Circuit diagram of the u.h.f. tuner



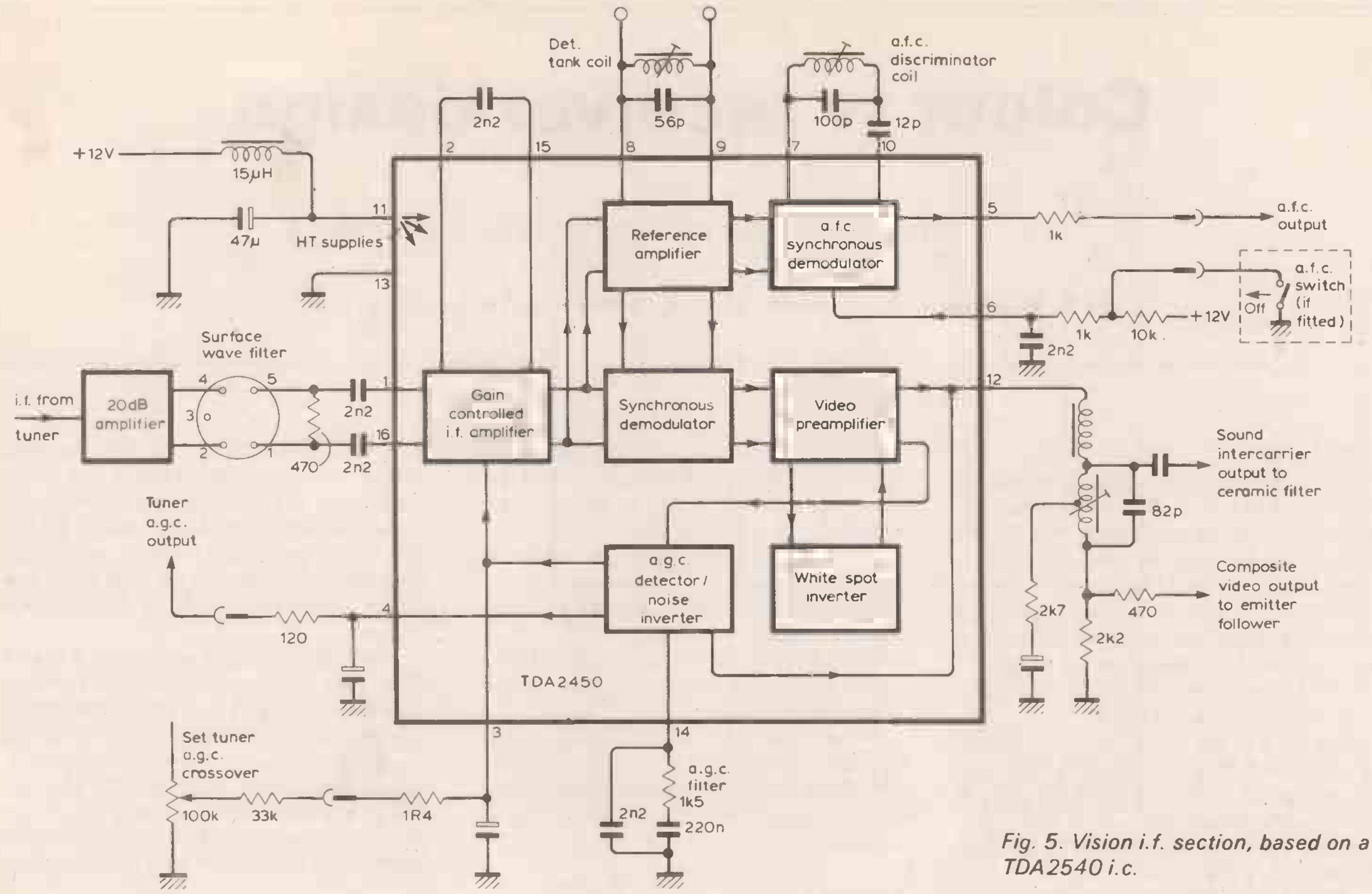


Fig. 5. Vision i.f. section, based on a TDA2540 i.c.

reconverted to an electrical signal by the receiving transducers. The shaping of the "fingers" of the transducers determines the shape of the i.f. response (Fig. 7).

It is only comparatively recently that s.a.w. filters have become suitable for incorporation in a tv receiver. The response is very stable over a wide temperature range and the cost is comparable with the coils and traps the device replaces. It does away with the need to align these coils in production and avoids the possibility of drift or accidental maladjustment in operation or servicing. It also takes up much less space than these coils.

A further advantage is its much improved group delay characteristic (Fig. 8) which is desirable for good reception of teletext.

The only significant disadvantage of the s.a.w. filter is its insertion loss of about 20dB at mid-band. For this reason it is preceded by an amplifier with fixed gain of 20dB.

The output of the s.a.w. filter is fed differentially to the TDA2540, where the signal is amplified and limited and the carrier filtered by the 'tank' circuit across pins 8 and 9. This signal is then used to provide a reference for the synchronous video demodulator whose other input is fed with the non-limited i.f. signal.

A proportion of the vision carrier from the tank circuit is coupled by capacitors formed by adjacent tracks on the printed circuit panel to the a.f.c. tuned circuit. This drives one input of the a.f.c. synchronous demodulator. The other input to the demodulator is driven with the carrier signal taken directly from pins 8 and 9 within the i.c. The phase shift between these two inputs varies with the frequencies of the i.f. signal. The output of a synchronous demodulator varies with the relative phase of the inputs and this results in an output voltage which varies with frequency.

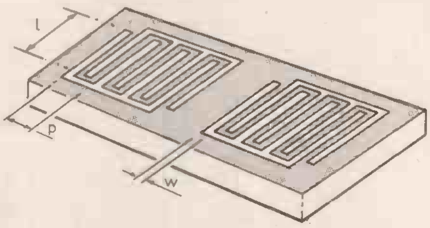


Fig. 6. Simplified diagram of a s.a.w. (surface acoustic wave) filter.

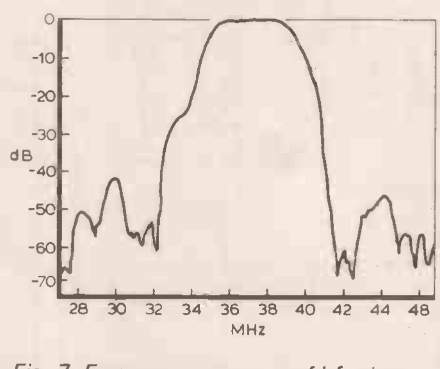


Fig. 7. Frequency response of i.f. given by s.a.w. filter.

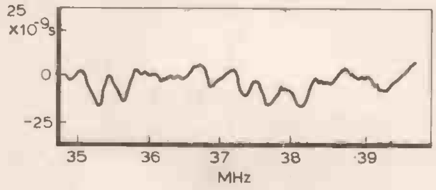


Fig. 8. Group delay characteristic of s.a.w. filter.

For optimum performance, low harmonic distortion and intermodulation the Q of the reference tuned circuit must be high but this means that the tuning point is critical. Automatic frequency control is therefore included in the system to minimise the effected drift and slight mistuning. When aligned correctly, a.f.c. is an advantage in operation, providing a predictably correct tuning point.

Some receivers have an arrangement which switches off the a.f.c. to enable the customer to tune to the approximately correct position then switches on again to lock the receiver exactly on tune. It is possible for the customer to be confused by this procedure (in fact, many customers call in a service engineer just to tune the set) and one has heard of instances where the customer has switched *on* the a.f.c. while tuning and switched it *off* near the approximate tuning position.

The system used in all Decca models adds the a.f.c. voltage to the tuning voltage so that there is sufficient

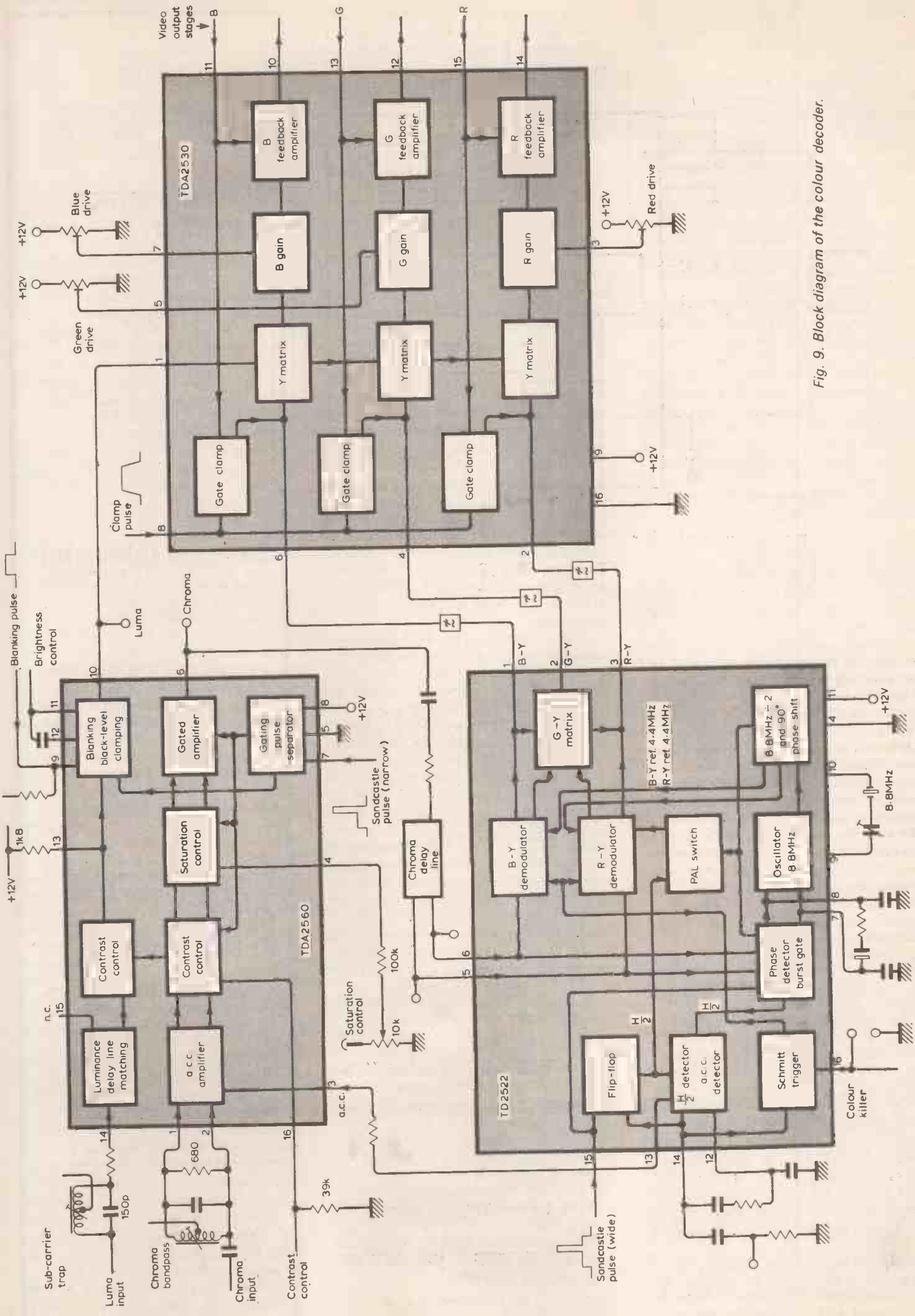


Fig. 9. Block diagram of the colour decoder.

automatic control to lock the receiver when on tune whilst still allowing tuning from station to station when required.

The a.g.c. signal, which is detected from the output of the video-preamplifier, is applied within the i.c. to the three-stage i.f. amplifier where control is applied progressively to each stage, starting with the third stage.

To accommodate high aerial input signals without overloading the tuner, a.g.c. is applied to the p-i-n diode attenuator (see above). When the limit of control of this attenuator is reached, the i.f. a.g.c. can again resume control for a further increase of signal.

The TDA2540 also contains sophisticated circuits for noise inversion. These are required for two reasons: to prevent false a.g.c. action due to noise pulses, and to limit the video signal amplitude in the presence of noise. Negative noise pulses (i.e. those going below video black-level) are inverted and clamped to black-level. Positive noise pulses, which could produce high peak beam currents in the picture tube and defocused white spots on the screen, are inverted to a mid-grey level.

Sound i.f. and output

The output from the TDA2540 is fed to a ceramic filter tuned to the sound carrier (6MHz in the UK). The sound signal processing is thence carried out by a TDA1190Z which has an i.f. amplifier/limiter followed by an f.m. detector and audio power amplifier with d.c. volume control.

The main advantages of having all this circuitry in one package is, clearly, reduction in components, which means lower cost; smaller printed panel area (important in a portable); shorter factory test time and increased reliability. The main disadvantage is that features suitable for larger sets, such as tone controls, higher output power, audio input, are more difficult (albeit not impossible) to accommodate.

Colour decoder

A three-chip decoder is used in the 70 series chassis (Fig. 9). At the time of development of the chassis the single-chip decoder was still in its infancy and came under the heading of "advances in technology" (see previous article).

The TDA 2522 contains the main PAL signal processing and demodulation; the TDA 2560 processes the luminance part of the video signal and includes circuits for the customer control (brightness, colour and contrast); the TDA 2530 contains black level clamps and the luminance-chrominance matrices; it also contains some circuitry which forms part of the video output amplifiers. Because the black level clamps are at a low level, fairly early in the system, the subsequent circuitry up to the tube cathodes must be d.c. coupled.

The chrominance input, filtered out from the full video signal, is applied differentially (pins 1 and 2) to the automatic chrominance control amplifier in the TDA 2560 whence it is operated on by the contrast and saturation controls in turn. These are both d.c. controlled amplifying/attenuating stages. The former operation ensures that the picture colour saturation remains constant as the contrast control is adjusted.

To reduce any differential phase effects between the colour burst and the chrominance signal, both burst and chrominance are sent through the chrominance delay line before the burst is processed and used to regenerate the colour subcarrier. As is normal in colour decoders, the burst amplitude is maintained at a constant level by a control loop to minimise saturation changes due to detuning or interference. In this decoder the a.c.c. loop includes the PAL delay line in order to compensate automatically for tolerance variations in the insertion loss of the line. Since the a.c.c loop operates on the burst, the saturation and contrast controls must not affect the burst amplitudes. Thus during the burst period the contrast and saturation control amplifiers are gated out to maximum gain and the burst amplitude is fixed at the level determined by the a.c.c. loop.

A novel feature in the TDA 2522 is the use of an oscillator running at twice the colour subcarrier frequency. This frequency is divided by two within the i.c. to produce two 4.43MHz subcarriers with a phase difference of 90° suitable for demodulating the two colour difference signals directly. Thus, an accurate stable phase shift is produced automatically without the need for adjustment or for external components.

A special feature in the 70 series 14-inch portable receiver is the disabling of the colour killer at low aerial signal levels. As the signal becomes degraded or becomes a monochrome signal the half-line frequency ident circuit determines the point where colour killing action begins. This may be accompanied by flashing on and off of the colour if the signal is a poor one.

In a portable receiver it may be desirable to display a colour picture even if the reception is poor at some remote location. Thus when the a.g.c. drives the tuner to maximum gain, it also switches on a transistor which "un-kills" the colour killer. This does have the slight disadvantage that if a poor monochrome signal is transmitted then the colour killer will still be disabled and coloured noise will appear on the picture. If felt objectionable this can, of course, be removed by reducing the colour control.

Normal colour killing action on monochrome signals is retained at normal aerial signal levels.

To be continued

Binary clock

A practical example of binary counting for displaying time

by J. M. Osborne

This design does not seriously challenge other published clock circuits, but is intended as an educational application of logic i.cs. The low-cost binary display may, however, have other applications where a translation to the decimal format is not necessary.

Because this clock design was originally intended as a school project, I decided to use an unconventional but low-cost binary readout. Only two displays are needed, one for minutes and one for hours as shown in Fig. 1. In practice this type of display can be read quickly because pattern recognition replaces mental arithmetic. The natural sequence seemed to be clockwise from the top so, when viewing, the most significant illuminated segment is located and the display is read anti-clockwise by adding the values of the less significant segments.

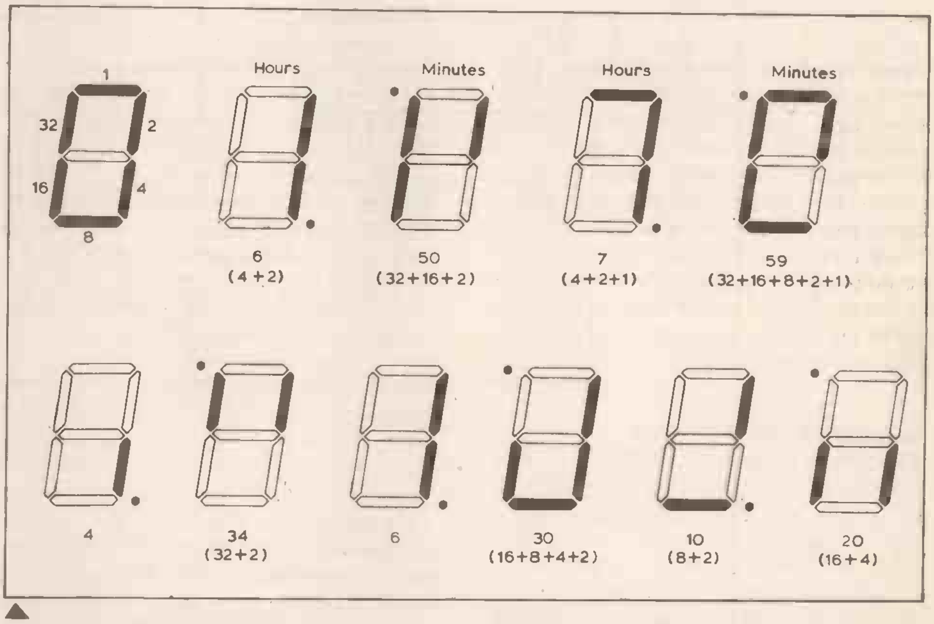
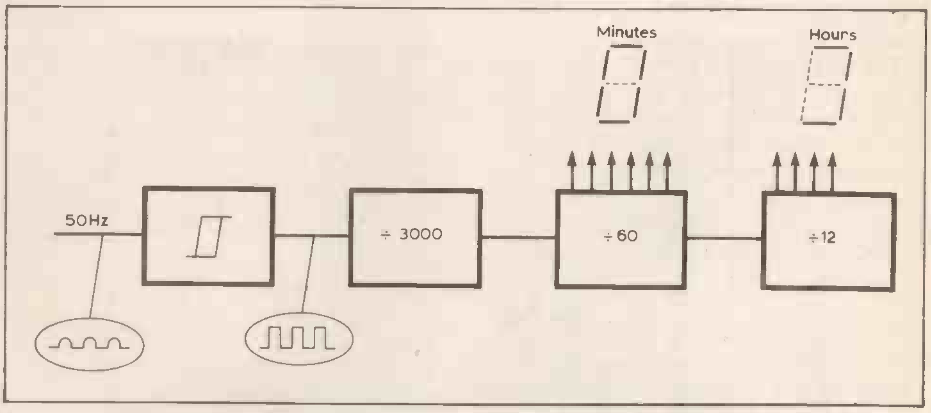


Fig. 1. Binary display based on two seven-segment characters.

Fig. 2. Block diagram of the clock.



The 50Hz mains frequency was chosen as a simple timing source and this is divided by 3000, 60 and 12 to produce the minute and hour pulses as shown in Fig. 2. The power supply is Zener stablized because the current varies with the number of segments illuminated. At noon and midnight only a decimal point is on, which requires about 5mA. At 07.59 and 11.59 the display draws about 45 mA. A separate half-wave rectifier provides a 50Hz pulse train, and to prevent mains noise from causing false counts, a Schmitt trigger is used as shown in Fig. 3.

Negative going edges from the pulse-train clock a 12-stage binary counter whose outputs are decoded by an eight-input NAND to recognise the 3000 count, binary 101110111000. The NAND output switches a flip-flop which then resets the divider and provides a minute pulse. The next positive going edge from the Schmitt resets the flip-flop. The minute pulses clock another counter which divides by 60, binary 111100, and a 4-input AND decodes the last count. The outputs drive six segments of a display as previously explained. Because the forward drop across a l.e.d. segment is typically 1.7V, the necessary input voltage for the AND gate is not reached. This problem is solved by including a 6.8V Zener in the cathode lead of the display. On logic 1, the segment voltage rises to 6.8 + 1.7V, and on logic 0 the segment becomes reverse biased by —6.8V, which is well within the typical reverse breakdown voltage. To ensure that the 8.5V represents a logic 1, the supply to the AND gate is lowered from 12 to 9.25V by a potential divider. A logic 1 of 9.25V from this gate is adequate to set the flip-flop and hence reset the counter. The rising edge of the Schmitt output is again used to reset this flip-flop. Therefore, a short pulse every hour drives the divide-by-twelve counter, which has four outputs wired to a display and two outputs to the AND gate for decoding binary 1100. Normally, a flip-flop would be used at this stage to give a reset pulse, but this was omitted to save one i.c. In practice the counter resets reliably and, as this is the last stage, no further pulse is required.

The clock is set by two push-button change over switches, wired via an inverter/buffer, which clock the displays at about 1Hz. Ideally, extra gates should be used to prevent contact bounce, but these circuits were omitted to retain simplicity.

Two remaining inverters are used to flash the two decimal points alternately. This indicates that the clock is operating, particularly during the first minute after twelve when the display is blank. The decimal points also provide a

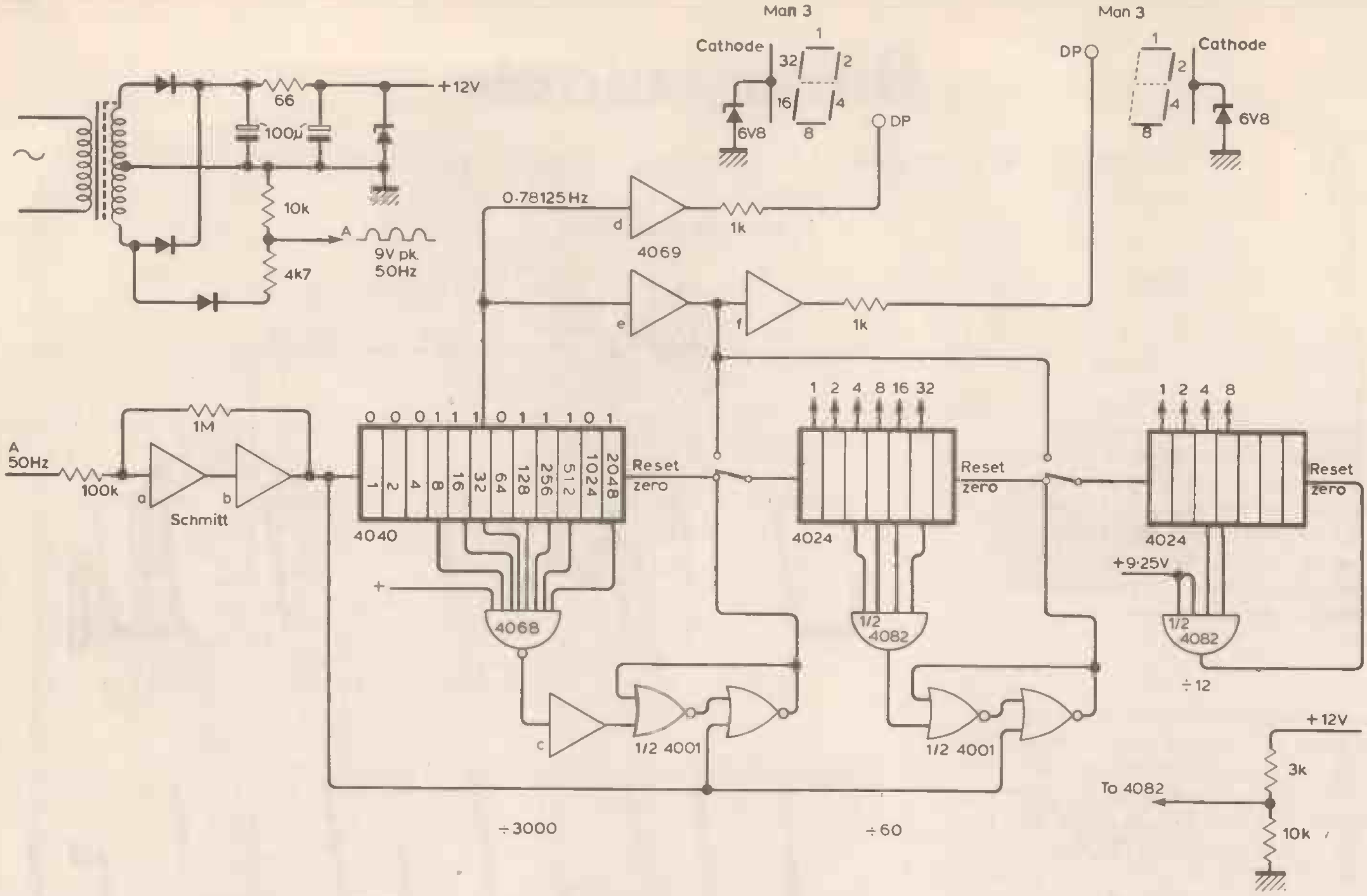


Fig. 3. Complete circuit comprising seven i.cs.

reference so that at night the eye can identify which bars of the display are illuminated.

Although the binary clock is an educational toy which demonstrates binary counting, it can be built for nearly half the cost of a traditional decimal clock using four displays and decoding i.cs. □

A high definition heat study of the British Isles taken by satellite, NOAA-6, equipped with infra-red sensors, from an altitude of 833km. The darker land mass denotes the relatively warmer ground temperatures compared with the sea — temperature differences as small as 1 °C can be detected by the satellite. The data broadcasts which built up the study were recorded at Dundee University's satellite station using SE Labs' SE 7000 instrumentation tape recorders.

Questionnaire draw winners

Winners in the draw associated with the 1980 Wireless World reader survey questionnaire are as follows:

The first prize, a pocket digital multimeter, goes to the reader who returned questionnaire form No. 9497; the second prize, a cordless soldering iron, to the sender of form No. 17760. Six further prizes, copies of the 18th edition of "Guide to Broadcasting Stations", have been sent to the readers who returned form numbers 01260, 04007, 06761, 12260, 15015 and 20519.

Digital capacitance meter

In the printed-circuit layout for this project, published in the May issue (p.64), a slight thickening of the tracks has caused pins 13 and 14 of IC_8 to be joined together. The two should be separate.

In the component list, C_2 should be C_4, and in Fig. 3, pin 15 on $IC_{7(a)}$ should be pin 5. IC_6 pin 3 is the one to which R_{21} is connected. R_6 and R_7 are transposed on the layout of Board A (May issue).

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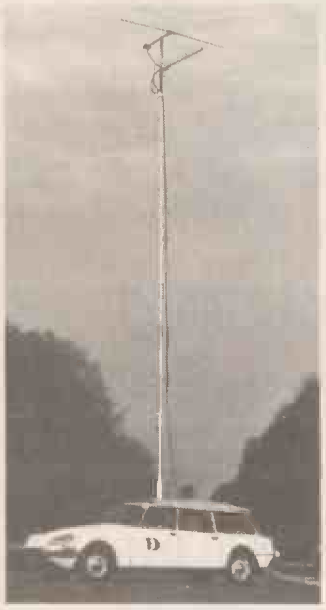

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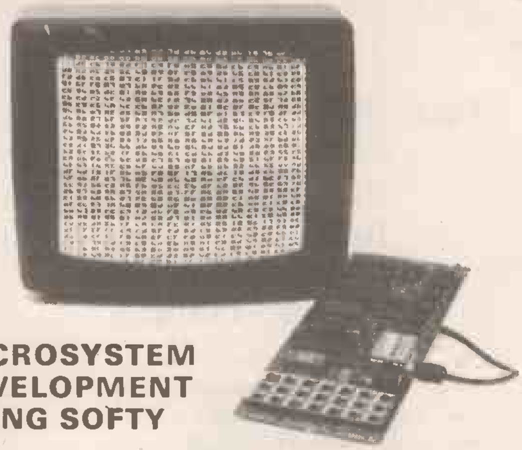

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To help in the process of program development SOFTY has various assembler key-functions, which include — **block shift without overwriting, block store, cursor control, match byte and displacement calculations (for jumps, etc.). A high-speed cassette interface** is also provided for storing working programs and useful subroutines.

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Transient recorder

Digital instrument stores analogue waveforms

by G. J. Adams B.Sc., Ph. D.

With the current development in logic based test instruments the transient recorder has become a popular and, in many cases, essential piece of laboratory equipment. This design uses low-cost r.a.ms for storage and allows the stored data to be examined word by word. The recorder can also be interfaced to a microcomputer which uses memory mapping. Total cost of the prototype was about £150, which compares with commercial models costing around £800.

The function of a conventional transient recorder is quite straightforward. On receipt of a trigger pulse from either a manual trigger control or from a test rig, the recorder samples the amplitude of a signal at regular intervals, known as the sampling period (1/sampling frequency). After each sample the amplitude is converted to a digital word of usually 8 to 10 bits, and is stored in a memory. The number of samples which can be stored depends on the number of memory locations, and the duration of the "recording" is determined by the product of the sample period and the number of memory locations.

When the signal is captured, the contents of the memory can be read out sequentially at a suitable rate into a d-to-a converter. If the contents of the memory are read out repeatedly, the analogue signal can be displayed on an oscilloscope as a continuous waveform. Alternatively, if the memory is "played back" once at a slower rate, the analogue signal can be plotted on a chart recorder.

Some commercial transient recorders have additional facilities which allow triggering from the test signal by defining a trigger threshold. In some instruments it is also possible to store information before or after the trigger occurs, a facility known as pre-trigger and delayed trigger.

Although transient recorders are widely used for storing single-shot events, they can also be used for measuring and plotting part of a continuous waveform.

This design allows the capture of one-shot events for subsequent continuous display, and it also has the facility to examine the contents of the memory word-by-word via a suitable display for on the spot measurements of the test signal.

Because the circuit has the ability to address any memory location and read or write data, the recorder can easily be interfaced to a microcomputer system which uses memory mapping. In this system the recorder memory is treated as part of the computer memory so the computer can analyze recorded data as required and write information into the recorder memory to display graphical results.

Fig.1 shows a block diagram of the transient recorder. The d.c. input range is +5 to −5V, and a switched-gain preamplifier increases low level a.c. signals to this range. The low-frequency −3dB point of the pre-amp is approximately 8Hz, and the high frequency limit, which is restricted by the maximum sampling frequency, is about 16kHz. After amplification, the signal is processed by a unity-gain low-pass filter, sampled and then converted to a binary representation by the a-to-d converter. After each sample and conversion, the digital word is stored in the next available memory location. The sequence of sample, conversion and storage is controlled by a variable-frequency clock, timing circuits and a memory-address counter. The clock frequency is equivalent to the sampling frequency, and switched ranges are provided from 0.3Hz to 33 kHz. After a recording, the contents of the memory can be read out under control of the same clock/counter circuit or by a manual single step clock control. Memory data can be displayed by a l.e.d. readout or on an oscilloscope via a d-to-a converter. To remove the staircase appearance of the oscilloscope display, a low-pass filter can be switched in circuit.

Because any memory location can be addressed, the contents of a location can be changed by applying the required data to the external digital input and pulsing the external write-signal line.

The prototype recorder stores 256 8-bit words, but the memory can be increased without difficulty. An 8-bit word gives a resolution of 1 part in 256, i.e. a signal-to-noise ratio of approximately 48 dB. This figure can be improved if necessary by using a 10-bit a-to-d converter which will give a s-to-n ratio of about 60dB.

The a.c. input amplifier in Fig.2 is a simple fixed-gain stage with a passive attenuator, which provides a constant input impedance of about 100kΩ.

If the amplified signal contains frequencies higher than half of the

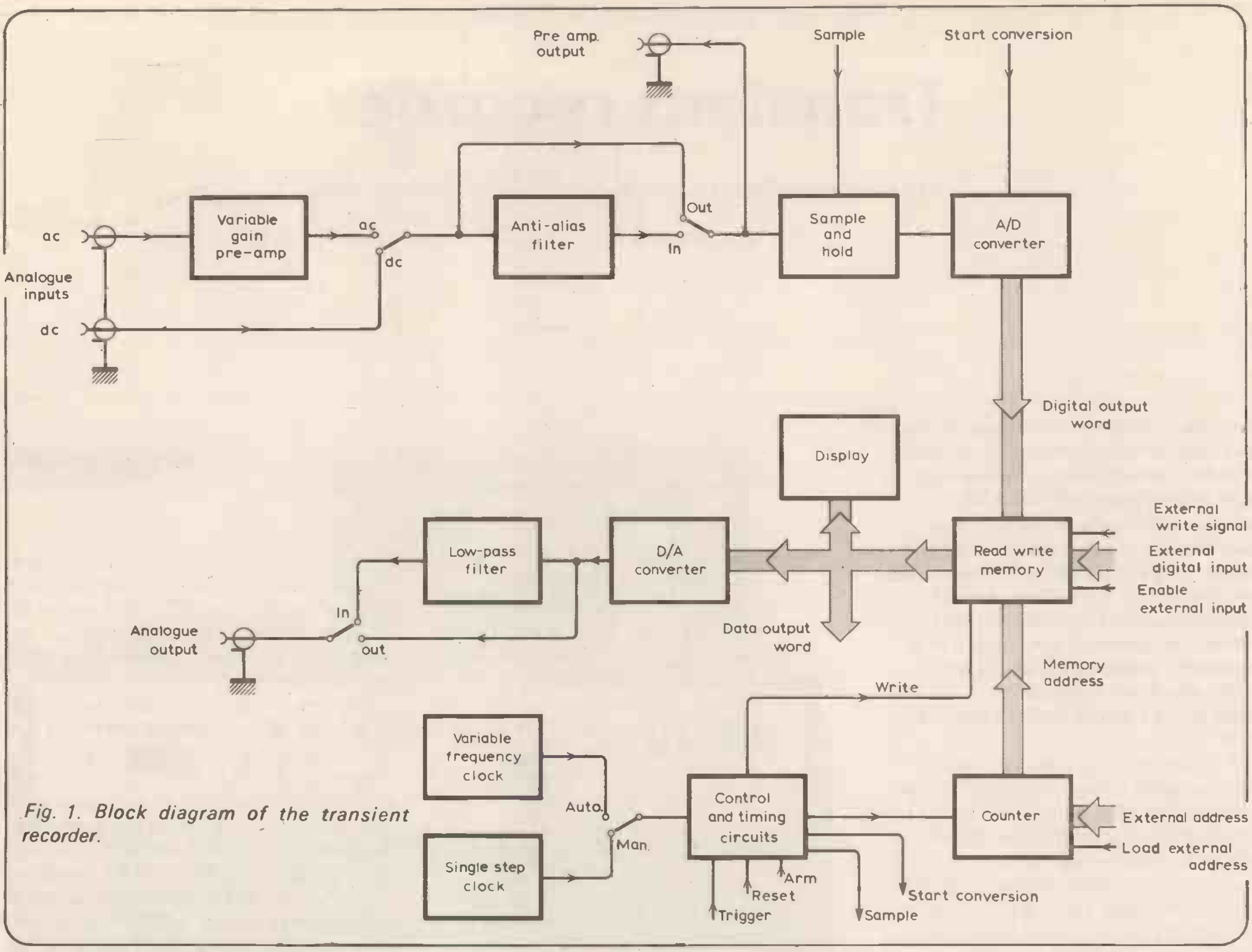


Fig. 1. Block diagram of the transient recorder.

sampling frequency, after reconstruction of the signal, the waveform will contain components having frequencies below half the sampling frequency which were not present in the original signal. This effect is known as aliasing because the high-frequency components produce their alias in the form of lower-frequency components in the reconstructed waveform. The hazard can be prevented by ensuring that the sampling rate is at least twice the highest-frequency component of the input signal which can be resolved by the a-to-d converter. Alternatively, an anti-alias filter as shown in Fig.3 can be used. The cutoff frequency and rate of this low-pass filter are chosen so that the attenuation is about the same as the dynamic range of the a-to-d converter, e.g. 48 dB for an 8-bit converter, at a frequency equal to half the sampling rate.

The prototype uses an 8-pole unity-gain Butterworth filter with a cutoff frequency of 6kHz and a cutoff rate of 48 dB/octave. The cutoff frequency can be changed as desired by scaling all of the resistance or capacitance values, or both by a suitable factor. For example, to double the cutoff frequency, the capacitance values can be halved. If the filter is used with a cutoff frequency above about 12kHz, 741S op-amps

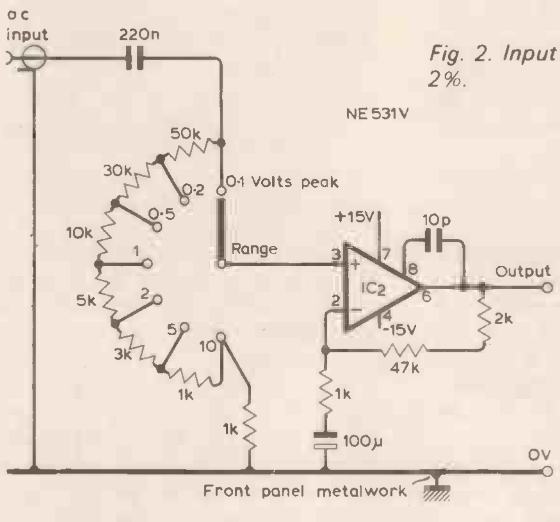


Fig. 2. Input amplifier. All resistors are 2%.

should be used to prevent slew-rate limiting.

When the filter is used with an 8-bit a-to-d converter, a sampling rate of 24 kHz or greater will prevent aliasing errors. A filter with a faster cutoff rate will allow a lower sampling rate to be used, but for good visual definition of a signal of frequency *f*, a sampling rate of at least *4f* is recommended. Therefore, for signals up to 6 kHz, a sampling rate of 24kHz or greater is recommended and an anti-alias filter with a cutoff rate of 48dB/octave is suitable for most purposes. A switch is provided for bypassing the filter, but ideally a different filter should be used for each sampling rate. Alternatively, the eight filter capacitors can be switched.

The sample-and-hold circuit in Fig.4 is based on an i.c. with an acquisition time of 4μs for 0.1% accuracy. When a sample is required, the t.t.l.-level line is taken low for 6μs and then returned to the high state to hold the output voltage. Approximately 4μs later, conversion starts which takes a further 20μs. The total cycle time is therefore about

30μs and this limits the maximum sampling frequency to 33kHz. Voltage drift in the hold state does not exceed a few microvolts during the conversion period when a 1nF hold capacitor is used. The d.c. offset control allows a signal with a non-zero mean level to be positioned within the +5 to −5V range of the sample-and-hold i.c. To facilitate this adjustment the sample-and-hold input is made available as a pre-amp output for display on an oscilloscope.

The sample-and-hold i.c. is followed by a unity-gain amplifier which shifts the output range by 5V to 0-10V as required by the a-to-d converter in Fig 5. This circuit is based on an 8-bit successive approximation type of converter and requires two adjustments for correct operation. With 20mV d.c. applied to the input, pulse the start line momentarily to the high state with a suitable switch. The state of the output word can be conveniently viewed by temporarily connecting l.e.ds from the outputs of IC_{11} and IC_{12} to ground. If the converter is operating, the output states will all be low except for the least significant bit which may be high. The offset potentiometer R_3 is adjusted while repeatedly pulsing the start line until the l.s.b. oscillates between high and low states in a random fashion. This procedure is repeated with 9.94 V d.c. at the input, using the gain potentiometer R_2 until the l.s.b. again flickers between the low and high states, and with the other seven outputs in the high state.

If the enable line is taken low, the output lines of IC_{10} float and data presented to the input lines then appears on the output lines and can be stored in the memory if required. When the converter is transferring data to the memory, enable high or floating, the input lines should be high or floating.

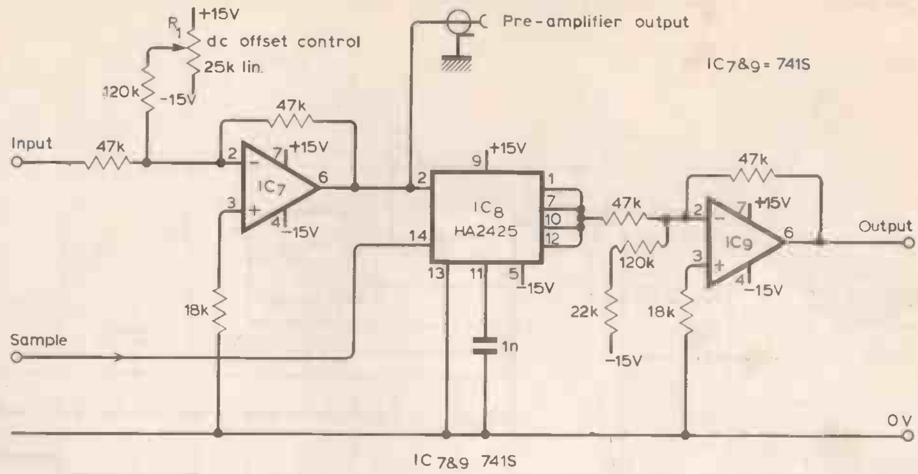


Fig. 4. Sample and hold circuit. The signal can be checked, prior to sampling, to ensure that it is within the +5 to −5V range of the a-to-d converter.

The $\overline{\text{busy}}$ output goes low when a conversion is in process, and can be monitored to check that the conversion time is approximately 20μs. If the conversion takes longer, the 47 pF capacitor should be reduced to 39 or 33pF.

The memory circuit shown in Fig. 6 uses two 256×4-bit r.a.ms. Both halves of the memory are addressed by an 8-bit input, and a data word is stored by pulsing the write line low. The write-cycle time depends on the memory in use, the prototype provides a 6μs pulse which is also used for the sample-and-hold circuit. Therefore, while the sample-and-hold circuit is in the sample mode, the digital word for the previous sample is stored in the memory. A 6μs pulse allows low-speed memories to be used, the P8101 device has a cycle time of 1.3μs. However, if the memory is to be accessed by a computer using memory-mapped input/output, IC_{14} and IC_{15} should have similar cycle times to those in the computer memory. The contents of the addressed memory location are available on the output lines and are buffered by IC_{16} and IC_{17}. The states of the output lines can be displayed by eight l.e.ds as shown, or in a two digit hexadecimal format.

To view a transient which has been stored, the recording must be converted to analogue form by an 8-bit d-to-a converter, see Fig.7. This circuit is based on the ZN425E and has a settling time of typically 2μs, which can easily cope with the maximum playback rate of 33k words/s. Op-amp IC_{21} buffers the output and amplifies the signal to produce a voltage range of 0 to +10V. The system gain from the input of the anti-alias filter to the analogue output is therefore unity.

No set-zero or gain adjustments are shown for IC_{21} as these were not found necessary in the prototype. However, IC_{20} may be subject to sample variations, so check that the analogue output is within a few millivolts of 0V when the input lines are all in the low state. When the input lines are all in the high state, the analogue output should be within a few millivolts of 9.96V d.c. Circuit modifications for set-zero and gain adjustments are given in the ZN425E data sheet. Fig.7 also shows a four pole unity-gain Butterworth low-pass filter with a cutoff frequency and rate of 12 kHz and 24 dB/octave respectively.

It is normal practice to use a cutoff frequency corresponding to half the playback rate. One filter is sufficient in this case because the playback rate can be selected. However, the cutoff frequency of the filter can be modified in a similar way to the anti-alias filter.

The logic required to trigger a single sweep of recorded data is shown in Fig.8. Momentary operation of the reset button clears the address counter via the clear line, and momentary operation of the trigger button, or a high-to-low transition on the trigger input, causes the counter to start at a rate determined by the sampling frequency. If the sweep switch is in the single position, the counter reaches 255 and remains in that

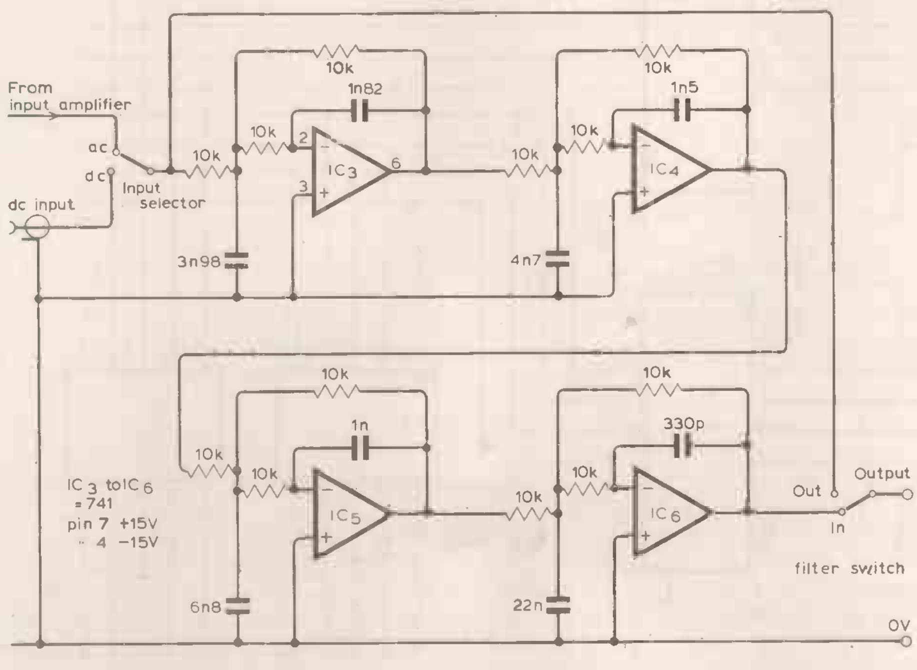
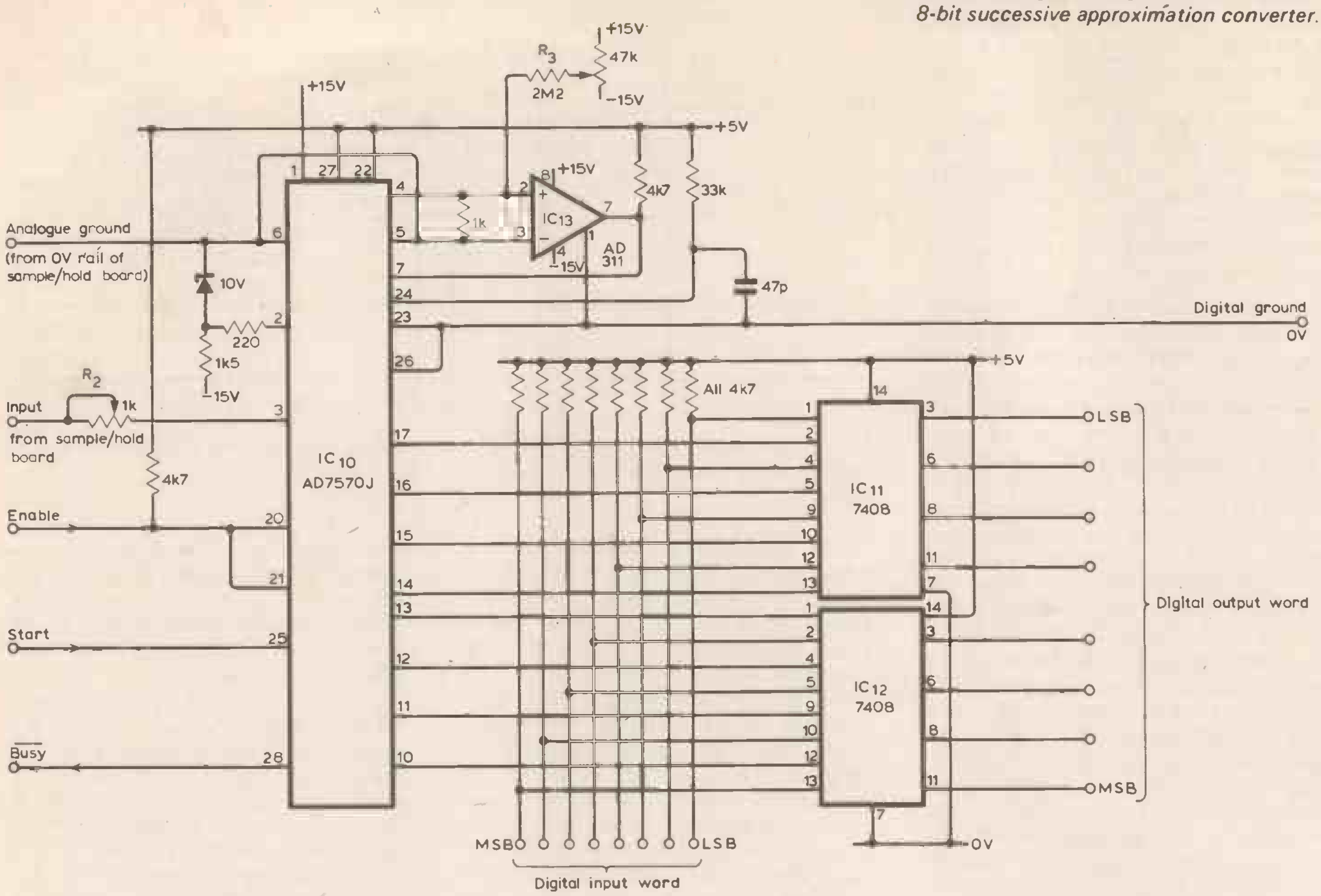


Fig. 3. Anti-alias filter. With the values shown, the cutoff frequency is 6kHz.

Fig. 5. Analogue-to-digital circuit uses an 8-bit successive approximation converter.



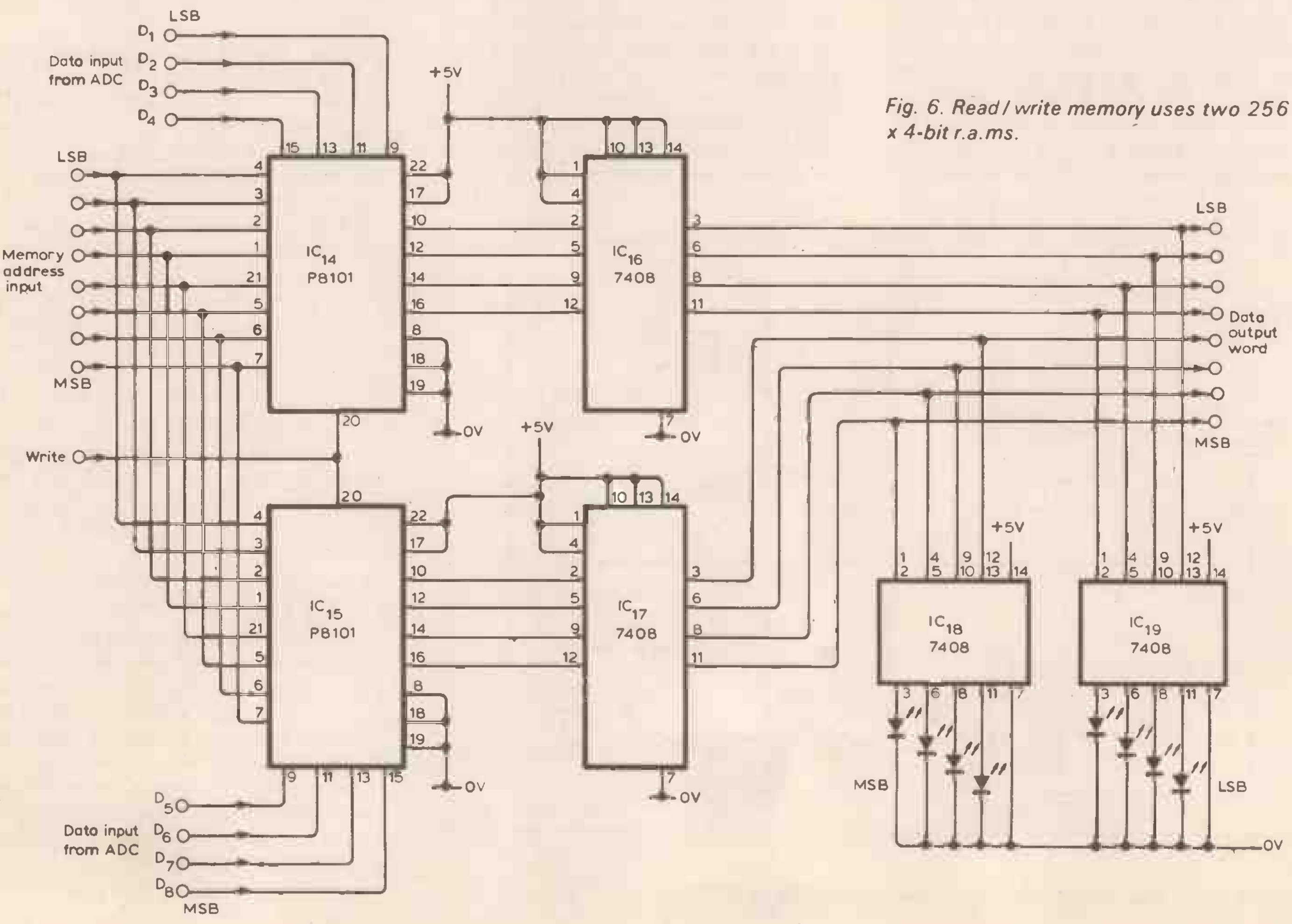


Fig. 6. Read/write memory uses two 256 x 4-bit r.a.ms.

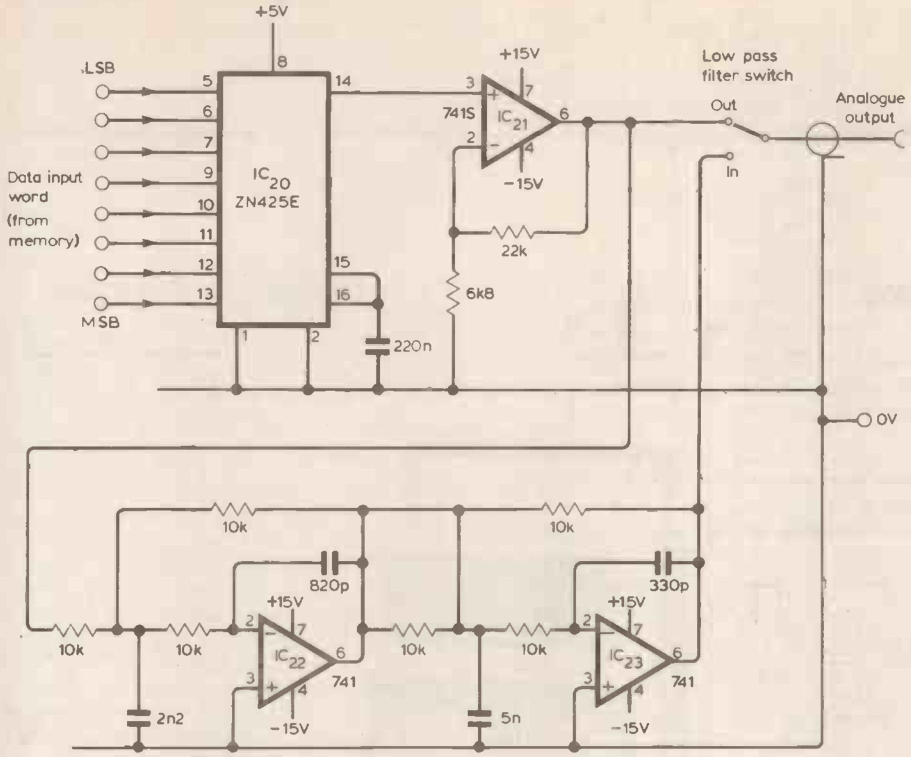


Fig. 7. Digital-to-analogue converter and low-pass filter which can be switched in circuit to smooth the staircase output waveform.

state. The contents of the 256 memory locations are therefore scanned or swept once. If the repetitive mode is selected, the counter continues and scans the memory repeatedly. To store data in the memory the reset button is operated, followed by the arm button which turns on the l.e.d. to indicate that the recorder is ready for a trigger pulse. When a trigger is received, the memory is swept once as before, except that write pulses are sent to the memory, which stores the output of the a-to-d converter after each sample has been taken. During this period the recording l.e.d. is on. When the recording is complete, the address counter continues to scan the memory contents if the sweep switch is in the repetitive position. However, the write signal is now disabled.

To be continued

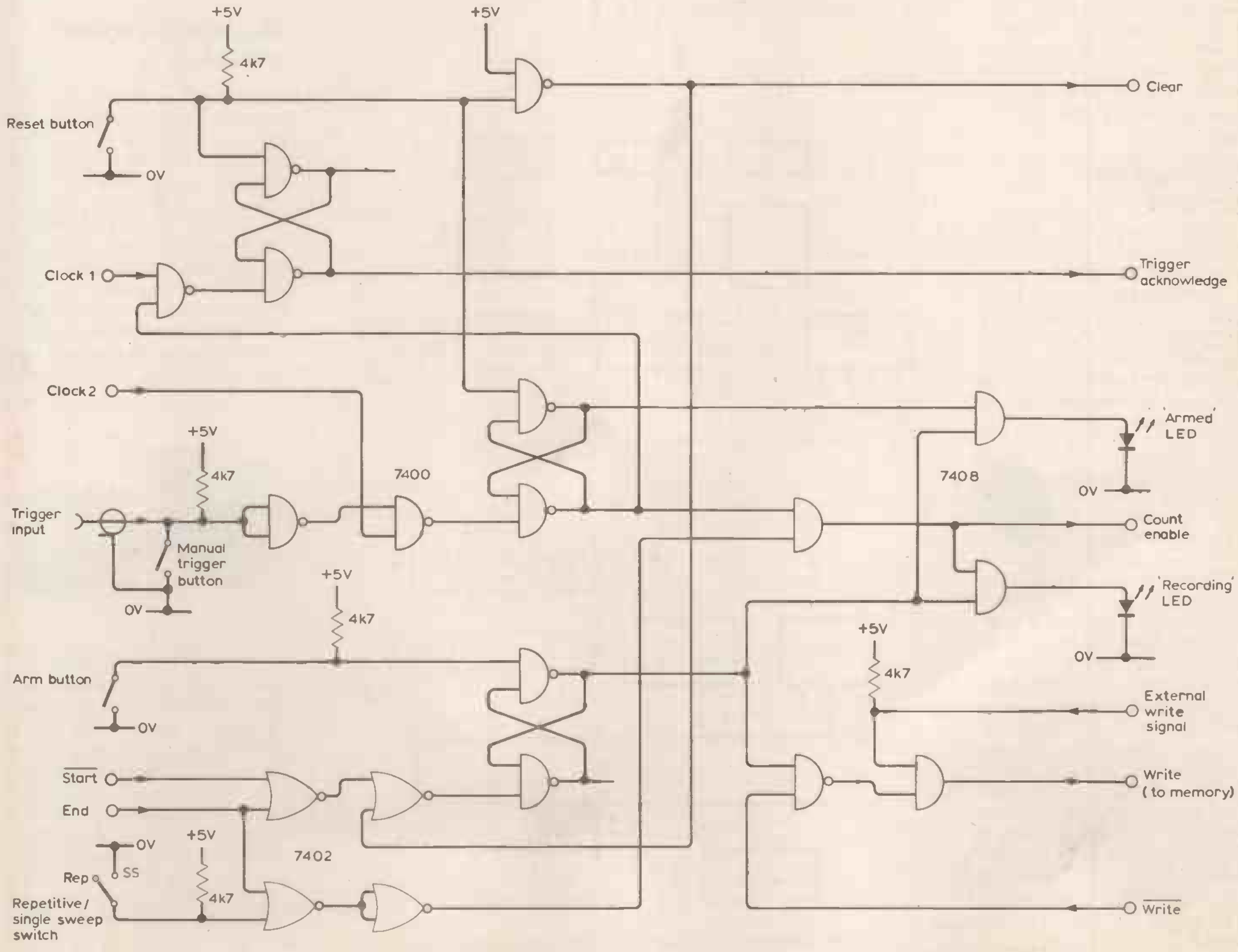


Fig. 8. Control logic triggers a sweep of the recorded data.

NEW PRODUCTS

Lightweight magnetron

This device, the MG5200, is a fixed-frequency magnetron operating in the 94-96 GHz band and is a recent addition to English Electric Valve Co's range of tubes. EEV claims a 50% reduction in weight over the standard design, which has been achieved by the use of a rare-earth samarium cobalt magnet structure, although the tube is basically an extension of the company's range of 80 and 90 GHz magnetrons. Like the earlier forms, this item has an expected life of more than 750 hours. The MG5200 can operate at pulse lengths down to 4ns and is suitable for use in high-resolution radar applications. Essential data includes a peak anode voltage rating of 13kV, peak anode current of 7A, duty cycle at 0.0002, pulse duration 50ns, and output power 3kW. Cooling is by forced air. Overall dimensions are 152 x 108 x 76.5mm and the magnetron weighs 1.8kg. English Electric Valve Co Ltd, Waterhouse Lane, Chelmsford, Essex CM1 2QU.

WW301

R.f. amplifier modules

The QB-614 and QB14-2 are r.f. amplifier modules which cover the ranges of 2 to 300MHz and 5 to 200MHz respectively. Each amplifier is encapsulated in a black epoxy case which, according to the distributors, March Microwave, represents a total volume of 0.17 ins. The quoted inherent noise figure is 1.5dB

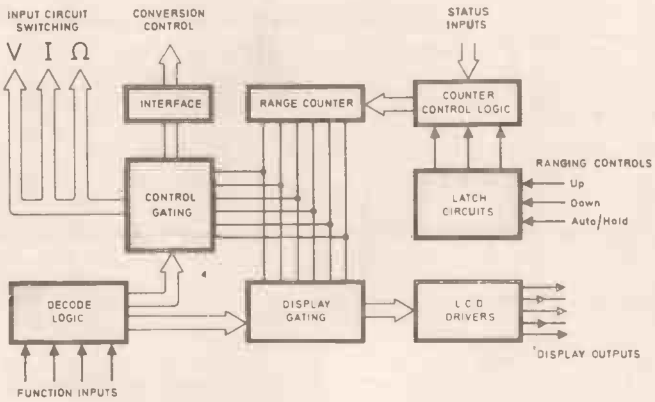
(QB-614-2), v.s.w.r. is 1.5:1 and signal gain is 12-13dB. Several amplifiers can be cascaded without loss of bandwidth and an internal power-line-decoupling network minimizes interference problems. Each module operates from a supply of 15V at 10mA, although satisfactory operation is possible with a supply rail of only 9V; connexions are made to 5 pins and each unit can be p.c.b. mounted. In small quantities the QB-614 costs £28 each and the QB-614-2 £35. March Microwave Ltd, 112 South St., Braintree, Essex.

WW302

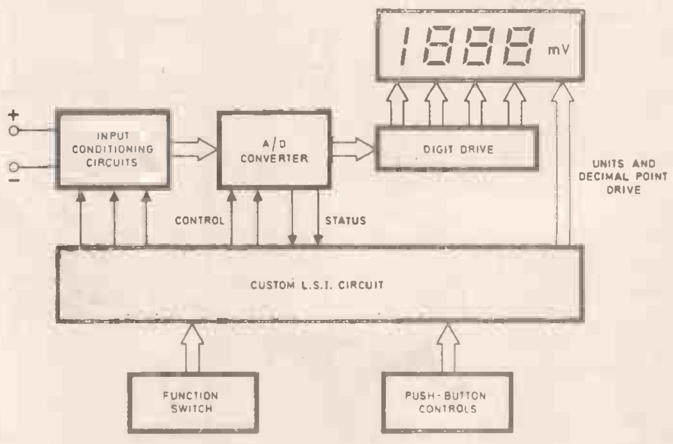
Auto-ranging Avometer

Full autoranging facilities are claimed for the model DA117 Avometer by the makers, Avo Ltd. This meter is an l.s.i.-based version of the Avo digital model DA116, which has been in production for some time. According to the company responsible for the development of the l.s.i. chip used in the DA117, GEC Semiconductors, fast autoranging was not possible in the field for vital checks on d.c. voltage, current and resistance, using the "separate chip" methods used in the DA116. The 50 or so needed to give the required auto-ranging capability were therefore replaced by a custom-designed l.s.i. chip. Measurement ranges cover a.c. or d.c. voltage up to 1000V, a.c. or d.c. current up to 2A (10A manual) and resistance up to 20M. A semiconductor junction test facility is also included. The price of the DA117 is £135 plus v.a.t. Avo Ltd, Archcliffe Road, Dover, Kent.

WW303



CIRCUITS CONTAINED WITHIN THE L.S.I. CUSTOM CIRCUIT



BLOCK DIAGRAM OF THE AVO DA117 AUTORANGING MULTIMETER

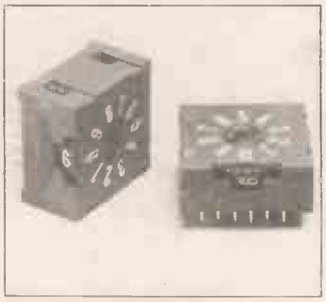
High friction mats

One of the main problems related to delicate work on small circuits or instruments is the tendency of the workpiece to move about on the workbench. "Stop slip" high friction mats are intended as an answer to this problem. The mats, made by the Swiss company Spirig and marketed in the UK by Cobonic, are elastomer material available as 1mm or 2mm thicknesses in dimensions up to 1m square. This material constitutes a scratch-preventive working surface which, according to the makers, can act as a "third hand" while soldering or fine adjustment is being carried out without the workpiece suffering crushing or scratching in the jaws of a vice. Cobonic Ltd, Knapton Mews, Seely Rd, London SW17 9RL.

WW304

Mini thumbwheel switches

A new range of thumbwheel switches, made by Roxburgh Electronics, is said to be resistant to process contamination as well as being suitable for wave soldering to p.c. boards, without the need for special precautions. The switches are available in two main forms: a low profile form and a taller, sealed form; each switch can be mounted directly to a p.c. board and is available with clockwise or anticlockwise rotation. In the sealed form a



heat-sealed sub-assembly encloses the electrical contacts and an O-ring gasket seals the rotating surfaces. Maximum non-switching load of all forms is 1A at 28V d.c., max. switching load is 100mA at 28V d.c., contact resistance is 100milliohms (first contact) and the operating temperature is −10°C to +65°C. Roxburgh Electronics Ltd, 22 Winchelsea Road, Rye, Sussex.

WW305

Audio level meter

Levels of audio signals between —72dB and +22dB with respect to zero level can be measured with this instrument, which comprises a peak-programme meter preceded by an amplifier. The p.p.m. measurement technique conforms to BS 5428 and calibration accuracy is 0.1dB. Amplifier gain is selected by eight press switches, giving 10dB steps from —60dB to +10dB, and there is also a rotary control which can be switched in to give a continuous 0 to —10dB uncalibrated variation. Input impedance is 100kΩ balanced but switchable to 600Ω and maximum input is 400V pk continuous. The amplifier output, available through a headphone jack socket, has an impedance of 50Ω and is short-circuited protected. The instrument is powered by rechargeable batteries and has a built-in mains adapter which continuously recharges them. Dimensions are 175 x 67 x 166 mm. Named, perhaps misleadingly, "Audio Multimeter", the level meter costs £198.28 plus v.a.t. Bulgin Electronics Soundex Ltd, Park Lane, Broxbourne, Herts, EN10 7NQ.

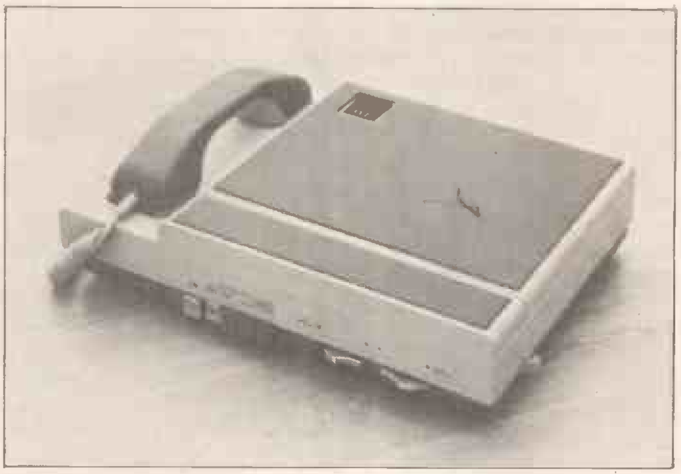
WW306

Telephone answering machine

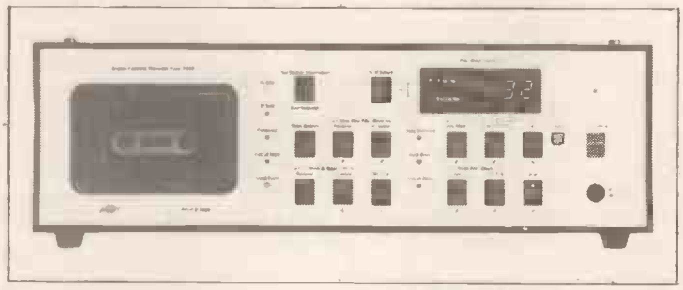
Each function of the Storacall Ansamaster II telephone answering machine is continually monitored by the self-contained microcomputer which directs operations. The makers say that the unit can "talk" to the operator through an alphanumeric display, the machine also indicating how much recording time has elapsed, how many calls have been received, which call is being played back, whether a call is being taken and faulty operation either by user or due to a faulty cassette being used. Standard features such as fast forward and fast rewind are complemented by a "remote call" facility, which enables the user to listen to messages without having to return to home or office. A voice code is used to activate the unit, this code being programmed by the setting of five switches on the back panel. The unit can be rented for £3.36 per week or purchased outright. Price is available from the manufacturer on request. Storacall Ltd, 28 York St, Twickenham, Middlesex.

WW307

WW306



WW307



WW308

Cassette data recorder

The primary application quoted by B and K for its type 7400 digital cassette recorder is the monitoring of measurement instrument digital outputs. Up to 500 K-bytes of data, transmitted over the IEC/IEEE bus or B and K low-power interface bus, can be recorded on a standard digital tape cassette and reconstructed on the bus later. The unit incorporates full manual and remote control facilities, permitting use independently of an IEC/IEEE controller during the recording or reading of data in the field. The recording formats meet ECMA 34 and ECMA 41 (Basic System). A 4-digit tape location display indicates the position of the tape and a "search" function can be used to speed the retrieval of data. In view of its conformity to ECMA standards, cassettes recorded on the 7400 can be read by ECMA compatible terminals and vice versa. The average record/read speed is 1000 bytes/sec with a tape speed of 15 i.p.s. Error-checking procedures are incorporated to ensure recording and reading accuracy; the search speed is 30 i.p.s. and the re-wind speed approximately 100 i.p.s. The unit may be powered from either a.c. or d.c. supplies. B and K. Laboratories Ltd, Cross Lances Road, Hounslow, Middlesex.

WW308

Gallium phosphide l.e.ds

Ten times as much light, compared with conventional l.e.d. lamps, is the main claim made by General Instrument for its two new ranges of l.e.ds, specified as MK9150/MK9350. Unlike most l.e.ds, the new illuminator is made using a process in which a nitrogen-doped gallium arsenide phosphide layer is grown on a gallium phosphide substrate. As gallium phosphide is transparent to light, greater light emission is possible and the makers claim operation of each

WW309

WW310

l.e.d. at 500mW, with a light output comparable with that of incandescent filament lamps, although with a longer lifespan and less susceptibility to damage by vibration. Each l.e.d. consists of two chips wired in series and mounted in an injection moulded package with an integral lens and reflector. General Instrument, Unit 2, Cock Lane, High Wycombe, Bucks.

WW309

Combined accelerometer and pre-amp

An accelerometer with a frequency response of 1.5Hz to 25kHz, a nominal sensitivity of 2mV per G and a noise floor of 0.01G r.m.s. is combined with a pre-amplifier to form the BBN Instruments' 501-ER. Natural frequency of resonance of the accelerator is 85kHz and it is said by the distributors, Data Acquisition Ltd, to be capable of withstanding a shock of 10,000G. Amplitude error from noise floor to 1000G is 1% and special versions, with a similar error level, are available for shock levels up to 4,000G. Output impedance is 1,200Ω. The case, which measures approximately 8×6mm, is made of titanium and the complete unit is fitted with a coaxial cable and microdot connector. Matching power supplies are available which include a b.n.c. output connector to enable results to be viewed on an oscilloscope or spectrum analyser. Data Acquisition Ltd, Electron House, Higher Hillgate, Stockport, Cheshire.

WW310

SIDEBANDS

By Mixer

Chimera

It's no good – I've got to say it. There is something about the way everyone is going steadily crackers over microcomputers and things that makes me want to hit somebody. Private small computers and processors have been with us several years now, and off-hand I can't think of one single way in which the human spirit has been uplifted or the sum of human happiness increased by their presence. I suppose I ought to keep my mouth shut, because I don't want to be a bore on the subject, but it's hard to sit by and watch the world's youth dedicatedly chasing rainbows without at least a nod as they go past.

There are two aspects of this madness that bother me, either of which is a subject fit for the pen of a philosopher or a psychologist, or both. Since I am neither, my views will probably be dismissed, but I'm having a go anyway. Firstly, there is the colossal waste of intellect and skill in designing and making the equipment. You take a team of scientists, engineers and production workers, put them to work for a couple of years with the directive to produce a better home computer. They carry out the task happily, because at least the product isn't going to kill anyone. It will perform all manner of impressive tricks in hardly any time at all and there will be thousands of people perfectly willing to be convinced that life without their own microcomputer is barely worth living. So they lay out anything up to £1,000 on the gear and promptly come face to face with a problem. Once they've worked out a set of trig. tables, discovered that they can't really afford to go on paying the mortgage and driven themselves and all their friends daft with playing one of those games, the overriding and pressing reasons for buying the thing in the first place begin to seem less than obvious. Not everyone has a compelling need to know the date of Easter in 2067, and many people I know find that a set of boxwood Staunton pieces on a big wooden board that doesn't go 'bleep' every so often satisfies most of their needs.

I don't propose to labour the second point, because I'm going on a bit, but I did just want to say that the sight of a bright-eyed youngster of twelve or thirteen solemnly sitting in front of a keyboard and v.d.u. is one that fills me with a sense of deep unease.

Maybe a government mental health warning would be a good idea.

Jingo lingo

It looks as though a citizens' band – or open channel – will be with us eventually, for certain. It's been approved in principle and all we need to know now is the frequency and type of modulation. It's good news – I think. Yes, I'm sure it is. Isn't it? Of course it is. It's what we've wanted for a long time, and it's a very good thing. It must be, I suppose.

I am, as you may have been able to discern, over the moon about the prospect of o.c. Well, actually, there is just one niggling little thought that is preventing me from climbing Nelson's column to proclaim my exultation to the world – what about language? What I mean is, will we be expected to use the same kind of gobbledegook as I am led to believe the Americans do? Will we require to become adept at assuring each other that, for example, a number of bears in plain wrappers have been sighted using a camera? Must we really refer to slavedriving sneakers in boots who are bleeding?

From the information I have been able to obtain from a study of some of the more strident c.b. publications, the language used by US c.b. operators seems to be designed more to conceal the message than to convey it. Since it appears not to be playing the game at all to say what you mean, we are going to have to develop our own o.c. language, if only to avoid incongruities. Tijuana taxis, for example, possess little relevance to Basingstoke.

There is a whole new sub-culture emerging here. Police cars will become fuzz-boxes; linear amplifiers can be outboards; the Post Office may well be referred to as Big Ears and the o.c. system itself as a rod and tackle. All it needs is a little imagination.

Closed shop

In any occupation where you are accessible to thousands of people, you are pretty well certain to come across one or two oddballs sooner or later. It can sometimes be a bit tricky, though, to decide which of the apparent oddballs are the one hundred per cent, 22 carat, genuine article and which only appear to be, their seemingly screwy ideas being revealed after mature consideration to be full of sound sense. Faced with someone who does appear, at first sight, to be a little off the beaten track, the people here usually find it pays not to jump to conclusions but to listen first and at least to extend the normal courtesies of reply to anyone who wants to talk to us. We get ourselves into some fairly glutinous conversational and postal quagmires this way, but it's a lot safer and certainly less offensive than simply refusing to talk to anyone who seems unconventional.

Judging by what I am told by a friend of mine who might qualify as an oddball, there are a great many people around in editors' chairs and in universities who seem to imagine that anyone who doesn't have a Ph.D. to wave and who prefers fishermens' jerseys to more pedestrian wear must have a tile loose and cannot be worth the negligible trouble of a considered reply to straight proposal or question.

My friend is a qualified mechanical engineer who has had the colossal cheek to venture away from his ordained path and to question some established natural 'laws' of nature. Whether he is right in his ideas or not, I am not able to judge, although they do possess considerable force and logic. Right or not, though, he experiences an almost total refusal by scientists to discuss his ideas or even, in some cases, to acknowledge his existence.

If his work is ill-founded tripe, then he has yet to hear an explanation of why it is. If it is not, why does no one acknowledge that, just possibly, he might have something? Scientists, by definition, are supposed to be seekers after knowledge: there is no law which says that the search must be the prerogative of those with a conventional training.

Look and learn

It was, I thought, considerate of the BBC and IBA to show all us trainee terrorists how the army and police go about their side of an operation like the Iranian Embassy caper. There aren't many ways in which we can gain experience of modern methods, apart from applying to join a terrorist gang, and they all have long waiting lists. So the training course on television, especially IBA television, will have been very worthwhile for a lot of probationers who haven't yet got much beyond blowing out the odd shopfront here and there.

Of course, the television programmes weren't really for our benefit: of course not. That would have been silly. No, I expect the chaps actually inside the embassy found them much more immediately useful than we did. And all praise here to the IBA, who smuggled their cameras courageously past the pi . . . police cordon to the back of the building, where the soldiers came down from the roof. Without those pictures, our lot might have made the same mistakes again, sometime in the future.

It has often been said that British television is the best in the world, particularly by British television people, who ought to know, and I think this proves their point. Which other country's networks would display such devotion to the educational interests of minority groups?

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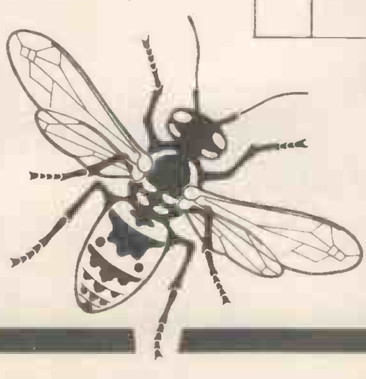

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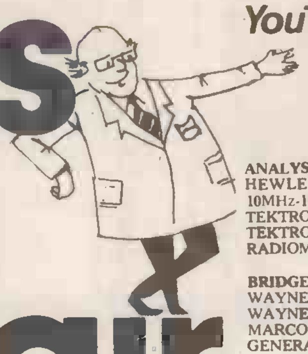

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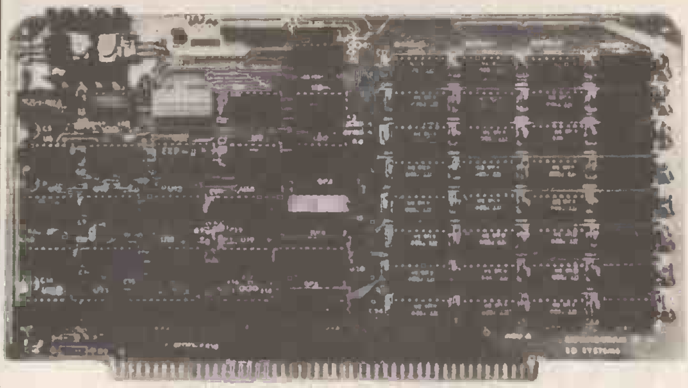

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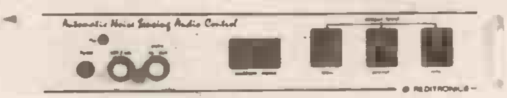

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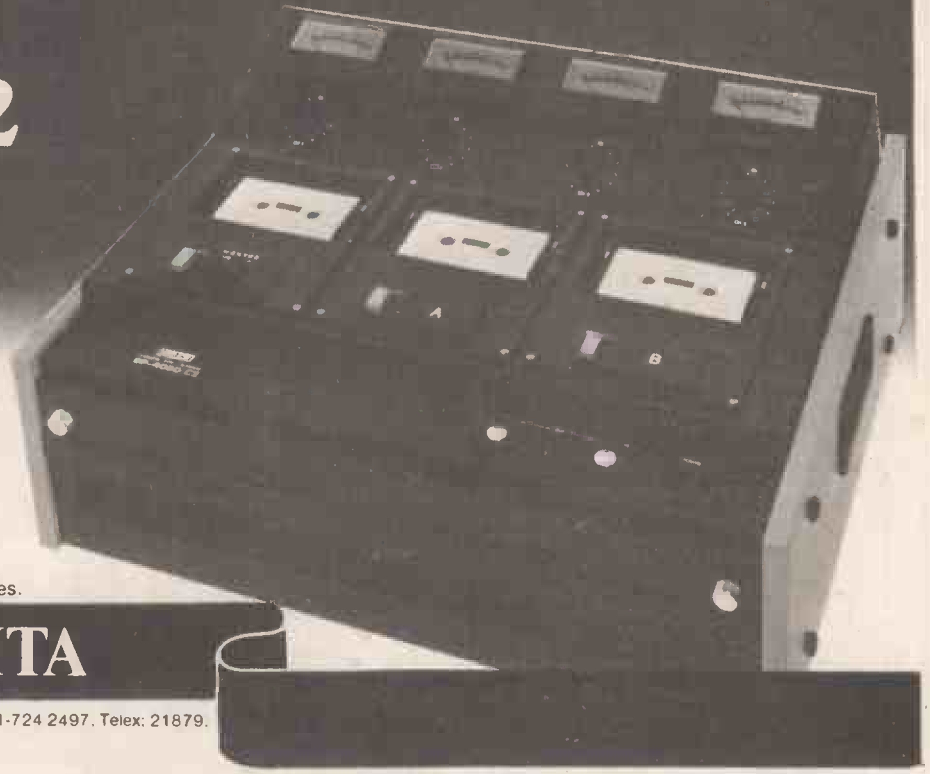

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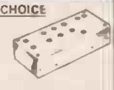

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2N3820	0.52
2N3823	0.63
2N3866	0.83
2N3904	0.15
2N3905	0.15
2N3906	0.15
2N4058	0.16
2N4059	0.12
2N4060	0.14
2N4061	0.14
2N4062	0.15
2N4124	0.17
2N4126	0.17
2N4286	0.23
2N4288	0.25
2N4289	0.28
2N5457	0.40
2N5458	0.40
2N5459	0.40
2S017	7.48
2S019	7.48
2S026	13.80
2S103	1.73
2S302	0.86
2S303	0.86
2S322	0.92
2S324	1.44
2S701	1.73
2S745A	6.40
2S746A	0.40

VALVES

A1834	10.35
A2087	13.58
A2134	10.06
A2293	8.62
A2426	17.63
A2521	11.62
A2900	10.98
A3343	25.56
AZ31	1.26
AZ41	1.32
BK448	88.43
BK484	119.54
BS90	31.33
BS810	35.24
BT5	43.47
BZ17	79.29
BT19	27.08
BT29	242.93
BT69	247.30
BT75	102.46
BT95	95.16
CBL31	2.30
CL33	2.30
CY31	1.15
C1K	11.50
C3A	11.50
C3JA	23.23
DA41	21.50
DA42	12.30
DA100	52.90
DAF91	0.46
DAF96	1.15
DET22	24.15
DET24	52.90
DF91	0.46
DF96	1.15
DK91	1.21
DK92	1.44
DK96	1.26
DL92	1.26
DL94	1.38
DL96	1.26
DLS10	9.48
DLS15	12.37
DLS16	12.37
DLS19	12.37
DM70	1.44
DM71	1.44
DM160	3.96
DY86/7	0.73
DY802	0.96
E55L	25.17
E80CC	9.27
E80CF	11.96
E80F	9.75
E80L	9.51
E81CC	6.62
E81L	10.28
E82CC	7.03
E83CC	7.16
E86C	12.48
E88C	6.71
E88CC	3.86
E90CC	9.34
E90F	9.71
E91H	5.34
E92CC	8.86
E99F	9.39

E130L	19.39
E180CC	8.86
E180F	7.83
E182CC	9.34
E186F	11.62
E188CC	7.36
E280F	25.88
E283CC	10.93
E288CC	17.25
EA52	19.43
EA76	2.02
EABC80	1.38
EAC91	0.92
EAF42	1.44
EAF801	2.02
EB41	2.30
EB91	1.01
EBC33	2.02
EBC41	1.44
EBC81	1.26
EBC90	0.97
EBF80	0.58
EBF83	1.44
EBF89	0.97
EBL31	2.88
EC90	1.26
EC91	8.35
EC92	1.44
EC157	276.92
ECC33	4.02
ECC35	4.02
ECC40	2.30
ECC81	1.01
ECC82	0.82
ECC83	1.01
ECC84	1.36
ECC85	1.38
ECC86	2.30
ECC88	2.07
ECC89	1.88
ECC91	10.27
ECC189	1.90
ECC807	2.02
ECC808	2.59
ECF80	1.24
ECF82	1.38
ECF86	1.73
ECH35	2.30
ECH42	1.32
ECH81	1.38
ECH83	1.44
ECH84	1.47
ECL80	1.15
ECL81	1.73
ECL82	1.15
ECL83	1.73
ECL84	1.61
ECL85	1.28
ECL86	1.38
EF37A	4.02
EF39	3.16
EF40	1.32
EF41	2.30
EF42	2.30
EF50	1.73
EF54	5.75
EF55	2.88
EF80	0.92
EF83	2.02
EF85	0.92

EF86	1.74
EF89	1.84
EF91	2.07
EF92	6.03
EF93	1.15
EF94	1.24
EF95	6.27
EF98	1.44
EF183	0.92
EF184	0.96
EF804S	12.65
EF805S	8.05
EH90	1.61
EK90	1.24
EL32	1.73
EL33	4.02
EL34TH	2.53
EL34MUI	3.16
EL36	1.84
EL41	1.44
EL42	2.02
EL81	2.88
EL83	1.44
EL84	1.15
EL86	2.88
EL90	1.10
EL91	8.21
EL95	1.51
EL156	97.60
EL360	6.32
EL500/504	2.16
EL509	3.63
EL821	11.06
EL822	11.38
EM34	5.75
EM80	1.26
EM81	1.15
EM84	1.15
EM85	1.44
EM87	1.73
EN32	16.28
EN91	2.94
EN92	6.18
EY51	2.02
EY81	1.89
EY83	2.02
EY84	10.57
EY86	0.96
EY88	2.02
EY500A	2.23
EY802	94
EZ35	97
EZ40	1.44
EZ41	1.44
EZ80	0.96
EZ81	0.96
EZ90	1.38
FW4-500	2.88
FW4-800	2.88
G1.371K	23.23
G551K	12.65
G180.2M	18.42
G240.2D	12.85
G400.1K	19.28
GN4	8.62
GN4A	8.62
GS16	10.35
GT1C	14.38
GU50	14.31
GU51	13.62

GXU1	16.10
GXU2	28.43
GXU3	30.49
GXU4	32.77
GXU50	12.80
GY501	3.16
GZ32	1.44
GZ33	4.60
GZ34	2.88
GZ37	4.60
KT61	4.02
KT66	11.50
KT88	13.80
KTW61	2.02
KTW62	2.02
KTW63	2.02
M8079	11.59
M8080	7.68
M8081	9.95
M8082	6.41
M8083	7.59
M8091	10.85
M8096	4.31
M8097	4.09
M8098	4.37
M8099	5.98
M8100	8.23
M8136	8.46
M8137	8.72
M8140	5.17
M8141	5.52
M8142	6.15
M8144	4.31
M8149	5.86
M8161	7.87
M8162	7.59
M8163	5.17
M8190	5.29
M8195	4.25
M8196	7.47
M8204	6.57
M8212	11.76
M8223	3.17
M8224	3.85
M8225	2.99
M8248	11.55
MU14	1.73
MX119	53.82
MX123	63.25
MX145	50.40
MX151	15.18
MX152	115.00
MX161	129.72
MX163	19.55
MX164	21.14
MX166	126.50
MX168	40.25
N78	10.35
OA2	1.96
OA3	5.69
OA4	4.02
OB2	1.44
OB3	2.20
OC2	3.04
OC3	2.20
OD3	2.20
OZ4	1.84
PC86	1.61
PC88	1.61
PC95	1.49

PC97	1.38
PC900	1.38
PCC84	1.15
PCC85	1.38
PCC88	1.38
PCC89	1.56
PCC189	1.61
PCC805	1.51
PCC806	2.07
PCE82	2.07
PCF80	1.15
PCF82	1.15
PCF86	1.84
PCF87	1.84
PCF200	3.74
PCF201	2.45
PCF801	1.84
PCF802	2.19
PCF805	1.84
PCF806	1.84
PCF808	1.84
PCL82	1.15
PCL83	2.30
PCL84	1.15
PCL85	1.24
PCL86	1.24
PCL805/85	1.24
PD500	4.14
PE06-40N	31.40
PFL200	2.07
PL36	1.38
PL81	1.38
PL81A	1.38
PL82	1.38
PL83	2.55
PL84	1.24
PL504/5	1.61
PL508	2.07
PL509	3.73
PL519	3.73
PL801	1.27
PL802	3.40
PY33	1.27
PY81	0.97
PY82	0.92
PY83	0.81
PY88	1.01
PY500A	2.07
PY800	0.97
PY801	0.97
QQV02-6	13.91
QQV03-6	5.44
QQV03-20A	20.13
QQV06-40A	40.25
QQV07-50	53.13
QQZ03-20A	59.80
QQZ06-40A	55.10
QU37	14.38
QV03-12	4.31
QV04-7	2.01
QV08-100	118.45
QY3-65	53.74
QY3-125	56.78
QY4-250	65.93
QY4-400	75.67
QY5-500	59.39

QY5-3000A	82.56
QZ06-20	27.72
R10	5.75
R17	1.89
R18	4.89
R19	1.38
R20	1.66
RG3-250	32.49
RG3-250A	34.09
RG3-1250	29.56
RG4-1250	13.13
RG4-3000	75.44
RR3-250	48.68
RR3-1250	86.20
S11E12	30.48
S130	2.30
S130P	2.88
STV280-40	111.50
STV280-80	24.15
SU41	2.88
SU42	10.35
TD03-10	24.73
TD03-10E	8.16
TD03-10F	27.60
TT15	34.50
TT21	14.16
TT22	14.16
TT100	59.51
TY2-125	65.33
TW4-400	71.61
TY4-500	95.40
TY5-500	147.20
TY6-800	165.70
TY6-5000A	263.05
TY6-5000B	236.90
TY6-5000W	23 V44
TY7-6000A	286.93
TY7-6000W	232.47
TZ40	17.25
U18-20	2.88
U19	10.33
U25	1.33
U26	1.66
U37	10.35
UABC80	1.44
UAF42	1.44
UB41	1.44
UBC41	1.73
UBF89	1.38
UCC84	1.26
UCC85	1.38
UCF80	1.32
UCH42	1.38
UCH81	2.67
UCL82	1.20
UCL83	1.66
UF41	1.15
UF42	1.44
UF80	1.66
UF85	1.66
UF89	1.66
UL41	2.88
UL84	1.38
UM80	1.15

UY41	1.44
UY85	1.20
VLS631	15.24
XG1-2500	32.37
XG2-6400	92.98
XG5-500	19.32
XGQ2-6400	106.15
XR1-1600A	27.54
XR1-3200	76.94
XR1-3200A	76.94
XR1-6400	84.24
XR1-6400A	149.30
YD1120	210.60
YD1240	241.50
Z759	11.04
ZM1000	6.03
ZM1001	6.19
ZM1020	10.63
ZM1021	10.17
ZM1022	10.60
ZM1023	8.81
ZM1040	22.26
ZM1041	19.16
ZM1042	20.44
ZM1051	100.05
1B3GT	2.58
1B24	11.50
1B35A	28.75
1B63	57.50
1R5	1.21
1S5	0.46
1T4	0.46
2AS15	11.50
2C39A	21.85
2C43	20.70
2D21	2.94
2E26	7.82
2J42	89.70
2J55	201.25
2J70A	270.25
2J70B	287.50
2K25	40.25
3-400Z	51.75
3-500Z	63.25
3A5	1.55
3B24	9.20
3B28	5.18
3B29	11.50
3B240M	17.25
3B241M	17.25
3C23	13.89
3C45	22.77
3CX100A5	23.00
3E29	29.67
3S4	1.26
3V4	1.38
465A	29.15
4-125A	41.99
4-250A	41.99
4-400A	52.05
4B32	29.16
4C35	46.00
4CX250B	28.53
4CX350A	48.88
4X150A	24.41
4X150D	28.75

5B254M	23.12
5B255M	23.12
5C22	46.00
5J180E	851.00
5R7GY	2.30
5U4G	4.35
5U4GB	2.60
5V4G	1.75
5Y3GT	0.98
5Z3	1.73
5Z4G	1.75
5Z4GT	1.75
6-30L2	1.79
6AB4	1.44
6AB7	1.73
6AC7	1.61
6AF4A	1.84
6AG7	2.30
6AH6	5.52
6AK5	3.98
6AK6	2.81
6AL5	1.01
6AM4	2.65
6AM5	4.43
6AM6	2.07
6AN5	6.12
6AN8A	3.80
6AQ5	1.10
6AS5	1.84
6AS6	6.42
6AS7G	7.76
6AT6	0.98
6AU5GT	4.81
6AU6	1.24
6AV5GT	4.36
6AV6	0.98
6AX5GT	3.57
6B7	1.73
6B8	2.02
6BA6	1.15
6BA7	5.89
6BA8A	4.31
6BC4	4.27
6BE6	1.24
6BH6	1.75
6BJ6	1.24
6BK4	4.84
6BL6	97.75
6BL7GT	4.44
6BM6	97.75
6BN6	1.89
6BQ7A	4.14
6BR7	4.60
6BR8	2.02
6BS7	4.60
6BW6	4.60
6BW7	1.75
6BX7GT	5.70
6BZ6	2.62
6C4	1.01
6CB6A	2.86
6CD6GA	5.64
6CG7	2.55
6CH6	7.48
6CL6	4.12
6CW4	8.33
6D2	1.01
6DK6	2.59
6DQ6B	4.49
6EA8	3.31

6EB8	2.44
6EW6	1.73
6F6	2.02
6F23	1.84
6F28	1.33
6F33	22.08
6H1	14.38
6H2N	1.21
6H3N	1.21
6H6	1.73
6J4	6.10
6J6	6.21
6J7	9.04
6K4N	1.44
6K6GT	1.50
6K7	1.73
6K8	2.02
6KD6	7.08
6L6G	2.88
6L6GA	1.73
6L6GT	2.24
6L6GC	2.88
6L7	2.30
6N2P	1.21
6N3P	1.21
6N7	1.73
6P25	4.14
6Q7	2.53
6R7	2.07
6SA7	1.67
6SC7	1.73
6SF7	1.84
6SH7	1.73
6SJ7	1.84
6SK7	1.50
6SK7GT	3.08
6SN7GT	1.84
6SQ7	1.50
6SR7	1.73
6SS7	2.07
6U5G	2.30
6U8	0.92
6U8A	3.24
6V6GT	1.84
6X4	1.38
6X5GT	0.97
7B7	1.96
7C5	3.40
7C6	2.60
7H7	2.30
7R7	1.73
7S7	2.59
7Y4	1.84
7Z4	2.13
11E3	60.82
12AT6	1.38
12AT7	1.01
12AU6	2.83
12AU7	0.83
12AV6	2.30
12AV7	3.98
12AX7	1.01
12AY7	5.24
12B4A	3.50
12BA6	2.42
12BE6	2.55
12BH7	1.29
12BY7	3.01
12E1	8.17
12E1ITT	19.26

12E14	34.50
13E1	62.20
19H4	28.75
19H5	40.25
24B9	43.87
30C15	1.84
30C17	1.84
30C18	1.84
30F5	1.93
30FL1/2	1.28
30FL12	2.07
30FL14	1.84
30L1	1.15
30L15	2.07
30L17	2.07
30P4	1.06
30P19	1.38
30PL13	2.07
30PL14	1.93
30PL15	2.07
35W4	0.69
50C5	0.81
75B1	4.26
75C1	2.24
85A1	8.63
85A2	2.42
90AG	9.15
90AV	9.15
90C1	2.47
90CG	15.73
90CV	15.30
92AG	9.15
92AV	9.15
95A1	6.56
150B2	2.76
150B3	5.06
150C2	1.73
150C4	2.42
211	6.90
723AB	40.25
803	11.50
805	23.00
807	2.30
811A	9.78
812A	9.60
813	36.80
833A	86.25
866A	6.61
872A	15.81
922	5.01
931A	14.08
1624	2.59
1625	1.96
2050	8.00
4212E	169.90
4212H	207.00
5544	62.10
5545	67.85
5551A	88.44
5552A	119.54
5553A	259.10
5642	6.05
5654	4.05
5651	2.07
5670	5.29
5675	14.03
5687	7.08
5696	4.53
5718	7.36
5725	6.28

5726	4.05
5727	5.52
5749	5.73
5751	5.36
5763	4.14
5814A	4.81
5840	5.06
5842	15.59
5876A	13.06
5879	5.57
5886	12.08
5963	3.45
5965	4.07
6005	6.33
6021	5.13
6057	4.02
6058	10.40
6059	4.60
6061	4.89
6062	4.31
6063	4.20
6064	6.50
6067	4.02
6072	6.53
6080	7.88
6097A×B×C	46.00
6146A	5.89
6146B	6.42
6159	9.18
6189	9.25
6201	5.93
6442	17.25
6883B	6.81
6973	4.05
7025	2.62
7551	6.83
7586	13.09
7587	22.54
7609	36.57
7868	4.53
7895	14.84
8005	34.50
8068	6.33
6122	48.30
8136	2.81
8417	6.14
18042	6.92
18045	10.66

Tested
Ex-Equipment
4CX250B 5.75

BASES

B7G unskirted	0.17
B7G skirted	0.35
B9A unskirted	0.17
B9A skirted	0.35
Int Octal	0.29
Loctal	0.63
Nuvistor base	0.86
8 pin DIL	0.17
14 pin DIL	0.17
16 pin DIL	0.20
Valve screening cans all sizes	0.35

CRTs

2AP1	9.78
2BP1	10.35
3BP1	11.50
3DP1	10.35
3EG1	8.05
3FP7	6.90
3GP1	6.90
3JP1	9.20
3JP2	9.20
3JP7	11.50
3KP1	17.25
3RP1	40.25
3WP1	23.00

5ADP1	40.25
5BP1	11.50
5CPJ	11.50
5CP1A	46.00
5FP15A	17.25
5UP7	16.10
DG7-5	28.75
DG7-32	41.40
DH3-91	35.65
DH7-11	78.20
VCR97	13.80
VCR138	11.50

VCR138A	14.38
VCR139A	9.20
VCR517A	11.50
VCR517B	11.50
VCR517C	11.50

Tube Bases
Prices on application

INTEGRATED CIRCUITS

7400	0.18
7401	0.18
7402	0.18
7403	0.18
7404	0.20
7405	0.18
7406	0.46
7407	0.46
7408	0.23
7409	0.23
7410	0.18
7412	0.30
7413	0.37
7416	0.37
7417	0.37
7420	0.20
7422	0.23

7423	0.37
7425	0.35
7427	0.35
7428	0.49
7430	0.20
7432	0.35
7433	0.41
7437	0.37
7438	0.37
7440	0.21
7441	0.97
7442	0.83
7447AN	1.04
7450	0.21
7451	0.21
7453	0.21
7454	0.21

7460	0.21
7470	0.40
7472	0.38
7473	0.41
7474	0.46
7475	0.62
7476	0.46
7480	0.63
7482	0.88
7483	1.04
7484	1.15
7486	0.40
7490	0.60
7491	0.92
7492	0.69
7493	0.69
7494	0.92

7495	0.83
7496	0.92
7497	3.45
74100	1.73
74107	0.52
74109	0.81
74110	0.58
74111	0.81
74116	2.02
74118	1.15
74119	1.73
74120	0.95
74121	0.46
74122	0.69
74123	1.15
74125	0.63
74126	0.63
74128	0.69

74132	0.81
74136	0.63
74141	0.92
74142	2.65
74143	2.88
74144	2.88
74145	1.04
74147	2.30
74148	2.02
74150	1.84
74151	0.97
74154	2.02
74155	0.97
74156	0.97
74157	0.86
74159	2.42
74170	2.65
74172	5.06

74173	1.61
74174	1.73
74175	1.04
74176	1.26
74178	1.44
74179	1.44
74180	1.32
74190	1.73
74191	1.73
74192	1.55
74193	1.55
74194	1.44
74195	1.15
74196	1.38
74197	1.26
74198	2.59
74199	2.59
76013N	2.02

TAA570	2.65
TAA630S	4.02
TAA700	4.50
TBA480Q	2.12
TBA520Q	2.65
TBA530	2.28
TBA540Q	2.65
TBA550Q	3.70
TBA560CQ	3.70
TBA673	2.52
TBA700	1.75
TBA720Q	2.65
TBA750Q	2.38
TBA800	1.38
TBA920	3.34
TBA920Q	3.34
TBA990Q	3.34
TCA270Q	3.34
TCA760A	1.59

Terms of business: CWO. Postage and packing valves and semiconductors 30p per order. CRTs £1. All prices include VAT. Price ruling at time of despatch.
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200 Mixed Diodes – mainly Germ. OAB1-91-1N34/60 GC61.62 etc. Case DO-7. Coded and uncoded – You to test – **Value all the way!**
O No. SJ127 **£1 per Pak.**

BC108 FALLOUTS
Manufacturers out of spec. on volts or gain or neither – Metal TO18 case – You test.
O No. SJ124 **50 for £1**

NPN
BD131, TO-126-NPN. Untested.
O No. SJ84 **25 for £1**

SCRs
TO66 SCRs 5 Amp – ALL good – untested for volt – **good yield 400+.**
O No. SJ130 **10 for £1**

IC SOCKET PAKS
SJ36	14	8 pin	SJ41	6	22 pin
SJ37	12	14 pin	SJ42	5	24 pin
SJ38	11	16 pin	SJ43	4	28 pin
SJ39	8	18 pin	SJ44	3	40 pin
SJ40	7	20 pin			

ALL AT ONLY £1 EACH

SIL. DIODES
200 Mixed Diodes – mainly SILICON case DO-7, OA200/202. General purpose 200mA marked and uncoded – you to sort and test – **Outstanding Value!**
O No. SJ128 **£1 per pak**

DIODES
300 IN4148 Type – uncoded Silicon Diodes. Case DO-35 – **you to test.**
O No. SJ129 **£1 per Pak**

Silicon Fast Switch
NPN – like 2N706 2N2369 – **You select by test!**
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FM Indoor Tape/Ribbon Aerial
O No. 107 **40p each**

HI-FI CAR AERIAL
4-section fully retractable and locking.
SPECIAL PRICE
O/No. 109 **£1.40 each**

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Cast TO220

Positive		Negative	
uA7805	£0.65	uA7905	£0.70
uA7812	£0.65	uA7912	£0.70
uA7815	£0.65	uA7915	£0.70
uA7818	£0.65	uA7918	£0.70
uA7824	£0.65	uA7924	£0.70

AUDIO AMPLIFIER
5 watt Audio Amplifier Module.
Special Clearance Offer
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The last of the Germanium PNP OC71-71-75 etc. Mullard Black Glass Type – You test **(5 could cost you that!)**
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GERM. POWER TRANS.
AD149-OC26-AD140 ....**£0.50 each**
AD142-OC28-2N3614 ....**£0.65 each**

STEREO 30
Complete 7 watt per channel Stereo Amplifier Board – includes amps, pre-amp, power supply, front panel, knobs, etc. PLUS transformer and real Teak Cabinet for that professional finish!

SPECIAL SALE PRICE
SAVING £5!
OUR PRICE £25

TEXAS NPN
Texas NPN silicon transistors, metal can – perfect and coded. 2S503 = BC108, TO-18.
O No. SJ29 **50 off £2.50**
100 off £4. 1,000 off £35

HEADPHONES
NEW Improved Lightweight Stereo Headphones including double headband and padded earcups – Impedance 8ohms – Frequency 30-1800HZ. ALL Black.
O No. 885 **£4**

As above but with coiled lead and rotary volume controls.
O No. 884 **£7**

VERO PLASTIC CASE
Complete with lid and fixing screws. Finished white. Size: 72mm x 50mm x 25mm.
O No. 173 **35p each**

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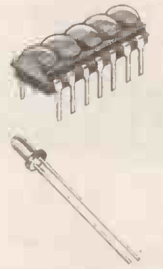
SJ75. FM coax cable – plain copper conduction cellular polythene insulated and plain copper braided PVC sheath – impedance 75ohms.
£0.10 per metre
SJ76. 1 Board containing 2 x 5pin DIN sockets 180° 02-2pin DIN **loudspeaker sockets £0.30.**
SJ77. A 5pin DIN 180° chassis/normal socket incl. **DPDT Switch £0.20.**

HEADPHONE ACCESSORIES
7 metre Headphone Extension Lead
O No. 136. **£1.50.**

HEADPHONE JUNCTION BOX
Gives facility for using Stereo Headphones with amplifiers and radiogrammes which do not have a headphone outlet. **TO CLEAR!**
O No. 881. **£1.20 each.**

BI-PAK'S OPTO BARGAIN OF THE YEAR

Valued at over £10 – Normal Retail – We offer you a pack of 25 Opto devices to include LED's Large and Small in Red, Green, Yellow and Clear. 7 Segment Displays both Common Cathode and Common Anode PLUS bubble type displays – like DL-33. Photo Transistors – similar to OCP71 and Photo Detectors – like MEL11-12. This whole pack of 25 devices will cost you just

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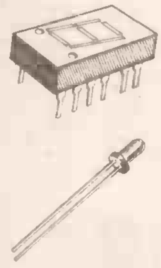
And we guarantee your money back if you are not completely satisfied.
FULL data etc. included
O/No. SJ120.


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100 Disc Ceramic CAP. Mixed values covering complete range 3PF-4,700PF. **SUPER VALUE**
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Antex X25 Iron – 25 watt soldering iron **OUR SUPER SALE PRICE,** Great reduction.
O No. 1931. **£4.00.**
ST3 Iron Stand – Suitable for above – **OUR Sale Price**
O No. 1939. **£1.25 each.**

SWITCHES
Push-to-make. 6mm panel mounting.
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Push-to-break as above.
O No. SJ132. **4 for £0.50**

METERS
23mm Level Meter **Special Sale Price.**
O No. 1320. **£1.00.**

40mm V.U. Meter **OUR SPECIAL PRICE**
O No. 1321. **£1.50.**

SILICON TRANS.
SJ25. 100 Silicon NPN transistors all perfect and coded – mixed types with data and equivalent sheet – no rejects £2.50
SJ26. 100 Silicon PNP transistors all perfect and coded – mixed types and cases, data and equivalent sheet.......................£2.50
SJ27. 50 Assorted pieces of SCR's, diodes and rectifiers incl. stud types, all perfect – no rejects, fully coded – data incl.................£2.50

PRECISION VOM MULTITESTER
20,000ohms volts DC Complete with test leads and Instructions.

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2nd Quality Paks
1507. 10 Assorted colours and sizes..........£0.65
S122. 10 125 RED..............................£0.50
S123. 10.2 RED.................................£0.50

LED CLIPS
1508 125. .125 ....5 for £0.10
1508 2. .2 ....5 for £0.12

PLUGS & SOCKETS
Set of 4 1-metre Colour coiled leads with phono plug ends – ideal for audio and test use. **Outstanding Value**
O No. SJ122. **£1.00 per Pak**
1mm Plugs & Sockets in Red & black
O No. SJ123. **5 prs. £1.00**

TTL's
SJ28. 20 TTL74 series gates – assorted 7401-7460......................................£1.00
SJ53. Mammoth IC Pak Approx. 200 pcs assorted fall-out integrated circuits including logic 74 series – Linear audio and DTL many coded devices but some unmarked – you to identify £1.00

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SJ68. 30 ZTX300 type transistors NPN preformed for P C Board colour coded Blue – all perfect £1.00
SJ70. 25 BC107 NPN TO106 case perfect transistors Green Spot £1.00
SJ71. 25 BC177 PNP TO106 case perfect transistors code C1395..............................£1.00
SJ72. 4 2N3055 silicon power NPN transistors TO3 ....£1.00

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SJ20. 2 Large croc clips 25A rated – ideal for battery chargers etc. £0.30
SJ21. Large 7 1/2" Mains Neon Tester – screwdriver chrome finish £0.85
SJ22. Small pocket size Mains Neon Tester screwdriver £0.55
SJ23. Siemens 220v AC relay DPDT contacts 10amp rating – housed in plastic case £1.00
SJ24. Black PVC tape (5/8) 15mm x 25m – strong tape for electrical and household use ....**£0.35 per roll**

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SJ11. 150 Capacitors mixed types and values £0.50
SJ12. 60 Electrolitics all sorts mixed £0.50
SJ13. 40 Polyester polystyrene capacitors mixed £0.50
SJ14. 50 C280 type capacitors mixed £1.00
SJ15. 40 High quality electrolitics 100-470mfd. £1.0
SJ16. 40 Low volts electrolitics mixed values up to 10v...£0.50

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SJ1. 200 Resistors mixed values £0.50
SJ2. 200 Carbon resistors 1/4-1/2 watt preformed. £0.50
SJ3. 100 1/8 watt miniature resistors mixed values £0.50
SJ4. 60 1/2 watt resistors mixed values £0.50
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SJ7. 30 2-10 watt wirewound resistors mixed £0.50

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16173. 15 Assorted Pots £0.50
SJ54. 20 Assorted Slider Pots £1.00
SJ56. 10 100K Lin Slider Pots 40mm £0.50
16186. 25 Pre-sets Assorted.........................£0.50
SJ49. 8 Dual gang carbon pots log and lin mixed values £1.00
SJ50. 20 Assorted slider knobs – chrome black £1.00

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16187. 30 metres stranded wire mixed colours £0.50
16178. 5 Main slider switches assorted.......£0.50
SJ76. 1 Board containing 2 x 5-pin, DIN sockets 180 & 2 x 2-pin, DIN loudspeaker sockets £0.30

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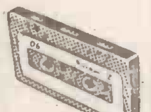
MINIATURE MAINS Primary 240v.

No.	Secondary	
2021.	6v-0-6v 100mA	£0.75
2022.	9v-0-9v 100mA	£0.75
2023.	12v-0-12v 100mA	£0.95
2035.	240v Primary 0-55v 2A Secondary	£5.50

CASSETTES
SUPER VALUE
And A
GREAT SAVING!!!

C120 Dindy Cassettes Low noise – astounding value and sound O/No. SJ32.
10 for £3.50

METAL SLIDERS
Metal Case Dual Slider Pots: 45mm travel
SJ65. 10K log ....**£0.25 each**

SJ66. 100K lin ....**£0.25 each**
SJ67. Chrome slider knobs to fit ....**£0.10 each**

KNOBS
SJ62. 5 15mm chrome knobs standard push fit £0.50
SJ63. Instrument knob – black winged (29 x 20mm) with pointer. 1/4" standard screw fit £0.15
SJ64. Instrument knob – black silver aluminium top (17 x 15mm) 1/4" standard screw fit £0.12

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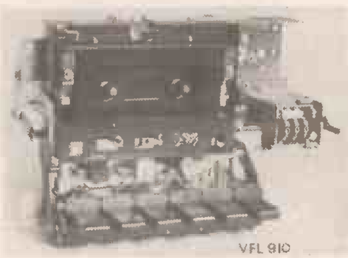
J. L. Linsley Hood High Quality Cassette Recorders

LINSLEY HOOD CASSETTE RECORDER 1

We are the Designer Approved suppliers of kits for this excellent design. The Author's reputation tells all you need to know about the circuitry and Hart expertise and experience guarantees the engineering design of the kit. Advanced features include: High quality separate VU meters with excellent ballistics. Controls, switches and sockets mounted on PCB to eliminate difficult wiring. Proper moulded escutcheon for cassette aperture improves appearance and removes the need for the cassette transport to be set back behind a narrow finger trapping slot. Easy to use, robust Lenco mechanism. Switched bias and equalisation for different tape formulations. All wiring is terminated with plugs and sockets for easy aseembly and test. Sophisticated modular PCB system gives a spacious, easily built and tested layout. All these features added to the high quality metalwork make this a most satisfying kit to build. Also included at no extra cost is our new HS15 Sendust Alloy record/play head, available separately at **£7.60** plus VAT, but included FREE as part of the complete kit at **£81.50** plus VAT.
REPRINTS of the 3 articles describing this design **45p** No VAT.
REPRINT of Postcript article **30p** No VAT.



VFL 910. Vertical front loading Super Hi-fi deck, as used in our new Linsley-Hood Cassette Recorder 2. **£31.99** + VAT. Set of knobs **£1.46** + VAT.

CASSETTE HEADS

HS15 SENDUST ALLOY SUPER HEAD. Stereo R/P. Longer life than Permalloy. Higher output than Ferrite. Fantastic frequency response. Complete with data	**7.60**
HC20 Stereo Permalloy R/P head for replacement uses in car players, etc.	**4.25**
HM90 Stereo R/P head for METAL tape. Complete with data	**7.20**
H561 Special Erase Head for METAL tape	**4.90**
H524 Standard Ferrita Erase Head	**1.50**
4-Track R/P Head. Standard Mounting	**7.40**
R484 2/2 (Double Mono) R/P Head. Std. Mtg.	**4.90**
ME151 2/2 Ferrite Erase. Large Mtg.	**4.25**
CCE/8M 2/2 Erase. Std. Mtg.	**7.90**

We are the actual importers of these heads and invite Trade/quantity enquiries.

All prices plus VAT

We regret that due to the latest increase in postal costs we must now charge for carriage. Please add as follows:

Order up to £10 — 50p
Orders £10 to £49 — £1 P&P
Over £50 — £1.50

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£2 Documentation and Handling

Please send 9x4 SAE for lists giving fuller details and price breakdowns.

Instant easy ordering, telephone your requirements and credit card number to us on Oswestry (0691) 2894

Personal callers are always welcome
but please note we are closed all day Saturday

LINSLEY HOOD CASSETTE RECORDER 2

Our new improved performance model of the Linsley Hood Cassette Recorder incorporates our VFL 910 vertical front mechanism and circuit modifications to increase dynamic range. Board layouts have been altered and improved but retain the outstandingly successful mother and daughter arrangement used on our Linsley Hood Cassette Recorder 1.

This latest version has the following extra features. Ultra low wow-and-flutter of .09% — easily meets DIN Hi-fi spec. Deck controls latch in rewind modes and do not have to be held. Full Auto stop on all modes. Tape counter with memory rewind. Oil damped cassette door. Latching record button for level setting. Dual concentric input level controls. Phone output. Microphone input facility if required. Record interlock prevents re-recording on valued cassettes. Frequency generating feedback servo drive motor with built-in speed control for thermal stability. All these desirable and useful features added to the excellent design of the Linsley-Hood circuits and the quality of the components used makes this new kit comparable with built-up units of much higher cost than the modest **£94.90** + VAT we ask for the complete kit.

LINSLEY-HOOD 30 WATT AMPLIFIER

The very latest amplifier design to be published and in our opinion the best yet. The concept was to produce an amplifier that sounded as good as the authors 75 watt design but which was cheaper and simple to build for applications where the higher power is not needed. This new kit is designed to match the Linsley-Hood Cassette Recorder 2 and a tuner will be available later to make a complete stackable system. A very advanced assembly system has been devised by us to make construction ultra simple and anyone who can solder components in a printed circuit board will find it great fun. Conventional wiring is at an irreducible minimum, only being needed to connect the mains transformer and pilot light. For an amplifier of this quality this kit represents incredible value for money.

All parts can be bought separately at a total cost of £79.12 but complete kits are available at a special introductory discount price of only **£65** + VAT.

STUART TAPE CIRCUITS

(For reel-to-reel decks)

These circuits are just the thing for converting that old valve tape deck into a useful transistorised recorder. Total system is a full three head recorder with separate record and replay sections for simultaneous off tape monitoring. We also stock the heads. This kit is well engineered but does not have the detailed instructions that we give with our more recent designs. We would not therefore recommend it to beginners. Reprints of the original three articles 45p. Post free. No VAT.

4118

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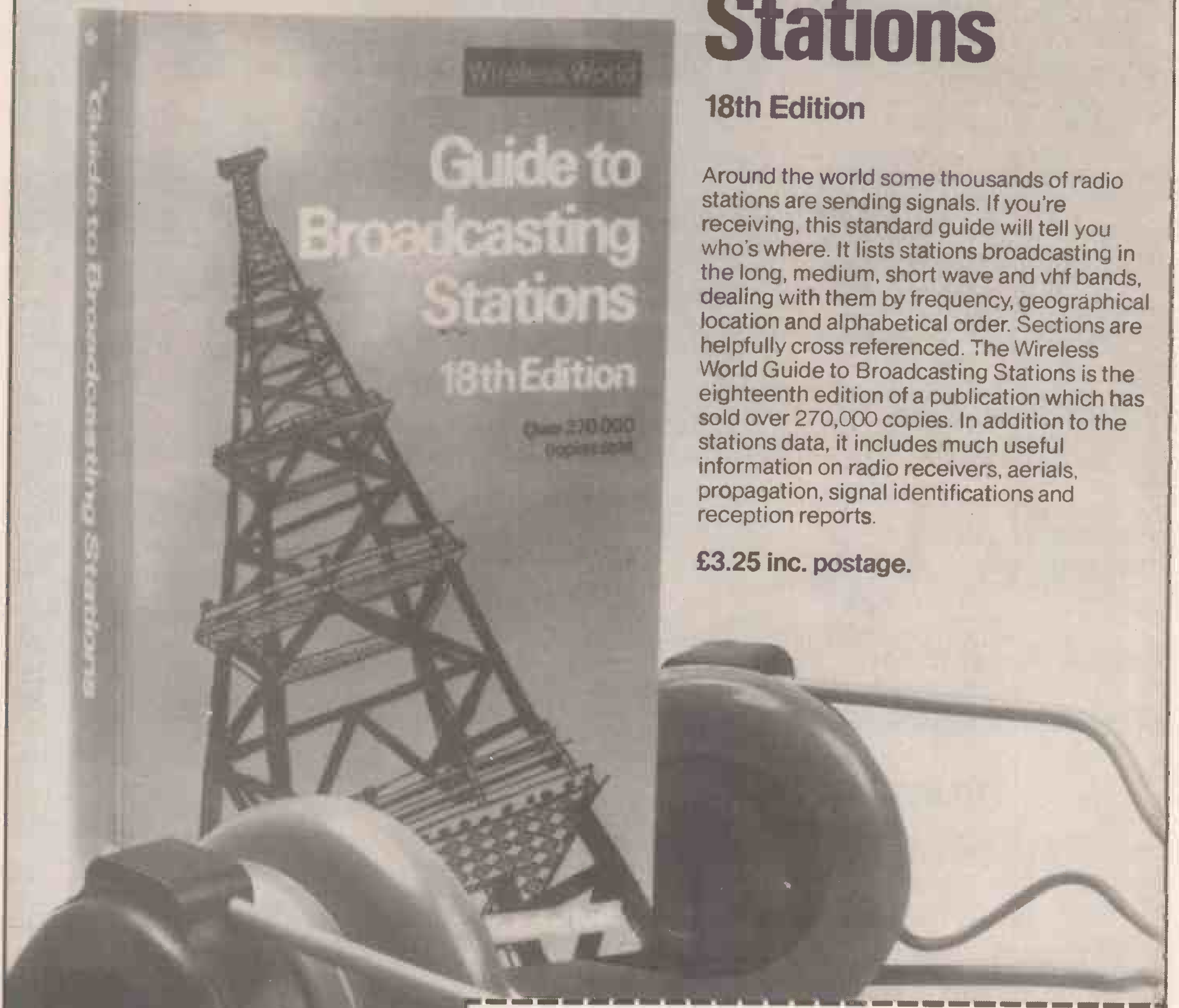
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BSR DE LUXE AUTOCHANGER

Plays 12", 10" or 7" records, Auto or Manual. A high quality unit backed by BSR reliability. Stereo Ceramic Cartridge. AC 200/250V. Size 13½-11¼in. 3 speeds. Above motor board 3¾in. Below motor board 2½in. with Ceramic Stereo cartridge.

£20 Post £2 — Ready cut Mounting Board £1 extra

GARRARD AUTOCHANGER CC10A.
3 speed stereo cartridge. Plays all sizes of records, 7", 10", 12". Turntable 7in. **£8.50**, post £1.

HEAVY METAL PLINTHS

Cut out for most BSR or Garrard decks. Post £2.00
Silver grey finish.
Size 16 x 14 x 3in. **£4.50**
Tinted Cover for above **£6.00**
Special Tinted Plastic Cover for above
Sizes: 14½ × 12½ × 4¼in. or 14½ × 12½ × 3in. £3.50. 15¼ × 13½ × 4in. £4. 18 × 13¼ × 4in. £6. 17¼ × 9½ × 3½in. £3. 18 × 12½ × 3in. £6. 18 × 13¾ × 3½in with standup hinges £7. Post £2
Ideal for record decks, tape decks, etc.

BSR SINGLE PLAYER DECKS

BSR P182 3 speeds flared aluminium turntable "S" shape arm, cueing device, ceramic cartridge **£26** Post £2.00. Ready cut mounting board, £1 extra

BSR C142 RIM DRIVE QUALITY DECK
Manual or automatic play. Two speeds. Precision ultra slim arm. Cueing device. Bargain price **£20** Post £2. With stereo ceramic cartridge

BSR P207 BUDGET SINGLE PLAYER ideal for disco or small two-speed Hi-Fi system with stereo cartridge and cueing device. **£15** Post £2

GARRARD 6-200 SINGLE PLAYER DECK
Brushed Aluminium Arm with stereo ceramic cartridge and Diamond Stylus, 3-speeds. Manual and Auto Stop/Start. Large Metal Turntable. Cueing Device and Pause Control. Ready cut mounting board only £1 extra. **£22** Post £2

ELAC HI-FI SPEAKER 10in. TWIN CONE

Large ceramic magnet. 50-16,000 c/s. bass resonance 40 c/s. 8 ohm impedance. 10 watts. RMS **£7.95** Post 99p

POTENTIOMETERS Carbon Track

5kΩ to 2MΩ. LOG or LIN. L/S **50p**. DP **90p**. Stereo L/S **£1.10**. DP **£1.30**. Edge Pot 5K. SP **45p**. Sliders Mono **65p**. Stereo **85p**.

EMI 13½ x 8in. LOUDSPEAKERS

With tweeter and crossover. 10 watt. 3 or 8 ohm. **£9.95** Post 99p

With tweeter and crossover. 8 ohm. 15 watts. **£10.95** Post 99p

Bass woofer 15 ohm. 20 watt. **£10.95** Post 99p

THE "INSTANT" BULK TAPE ERASER

Suitable for cassettes, and all sizes of tape reels. AC mains 200/250V.
Will also demagnetise small tools **£7.50** Post 50p
Head Demagnetiser only £5

RELAYS. 12V DC 95p. 6V DC 85p.
BLANK ALUMINIUM CHASSIS. 6 x 4—95p; 8 x 6—£1.40; 10 x 7—£1.55; 12 x 8—£1.70; 14 x 9—£1.90; 16 x 6—£1.85; 16 x 10—£2.20. **ANGLE ALI.** 6 x ¾ x ¾in—25p.
ALUMINIUM PANELS. 6 x 4—24p; 8 x 6—38p; 14 x 3—40p; 10 x 7—54p; 12 x 8—70p; 12 x 5—44p; 16 x 6—70p; 14 x 9—94p; 12 x 12—£1; 16 x 10—£1.16.
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ALUMINIUM BOXES. 4 x 4 x 1½ £1. 4 x 2 x 2 £1. 3 x 2 x 1 70p. 6 x 4 x 2 £1.20. 7 x 5 x 2½ £1.45. 8 x 6 x 3 £2.20. 10 x 7 x 3 £2.50. 12 x 5 x 3 £2.30. 12 x 8 x 3. 3.
BRIDGE RECTIFIER 200V PIV 4 amp £1.50. 8 amp £2.50.
TOGGLE SWITCHES SP 30p. DPST 40p. DPDT 50p.
PICK-UP CARTRIDGES ACOS. GP91 £2.00. GP94 £2.50.
SONOTONE 9TAHC Diamond £3.75. V100 Magnetic £6.50.
RESISTORS. 10Ω to 10M. ¼W. ½W. 1W. 1p; 2W 10p.
HIGH STABILITY. ½W 2% 10 ohms to 1 meg. 8p.
Ditto 5%. Preferred values. 10 ohms to 10 meg. 3p.

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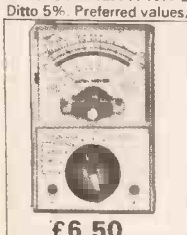

Deluxe pocket size precision moving coil instrument, jewelled bearings — 2000 o.p.v. Battery included
11 instant ranges measure:
DC volts 10, 50, 250, 1000.
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DC amps 0-100 mA.
Continuity and resistance 0-1 meg ohms in two ranges.
Complete with Test Prods and instruction book showing how to measure capacity and inductance.
£6.50 — **50p** post and insurance.

HIGH QUALITY

JVC DECK

£28.50 Post £2

J.V.C. BELT DRIVE STEREO DECK
Detachable head, adjustable counter balance weight, hydraulic damped cueing platform, automatic pick-up arm return, 2 speeds, 33 and 45 rpm, suppression circuit to start stop switch, 240V AC motor, dynamic pendulous bias compensator. Teak veneered base, 19in. x 14½in £9. Post £2, plastic cover £6, post £2. Suitable stereo magnetic cartridge **£6.50** extra.

RCS SOUND TO LIGHT KIT Mk. 2

Kit of parts to build a 3 channel sound to light unit 1,000 watts per channel. Suitable for home or disco. Easy to build. Full instructions supplied. Cabinet **£4.50** extra. Will operate from 200MV to 100 watt signal. **£18** Post 50p
200 Watt Rear Reflecting White Light Bulbs. Ideal for Disco Lights, Edison Screw. 6 for **£4**, or 12 for **£7.50**. Post 50p.

"MINOR" 10 watt AMPLIFIER KIT £12.50

This kit is suitable for record players, guitars, tape playback, electronic instruments or small PA systems. Two versions available: Mono, **£12.50**; Stereo, **£20**. Post 45p. Specification 10W per channel; input 100mV; size 9½ x 3 x 2in. approx. SAE details. Full instructions supplied. AC mains powered. Input can be modified to suit guitar.

RCS STEREO PRE-AMP KIT. All parts to build this pre-amp. Inputs for high, medium or low imp per channel. with volume control and PC Board **£2.95** Post 35p
Can be ganged to make multi-way stereo mixers

MAINS TRANSFORMERS ALL POST 99p.

250-0-250V 70mA, 6.5V, 2A	£3.45
250-0-250V 80mA, 6.3V 3.5A, 6.3V 1A	£4.60
330-0-330V 200mA, 6.3V 2A, 6.3V 2A, 6.3V 3A	£12.00
300-0-300V 120mA, 2×6.3V 2A C.T.; 5V 2A	£10.00
220V 45mA, 6.3V 2A	£2.50

GENERAL PURPOSE LOW VOLTAGE.

Tapped outputs available

2 amp. 3, 4, 6, 6, 8, 9, 10, 12, 15, 18, 25 and 30V	£6.00
1 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£6.00
2 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£9.50
3 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£12.50
5 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£16.00

12V, 100mA	£1.30	20V, 40V, 60V, 1 amp	£4.00
12V, 750mA	£1.75	12V, 3 amp	£3.50
10-0-10V 2amp	£3.00	10V, 30V, 40V, 2 amp	£3.50
30V, 5 amp and 17V-0-17V, 2 amp	£4.00	40V, 2 amp	£3.50
		20V, 1 amp	£3.00
0.5, 8, 10, 16V, 4 amp	£2.50	20V-0-20V, 1 amp	£3.50
9V, 3 amp	£3.50	30V-0-30V, 2 amp	£8.00
25-0-25V 2 amp	£4.50	2 of 18V, 6 amp, each	£11.00
30V, 1½ amp £3.00 2 amp	£3.50	12-0-12V, 2 amp	£3.50
6V ½ amp	£2.00	9V, ¼ amp	£1.50
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FULL WAVE BRIDGE CHARGER RECTIFIERS
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12V, 1½ amp Half Wave Selenium Rectifier 25p.

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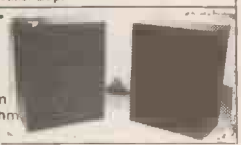

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2000mF 6V **25p**; 25V **42p**; 40V **60p**; 1200mF 76V **80p**.
2500mF 50V **62p**; 3000mF 25V **47p**; 50V **65p**.
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SHORT WAVE 100pf air spaced gangable tuner, **95p**.
TRIMMERS 10pF, 30pF, 50pF, **5p**. 100pF, 150pF, **15p**.
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SUB-MIN MICRO SWITCH, 25p. Single pole change over.
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DELUXE MK II	12	8-16	15	HI-FI	£14
SUPERB	12	8-16	30	HI-FI	£20
AUDITORIUM	12	8-16	45	HI-FI	£20
AUDITORIUM	15	8-16	60	HI-FI	£29
GROUP 35	12	4-8-16	40	PA	£12
GROUP 45	12	4-8-16	45	PA	£15
GROUP 50	12	4-8-16	60	PA	£20
GROUP 75	12	4-8-16	75	PA	£22
GROUP 100	12	8-16	100	PA	£26
GROUP 100	15	8-16	100	PA	£29
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MAKE	MODEL	SIZE	WATTS POWER	OHMS	OUR PRICE
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GOODMANS	TWEETER	3½in square	25	8	£4.00
AUDAX	TWEETER	3¾in square	60	8	£10.50
SEAS	MID-RANGE	4in	50	8	£7.50
SEAS	MID-RANGE	5in	80	8	£10.50
SEAS	MID-RANGE	4½in	100	8	£12.50
GOODMANS	FULL-RANGE	5½in	15	8	£6.50
GOODMANS	FULL-RANGE	8in	20	8	£5.50
SEAS	WOOFER	8in	30	8	£14.00
R.C.S.	GENERAL	10in	20	8	£8.50
McKENZIE	DISCO-GROUP	15in	150	8 + 16	£56.00
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RICHARD ALLAN TWIN CONE LOUDSPEAKERS
8in. diameter 4W **£2.50**. 10in. diameter 5W **£3.50**; 12in diameter 6W **£4.50**. 3 or 8/15 ohms. please state.
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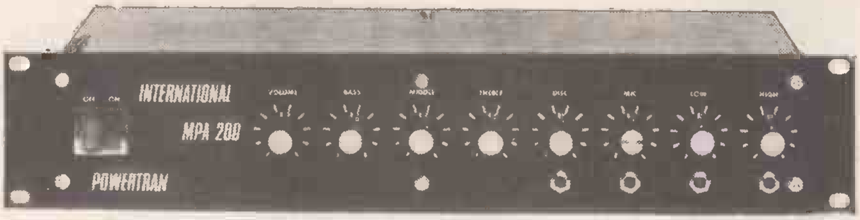
Featured as a constructional article in ETI, the MPA 200 is an exceptionally low priced — but professionally finished — general purpose high power amplifier. It features an adaptable input mixer which accepts a wide range of sources such as a microphone, guitar, etc. There are wide range tone controls and a master volume control. Mechanically the MPA 200 is simplicity itself with minimal wiring needed making construction very straightforward.
The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.



Panel size 19.0"×3.5". Depth 7.3"

COMPLETE KIT ONLY £49.90+VAT!

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CHROMATHEQUE 5000 5 CHANNEL LIGHTING EFFECTS SYSTEM

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Kit includes fully finished metalwork, fibreglass PCB controls, wire, etc. — Complete right down to the last nut and bolt!

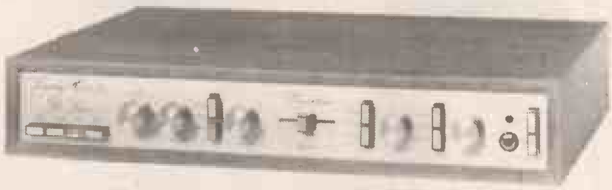
COMPLETE KIT ONLY £49.50 + VAT!

Panel size 19.0"×3.5". Depth 7.3"

POWERTRAN

SYNTHESIZER KITS ON PAGE 103. MORE KITS AND ORDERING INFORMATION ON PAGE 101.

All kits also available as separate packs (e.g. PCB, component sets, hardware sets, etc.). Prices in our FREE CATALOGUE.



DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO AMPLIFIER £99.30+VAT

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T20+20 20W STEREO AMPLIFIER £33.10+VAT

This kit, based upon a design published in Practical Wireless, uses a single printed circuit board and offers at very low cost, ease of construction and all the normal facilities found on quality amplifiers. A 30 watt version of this kit (T30+30) is also available for £38.40+VAT. MATCHING TUNERS — See our FREE CATALOGUE!

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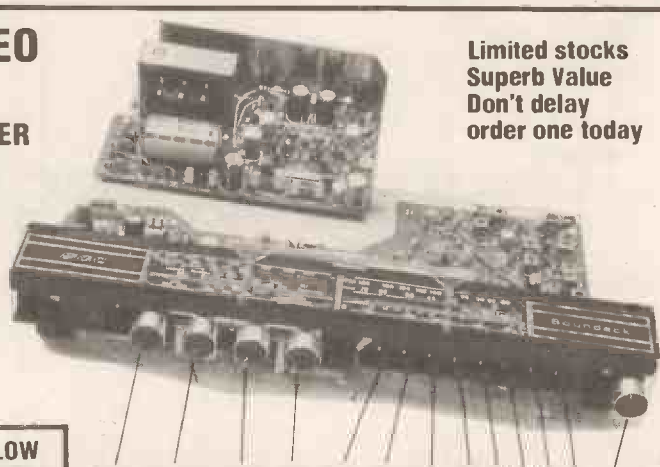

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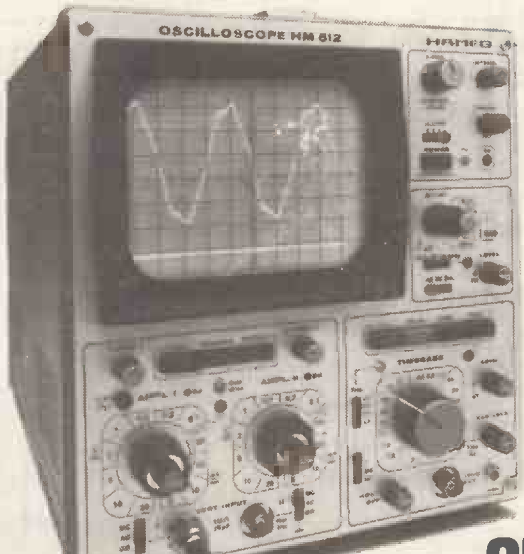

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A matching synthesiser unit will be made available later this year, and can be retrofitted to either version. All versions include digital frequency readout/clock, VU deviation meters, 6 preset stations, 10 turn pot manual tuning, toroidal PSU, output level adjustment, 110/240v AC input. Full alignment service available.

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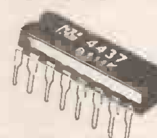
TBA120S	1.15	TDA1083	2.24	KB4417	2.53
KB4406	0.80	TDA1062	2.24	MC3357P	3.16



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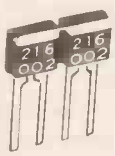
BB109	0.31	KV1225 25v triple	3.16
MVAM2	1.93	BB212 9v dual	2.25



POWER MOSFETS

100W PA's made simple

Since pioneering the 100W complementary MOSFET technique - Hitachi have developed a range of output devices and drivers that ought to revolutionise opinions and attitudes towards the design of all LF amplification systems. We have a new 48 page application note (£1.50 inc) and complete sets of parts, modules and now the new complete PA system (see above).

2SK133	120v N-ch 100W MOSFET	£6.33	2SJ48 Pch complement	£6.33
2SK135	160v N-ch 100W MOSFET	£7.29	2SJ50 Pch complement	£7.39
PA101B	Kit for 100W MOSFET PA less Heatsink £16.10. (£23 inc heatsink/bkt)			

ULTRA LOW NOISE PU PREAMPLIFIER

The HA12017 is the last word in PU preamps, and general low noise audio design. It is an SIL IC, with 86dB S/N in RIAA configuration, 10v RMS output capability, 0.002% typ THD at 10v RMS output (imagine the overload margin !!). It comfortably supercedes discrete circuit designs in terms of price/performance, and takes the art beyond the TDA1042's capabilties. (Replaces HA1457) £1.80 each - or an RIAA applications PCB with two ICs for £5.75. Complete with Rs&Cs £9.95.

Radio Control ICs

We have various RC ICs, including NE544 NE5044, and two new ones from OKI

KB4445 - 4 channel dig.prop. FM TX IC. 30mW out (amplifyable) -£2.30 inc
KB4446 - 4/5 ch. dig. prop FM RX IC. Suits KB4445 or RCME syst. £2.65.
KB4445/6 pair: £4.75. New 8 page data sheet 35p + SAE. More RC ICs in list

CMOS, LPSNTTL, TTL, MPU: Listings in the new pricelist.

Most CMOS is available in low volume - also LPSN. Standard linears and TTL OK.

Things like ICM7216B, ICL8038, 8080A, 6800P, 2708, NE555,NE556, etc

Coming Soon..........

Contain yourselves, RF fans ! Not yet ready for a full launch until autumn but previewed here:-

SSB transceiver system : 10kHz to 1000MHz !!

A modular VLF to UHF SSB TX/RX system at last. With the correct first mixer, the basic PCB covers 10kHz to 1000MHz - using LO fed from ext. source (Our 2 IC Mullard synth for instance) and RF PA for TX OP. 0.2uV basic sensitivity in HF, Typ cost for HF synth SSB RX will be less than £200. Add an RF PA for full TRX for another £50. See one in our foyer, and marvel.

Components

Crystal Filters

Most popular types are available ex-stock, and in quantity.

10.7MHz	25kHz Channel spacing 8pole	£16.67
	12½kHz	£17.82
	2.4kHz SSB	£19.78
	Monolithic dual roofing filter	£2.30
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RC XTALS	FM pairs (no spilts)	£3.74
	AM pairs ..	£3.57
USB/LSB	Xtals for 10.7SSB filter	£2.88 ea

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The most efficient warning sounders yet

The latest thing in electro-acoustic efficiency. 1mA of drive from CMOS will give an SPL of 83dB - 10v RMS drive from CMOS uses 3mA for 100dB SPL at 4.8kHz (88dB at 1.65kHz)
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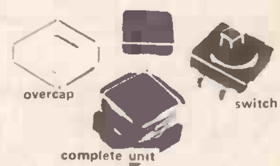
From the world's most widely used switch manufacturers - ALPS - come the biggest and best range of keyswitches, and data entry keyboard switches. The SCM81101 is shown here, with the KT5 2-part cap (with clear top, to enable easy fitting of your chosen legend. Other types are available with built in LED, 90° mounting etc.
SCM81101 : 17p, KT5 : 16p - or 29p/pair



LCD CLOCKS
LCD DVM

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7413	30p
7414	40p
74C14	90p
7416	27p
7417	27p
7420	17p
7421	40p
7422	22p
7423	34p
7425	30p
7426	40p
7427	34p
7428	36p
7430	17p
7432	30p
7433	40p
7437	35p
7438	35p
7440	17p
7441	70p
7442A	60p
7443	112p
7444	112p
7445	100p
7446A	93p
7447A	75p
7448	80p
7450	17p
7451	17p
7453	17p
7454	17p
7460	17p
7470	36p
7472	30p
7473	34p
7474	30p
7475	38p
7476	32p
7480	50p
7481	100p
7482	84p
7483A	90p
7484	100p
7485	110p
7486	34p
7489	210p
7490A	36p
7491	80p
7492A	46p
7493A	36p
7494	84p
7495A	70p
7496	65p
7497	180p
74100	130p
74107	34p
74109	55p
74116	200p
74118	130p
74119	210p
74120	110p
74121	34p
74122	48p
74123	60p
74125	75p
74126	60p
74128	75p
74132	75p
74136	75p
74137	50p
74141	60p
74142	200p
74145	90p
74147	190p
74148	150p
74150	130p
74151A	70p
74153	70p
74154	120p
74155	90p
74156	90p
74157	70p
74159	190p
74160	100p
74161	100p
74162	100p
74163	100p
74164	120p
74165	130p
74166	120p
74167	200p
74170	240p
74172	450p
74173	120p
74174	90p
74175	85p
74176	90p
74177	90p
74178	160p
74180	93p
74181	180p
74182	90p
74184A	150p
74185	150p
74186	500p
74188	325p
74190	120p
74191	120p
74192	100p
74193	100p
74194	120p
74195	95p
74196	95p
74197	80p
74198	150p
74199	150p
74221	160p
74251	140p
74259	250p
74278	290p
74279	110p
74283	160p
74284	360p
74285	360p
74290	180p
74293	150p
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74365	100p
74366	100p
74367	100p
74368	100p
74390	200p
74393	200p
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74LS04	16p
74LS05	25p
74LS08	22p
74LS10	20p
74LS11	40p
74LS13	40p
74LS14	60p
74LS15	45p
74LS20	20p
74LS21	40p
74LS27	38p
74LS30	20p
74LS32	27p
74LS37	30p
74LS38	36p
74LS42	70p
74LS47	90p
74LS51	24p
74LS55	30p
74LS73	50p
74LS74	36p
74LS75	45p
74LS76	45p
74LS83	70p
74LS85	80p
74LS86	40p
74LS90	50p
74LS92	70p
74LS93	60p
74LS96	110p
74LS107	45p
74LS109	80p
74LS112	40p
74LS113	90p
74LS114	45p
74LS122	80p
74LS123	70p
74LS124	180p
74LS125	50p
74LS126	50p
74LS132	60p
74LS133	30p
74LS136	55p
74LS138	75p
74LS139	75p
74LS145	120p
74LS147	220p
74LS148	175p
74LS151	80p
74LS153	60p
74LS154	200p
74LS155	80p
74LS156	90p
74LS157	60p
74LS158	60p
74LS160	90p
74LS161	100p
74LS162	140p
74LS163	100p
74LS164	120p
74LS165	140p
74LS166	180p
74LS173	110p
74LS174	100p
74LS175	100p
74LS181	320p
74LS190	100p
74LS191	100p
74LS192	100p
74LS193	100p
74LS195	140p
74LS196	120p
74LS197	90p
74LS221	120p
74LS240	175p
74LS241	175p
74LS242	170p
74LS243	170p
74LS244	150p
74LS245	350p
74LS247	140p
74LS248	140p
74LS249	140p
74LS251	140p
74LS253	90p
74LS257	90p
74LS258	160p
74LS259	160p
74LS266	100p
74LS273	170p
74LS279	90p
74LS283	90p
74LS298	249p
74LS324	200p
74LS348	200p
74LS365	48p
74LS367	70p
74LS368	100p
74LS373	150p
74LS374	150p
74LS378	140p
74LS390	160p
74LS393	160p
74LS445	140p
74LS668	100p
74LS669	100p
74LS670	400p

4000 SERIES

4000	15p
4001	20p
4002	20p
4006	95p
4007	25p
4008	80p
4009	40p
4010	50p
4011	25p
4012	25p
4013	50p
4014	84p
4015	84p
4016	45p
4017	80p
4018	89p
4019	45p
4020	100p
4021	110p
4022	100p
4023	27p
4024	50p
4025	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4033	180p
4034	200p
4035	110p
4036	295p
4037	115p
4038	120p
4039	340p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	55p
4049	50p
4050	49p
4051	80p
4052	80p
4053	80p
4054	150p
4055	125p
4056	135p
4059	600p
4060	140p
4063	120p
4066	55p
4067	450p
4068	27p
4069	20p
4070	30p
4071	25p
4072	25p
4073	25p
4075	25p
4076	107p
4081	27p
4082	27p
4086	72p
4089	138p
4093	80p
4094	250p
4095	95p
4096	95p
4097	340p
4098	120p
4099	200p
40100	220p
40101	132p
40102	180p
40103	180p
40104	99p
40105	99p
40106	90p
40107	60p
40108	470p
40109	100p
40110	300p
40114	250p
4502	120p
4503	70p
4507	55p
4508	290p
4510	99p
4511	150p
4512	80p
4514	265p
4515	300p
4516	110p
4518	100p
4520	100p
4521	250p
4526	108p
4527	150p
4528	120p
4532	140p
4534	550p
4538	120p
4543	180p
4553	450p
4556	72p
4560	250p
4569	250p
4572	40p
4583	90p
4584	90p
4585	150p
4724	250p
40097	90p
14411	1100p
14412	1100p
14433	1100p
14500	700p
14599	290p
CD22100	350p
CD22101	700p
CD22102	700p

INTERFACE I.C.s

DM8123	175p
DP8304	450p
DS8835	250p
DS8836	150p
MC1488	75p
MC1489	75p
25S10	350p
75107	160p
75150	175p
75154	175p
75182	230p
75322	300p
75324	375p
75325	375p
75361	300p
75363	400p
75365	350p
75451	72p
75491/2	96p
8T26	250p
8T28	250p
8T95	200p
8T97	160p
81LS95	120p
81LS96	140p
81LS97	120p
81LS98	140p
9601	110p
9602	220p

93 SERIES

9301	160p
9302	175p
9308	316p
9310	275p
9311	275p
9312	160p
9314	165p
9316	225p
9321	225p
9322	150p
9334	360p
9368	250p
9370	300p
9374	200p

74S SERIES

74S00	60p	74S114	120p
74S04	60p	74S124	300p
74S05	75p	74S132	160p
74S08	75p	74S133	75p
74S10	60p	74S138	225p
74S20	60p	74S139	225p
74S30	60p	74S157	250p
74S32	90p	74S174	250p
74S37	90p	74S175	320p
74S64	60p	74S194	350p
74S74	90p	74S241	450p
74S85	300p	74S260	70p
74S86	180p	74S373	500p
74S112	120p	74S374	500p

LINEAR ICs

AY1-0212	600p	MK50398	750p
AY1-1313	668p	ML920	775p
AY1-1320	320p	MM57160	620p
AY1-5050	140p	NE531	150p
AY3-1270	840p	NE555	22p
AY5-1224A	240p	NE556	70p
AY5-1315	600p	NE561B	425p
AY5-1317A	775p	NE562B	425p
AY5-4007D	520p	NE564	520p
CA3019	80p	NE565	130p
CA3046	70p	NE566	155p
CA3048	225p	NE567	175p
CA3080E	72p	NE571	425p
CA3086	48p	NE5534A	250p
CA3089E	225p	RC4151	400p
CA309—AQ	375p	S566B	270
CA3130E	90p	SAB3209	POA
CA3140E	50p	SAD1024A	1250p
CA3160E	100p	SFF96364	1100p
CA3161E	140p	SL490	400p
CA3162E	450p	SN76003N	250p
CA3189E	300p	SN76013N	140p
CA3280	100p	SN76013ND	120p
DAC1408-8	200p	SN76477	200p
FX209	750p	SP8515	750p
ICL7106	850p	TAA621	275p
ICL8038	340p	TBA641B11	225p
ICM7555	80p	TBA651	200p
LF356P	95p	TBA800	90p
LM10C	425p	TBA810	100p
LM301A	30p	TBA820	90p
LM311	70p	TBA950	300p
LM318	200p	TCA210	250p
LM319	225p	TCA220	350p
LM324	45p	TCA940	175p
LM339	75p	TDA1004	300p
LM348	95p	TDA1008	320p
LM377	175p	TDA1010	225p
LM380	75p	TDA1022	570p
LM381AN	180p	TDA1024	120p
LM393	100p	TDA1034B	250p
LM709	36p	TDA1170	260p
LM710	50p	TDA2002V	325p
LM725	350p	TDA2020	320p
LM733	100p	TL071	45p
LM741	18p	TL072	85p
LM747	70p	TL074	130p
LM748	35p	TL081	45p
LM2917	250p	TL082	70p
LM3900	70p	TL084	110p
LM3909	70p	TL170	50p
LM3911	130p	UAA170	200p
LM3914	250p	UDN6118	320p
LM3915	250p	UDN6184	320p
LM4136	120p	ULN2003	100p
MC1310P	150p	XR2206	350p
MC1458	48p	XR2207	400p
MC1495L	350p	XR2240	400p
MC1496	100p	ZN414	90p
MC3340P	120p	ZN419C	225p
MC3360P	120p	ZN424E	135p
		ZN425E	400p

VOLTAGE REGULATORS

Fixed Plastic TO-220

1A	+ve		−ve	
5V	7805	65p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	70p
18V	7818	60p	7918	70p
24V	7824	60p	7924	70p
100mA	TO92			
5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

OTHER REGULATORS

LM309K	135p	78HGKC	600p
LM317T	200p	78H05KC	600p
LM323K	550p	78MGT2C	135p
LM723	37p	78P05	900p
		79HGKC	700p

OPTO-ELECTRONICS

2N5777	45p	ORP60	120p
OCP71	130p	ORP61	120p
ORP12	120p	TIL78	55p

OPTO-ISOLATORS

ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MCS2400	190p	TIL116	90p

LEDS

0.125"		0.2"	
TIL32	55p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	Rectangular	
TIL216 Red	18p	LEDs (R, G, Y)	30p

DISPLAYS

3015F	200p	NSB5881	570p
DL704	140p	TIL311	600p
DL707 Red	140p	TIL312/3	110p
707 Gr	140p	TIL321/2	130p
DL747 Red	225p	TIL330	140p
747 Gr	225p	7750/60	200p
FND357	120p	**DRIVERS**	
FND500	120p	9638	250p
FND507	120p	9370	300p
MAN3640	175p	UDN6118	320p
MAN4640	200p	UDN6184	320p

TRANSISTORS

AC126	25p	BFR40	25p	TIP31A	58p	2N3553	240p
AC127/8	20p	BFR41	25p	TIP31C	62p	2N3565	30p
AC176	25p	BFR79	25p	TIP32A	68p	2N3584	250p
AC187/8	25p	BFR80	25p	TIP32C	82p	2N3643/4	48p
AF116	50p	BFR81	25p	TIP33A	90p	2N3702/3	12p
AD149	70p	BFX29	30p	TIP33C	114p	2N3704/5	12p
AD161/2	45p	BFX30	34p	TIP34A	115p	2N3706/7	14p
AU107	200p	BFX84/5	40p	TIP34C	160p	2N3708/9	12p
BC107/8	11p	BFX86/7	30p	TIP35A	225p	2N3773	300p
BC109	11p	BFX88	30p	TIP35C	290p	2N3819	25p
BC117	20p	BFW10	90p	TIP36A	270p	2N3820	50p
BC147/8	9p	BFY50	30p	TIP36C	340p	2N3823	70p
BC149	10p	BFY51/2	30p	TIP41A	65p	2N3866	90p
BC157/8	10p	BFY56	33p	TIP41C	78p	2N3902	700p
BC159	11p	BFY90	90p	TIP42A	70p	2N3903/4	18p
BC169C	12p	BRY39	45p	TIP42C	82p	2N3905/6	20p
BC172	12p	BSX19/20	20p	TIP54	160p	2N4037	65p
BC177/8	17p	BU104	225p	TIP120	120p	2N4058/9	12p
BC179	18p	BU105	190p	TIP122	130p	2N4060	12p
BC182/3	10p	BU108	250p	TIP142	130p	2N4061/2	18p
BC184	11p	BU109	225p	TIP147	130p	2N4123/4	27p
BC187	30p	BU205	200p	TIP2955	78p	2N4125/6	27p
BC212/3	11p	BU208	200p	TIP4055	70p	2N4401/3	27p
BC214	12p	BU406	145p	TIS43	34p	2N4427	90p
BC237	15p	E300	50p	TIS93	30p	2N4871	60p
BC327	16p	E308	50p	ZTX108	12p	2N5087	27p
BC337	16p	E310	50p	ZTX300	13p	2N5089	27p
BC338	16p	MJ2501	225p	ZTX500	15p	2N5172	27p
BC461	36p	MJ2955	90p	ZTX502	18p	2N5179	90p
BC477/8	30p	MJ3001	225p	ZTX504	30p	2N5191	90p
BC516/7	50p	MJE340	50p	2N457A	250p	2N5194	90p
BC547B	16p	MJE2955	100p	2N696	35p	2N5245	40p
BC548C	9p	MJE3055	70p	2N697	25p	2N5296	55p
BC549C	18p	MPF102	45p	2N698	45p	2N5401	50p
BC557B	16p	MPF103/4	40p	2N706A	20p	2N5457/8	40p
BC559C	18p	MPF105/6	40p	2N708A	20p	2N5459	40p
BCY70	18p	MPS6531	50p	2N918	45p	2N5460	60p
BCY71/2	22p	MPS6534	50p	2N930	18p	2N5485	44p
BD131/2	50p	MPSA06	30p	2N1131/2	20p	2N5875	250p
BD135/6	54p	MPSA12	50p	2N1613	25p	2N6027	48p
BD⅛⅜& ⅛	¼P	MPSA13	50p	2N1711	25p	2N6107	65p
BD140	60p	MPSA20	50p	2N2102	70p	2N6247	190p
BD189	60p	MPSA42	50p	2N2160	350p	2N6254	130p
BD232	95p	MPSA43	50p	2N2219A	30p	2N6290	65p
BD233	75p	MPSA56	32p	2N2222A	30p	2N6292	65p
BD235	85p	MPSA70	50p	2N2369A	25p	2SC1172	150p
BD241	70p	MPSU06	63p	2N2484	30p	3N128	120p
BD242	70p	MPSU07	90p	2N2646	45p	3N140	120p
BDY56	200p	MPSU45	90p	2N2904/5	30p	3N141	110p
BF200	32p	MPSU65	78p	2N2906A	30p	3N201	110p
BF244B	35p	OC28	130p	2N2907A	30p	3N204	100p
BF256B	70p	OC35	130p	2N2926	9p	40290	250p
BF257/8	32p	TIP29A	40p	2N3053	30p	40360	40p
BF259	36p	TIP29C	55p	2N3054	65p	40361/2	75p
BFR39	25p	TIP30A	48p	2N3055	48p	40364	120p
		TIP30C	60p	2N3442	140p	40408	70p

40409	85p
40410	85p
40411	300p
40594	120p
40595	120p
40673	75p
40841	90p
40871/2	90p

10A 400V	200p
25A 400V	400p

ZENERS

2.7V-33V

400mW	9p
1W	15p

TRIACS PLASTIC

3A 400V	60p
3A 500V	65p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

DIODES

BY127	12p
BYX36-300	20p
OA47	9p
OA81	15p
OA85	15p
OA90	9p
OA91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
IS920	9p

THYRISTORS

1A 50V	40p
1A 400V	65p
3A 400V	90p
8A 600V	140p
12A 400V	160p
16A 100V	160p
16A 400V	180p
16A 600V	220p
BT106	110p
C106D	45p
MCR101	36p
2N3525	130p
2N4444	140p
2N5060	34p
2N5064	40p

HEAT SINKS

For TO220 Voltage Regs and Transistors	22p
For TO5	12p

BRIDGE RECTIFIERS

1A 50V	19p
1A 100V	20p
1A 400V	25p
1A 600V	30p
2A 50V	30p
2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p
6A 50V	80p
6A 100V	100p
6A 400V	120p

LOUD-SPEAKERS

Size		
2½	64R	80p
2½	8R	80p
2	8R	90p
1½	8R	100p

MEMORIES

2102-2L	120p
2107B	500p
2111-2	250p
2112-2	300p
2114	300p
2114-2L	500p
4027-3	375p
4044	900p
4116	400p
5101	510p
6810	325p
74S201	350p
82S16	325p

ROM/PROMs

71301	700p
74S188	225p
74S287	350p
74S387	350p
74S470	650p
74S471	650p
74S571	650p
82S137	750p
93427	400p
93436	650p
93446	650p
93448	900p

CPUs

1600	1200p
1802CE	650p
2650A	2000p
6502	1000p
6800	650p
6802	1250p
6809	2500p
8080A	450p
8085A	1200p
1NS8060	1000p
Z80	£10
Z80A	1150p

EPROMs

1702A	600p
2708	450p
2716 (+5V)	£10

SUPPORT DEVICES

3242	800p
3245	450p
6532	1000p
6820	300p
6821	375p
6845	2500p
6850	300p
8205	320p
8212	225p
8216	225p
8224	275p
8228	525p
8251	550p
8253	1000p
8255	550p
8257	950p
8259	1200p
Z80P10	650p
Z80AP10	650p
Z80CTC	650p
MC14411	1100p
MC14412	1100p

UART

AY-3-1015P	500p
AY-5-1013P	400p
IM6402	500p
TMS6011NC	400p

CHARACTER GENERATORS

3257ADC	990p
MCM6576	£12
RO-3-2513 U.C.	600p
RO-3-2513 L.C.	700p
SN74S262AN	£10

KEYBOARD ENCODER

AY-5-2376	700p

TRANSFORMERS

(prim 220/240V)

6-0-6	100mA	88p
9-0-9	75mA	92p
0-120	12500mA	280p
0-25V (VA)		250p
9-0-9 1A		270p*
12V 2A		350p*
0-12-15		
20-24-30 1A		340p*
15-0-15 1A		265p*

(Please add 50p p&p charge to all marked * above our normal p&p charge)

RESISTORS High Stab 5% E12 Carbon Film

¼W 10R-1M one value	7p/5pcs
½W 10R-10M one value	5p/3pcs

Miniature Presets Hor/Vert 100R-1M	12p
Carbon Track Pots 5K-1M Log or Lin	
Single	30p
Single with Switch	60p
Dual	72p
SLIDER POTS 60mm Track LIN 5K, 10K, 50K, 100K	60p
LOG 10K	60p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	20p	28 pin	30p
16 pin	11p	22 pin	22p	40 pin	40p

WIRE WRAP SOCKETS BY TEXAS

8 pin	25p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

SUBMINIATURE SWITCHES

Toggle	
SPST	60p
SPDT	65p
DPDT	70p
DPDT (centre off)	85p
Push to make	15p
Break	25p
Push latching SPCO	60p
SLIDE DPDT	18p
ROCKER SPST	28p
WAFER	
1P/12W	45p
3P/4W	45p
4P/3W	45p
2P/6W	45p

ANTEX SOLDERING IRONS

C-15W	415p
CX-17W	425p
CCN-15W	425p
X25	440p
SPARE BITS	
C/CX/CCN	50p
X25	50p
SPARE ELEMENTS	
C/CX/X25	180p
CCN	200p
ADCOLA IRONS	
K1000	550p
K2000	550p

CRYSTALS

100KHz	300p
1MHz	370p
1.008MHz	370p
3.2768MHz	350p
3.579545MHz	200p
4MHz	350p
8.867237MHz	400p
10.7MHz	350p
18MHz	300p
26.690MHz	210p
27.145MHz	210p

VEROBOARDS

DIP Breadboar 4.15 x 6.15 (Suitable for 20 x 14 pin or 16 x 16 pin DIL ICs)	325p
DIP Breadboard as above with tracks for 31 way connector	375p
V-Q Boards for ICs (No track cutting)	130p

CONNECTOR PLUGS

31 way Plug	120p
31 way Socket	120p
S-100 Busboar	1500p

EDGEBOARD CONNECTORS 0.156" PITCH

2 x 10 way	85p	2 x 22 way	135p
2 x 15 way	100p	2 x 25 way	160p
2 x 18 way	120p		

COUNTERS

74C925	475p
74C928	600p
ICM7216B	2000p
ICM7217A	850p
ZN1040E	700p

TTL & ECL

MC4024	325p
MC4044	325p
10116	70p
10231	350p

SPECIAL OFFERS (subject to stocks)

555	£18/100	7805	£5/10
741	£16/100	7812	£5/10
2114L-3	£4.00	7905	£6/10
2708 (450 ns)	£4.50	7912	£6/10
2708 (650 ns)	£4.00	2114L 450 ns	£24/8
2716 (plus 5V only)	£9.00		
4116 (200 ns)	£28/8	P&P + VAT Extra	

BREADBOARDS

EXP350 3.6 x 2.1 (Up to 3 x 14 pin ICs)	£3.15
EXP650 3.6 x 2.4 (Up to 1 x 40 pin IC)	£3.60
EXP300 6 x 2.1 (Up to 6 x 14 pin ICs)	£5.75
EXP600 6 x 2.4 (Up to 1 x 40 pin DCs)	£6.30

PROTOBOARD (R) SOLDERLESS BREADBOARDS

Socket Strips/Bus Strips/Binding Posts mounted on sturdy base plate.

PB6	6 x 14 DIL ICs	£9.20
PB100	10 x 14 DIL ICs	£11.80
PB102	12 x 14 DIL ICs	£22.95
PB103	24 x 14 DIL ICs	£34.45
PB104	32 x 14 DIL ICs	£45.95

(The above boards are suitable for all DIL ICs.)

16 KEY KEYPAD (Reed Switches)	450p
UHF Modulator 6MHz	£3.75
UHF Modulator 8MHz	450p
Reed Switches (12VA)	£0.25
LOGIC PROBE	£18.00
SUPERTESTER 680R	£33.00
MICROTEST 80R	£17.00
TMK500	£22.00
Pocket multimeter	£4.75

VEROBOARDS

0.1 (copper clad)			
2.5x3.75	65p	Pkt of 100 pins	50p
2.5x5	75p	Spot face cutter	86p
3.75x3.75	75p	Pin insertion tool	118p
3.75x5	80p	Vero Wiring Pen + 2 wire spools + combs	370p
3.75x17	290p		
4.75x17.9	380p	Combs	7p

IC TEST CLIPS

14 pin	£2.60	24 pin	£4.90
16 pin	£2.75	40 pin	£7.90

We carry a large stock of 74 and 74LS TTLs, CMOS, Linears, Memories, etc. and can normally offer ex-stock deliveries. We welcome inquiries for volume quantities both from local and overseas buyers.

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NASCOM-2 MICRO-COMPUTER

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780A 8 bit. This will run at 4 Mhz but is selected between 2/4/Mhz.
On-board, addressable memory. 2K
2K Monitor — Nas-sys 1. 1K Video RAM
(MK 4118). 1K work space/User RAM
(MK 4118) (8K Microsoft Basic PR)
(MK 3600 ROM). 8K Static RAM/ 2708E Pr.

Power Supply £29.50 + VAT.

Microprocessors Z80A, 8 bit CPU. This will run at 4MHz but is selectable between 2/4 MHz. This CPU has now been generally accepted as the most powerful 8 bit processor on the market.

INTERFACE

Keyboard New expanded 57 key Licon solid state keyboard especially built for Nascom. Uses standard Nascom, monitor controlled, decoding.

T.V. The Iv peak to peak signal can drive a monitor directly and is also fed to the on-board modulator to drive the domestic T.V.

I.O. On-board UART (Int. 6402) which provides serial handling for the on-board cassette interface or the RS232/20mA teletype interface.
The cassette interface is Kansas City standard at either 300 or 1200 baud. There is a link option on the NASCOM-2 for 2400 Baud.
The RS232 and 20mA loop connector will interface directly into any standard teletype.
The input and output sides of the UART are independently switchable between any of the options —
i.e. it is possible to have input on the cassette and output on the printer.

PIO There is also a totally uncommitted Parallel I/O (MK 3881) giving 16, programmable, I/O lines. These are addressable as 2 × 8 bit ports with complete handshake controls.

Documentation Full construction article is provided for those who buy a kit and an extensive software manual is provided for the monitor and Basic.

Basic The Nascom 2 contains a full 8K Microsoft Basic in one Rom chip with additional features like DEEK, OOKE, SET-RESET for simple programming.

SYSTEM 80

KITS from £225

Microprocessor board* (Nascom 2)
4MHz Z80 CPU; TV or Video + 1200 baud Kansas City + Serial RS 232 printer Interfaces; Keyboard; 128 character ASCII plus 128 Graphics in 2 × 2K ROM; free 16-way parallel port; 8K BASIC; NAS SYS operating monitor. £280 built and tested.

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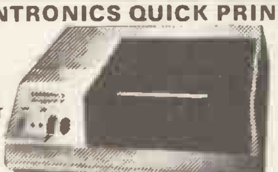

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CHARACTER SET — 64 ASCII alphanumerics and symbols.
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SCREEN — 12" diagonal. 1998 characters: 74 per line x 27 lines.
CHARACTERS — 5 x 7 Dot Matrix; 625 lines raster.
CHARACTER SET — 64 alphanumerics and symbols. 32 ASCII control codes.
KEYBOARD — Detachable, solid state. TTY design. 10-key numeric cluster plus editing and cursor control keys.
TRANSMISSION — Asychronous. Switch-selectable, for combinations of 5 standard rates, 110 to 9600 baud.
OPERATING MODES — Switch-selectable, full duplex, half-duplex or batch.
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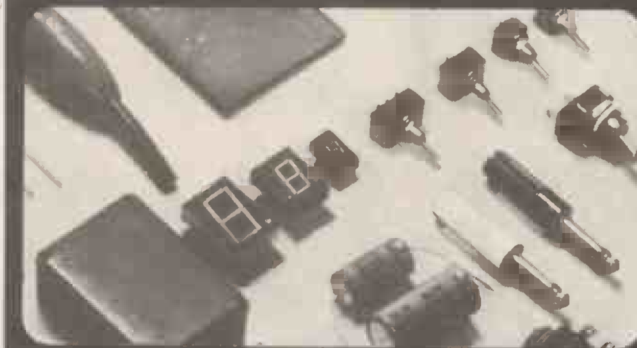

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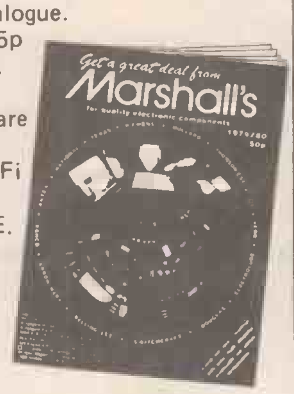

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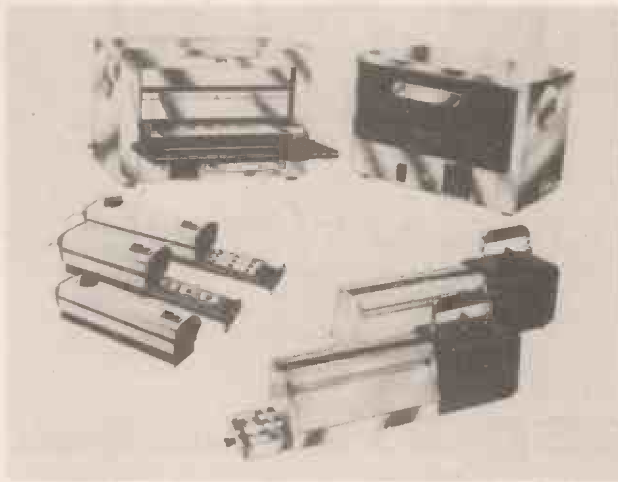

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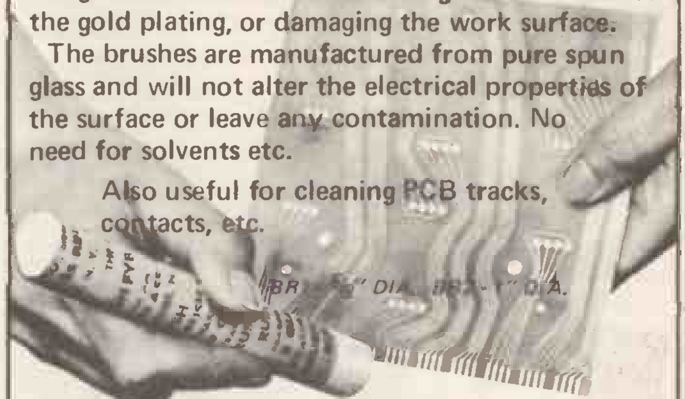

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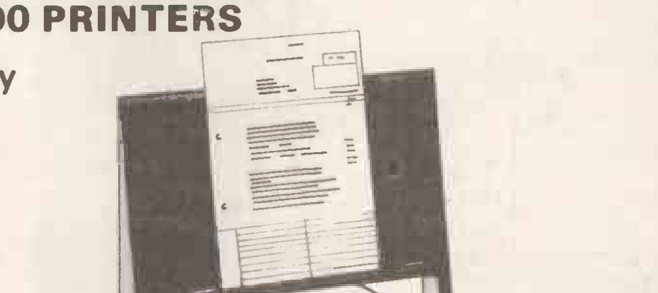

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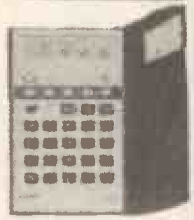

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Hours, minutes, seconds, day; And day, date, month and year. 12 or 24-hour display. 24-hour alarm, hourly chimes. Stopwatch from 1/100 second to 7 hours; net, lap and 1st and 2nd place times.
(£34.95) **£29.45**

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83QS-41B Alarm Chronograph
S/s encased

Mineral glass. Water resistant.
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Hours, minutes, seconds, date, am/pm; or hours, minutes, Alpha day, date, am/pm, 24 hour alarm, hourly chimes. Stopwatch from 1/10 second to 12 hours; net, lap and 1st and 2nd place. Nightlight.
ONLY £24.45
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Hours, minutes, seconds, am/pm, day. Day, date, month, auto calender pre-programmed to 2009. Professional 24-hour stopwatch; net, lap, 1st & 2nd place to 1/100 sec.
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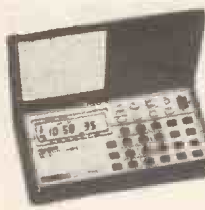

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Clock, calendar, two musical alarms, countdown timer. Stopwatch from 1/10 sec. to 12 hours; net, lap, 1st & 2nd place. Calculator with full memory. %, square roots. 5/16" x 4½" x 2¼". 1 year batteries.

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TERMS OF BUSINESS: Cheques or P.O. with order, made payable to B. Bamber Electronics, or phone your Access or Barclaycard No. Please add **15% VAT** on all goods advertised after adding postage as applicable.
CARRIAGE: Orders under £5 nett invoice add 75p. Orders over £5 but less than £20 add 50p. Orders over £20 carriage paid. **Callers welcome.** Tues.-Sat. 9.30 a.m.-5.30 p.m.

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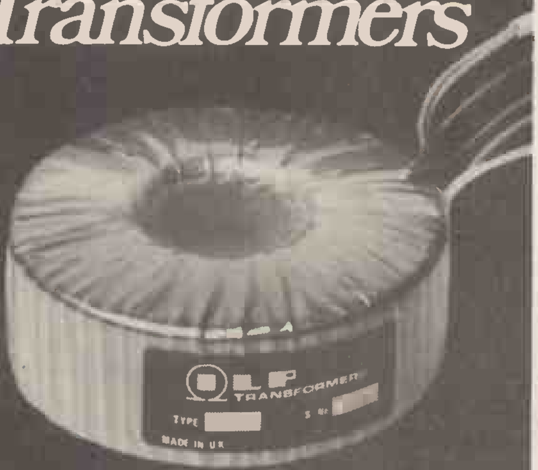
TEL: ELY (0353) 860185

WW — 069 FOR FURTHER DETAILS

Toroidal Transformers



Toroidal transformers have only half the weight and height of their laminated equivalents and are appreciably more efficient. Fields of radiation are far more restricted. Having our own manufacturing division, we are able to offer 25 types in a useful range of outputs at competitive prices. A strong mounting kit is supplied with each transformer.

TYPE	VA	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT	DIMENSIONS DIA-HT	WEIGHT KG	PRICE
2X010	50	6+6	4.16	70 × 40mm	0.9	EACH £5.40 +£1.10 P&P +98p VAT
2X011		9+9	2.77			
2X012		12+12	2.08			
2X013		15+15	1.66			
2X014		18+18	1.38			
2X015		22+22	1.13			
2X016		25+25	1.00			
3X010	80	6+6	6.64	90 × 30mm	1.0	EACH £5.76 + £1.20 P&P + £1.04 VAT
3X011		9+9	4.44			
3X012		12+12	3.33			
3X013		15+15	2.66			
3X014		18+18	2.22			
3X015		22+22	1.81			
3X016		25+25	1.60			
4X010	120	6+6	10.00	90x40mm	1.2	EACH £6.72 +£1.30 P&P +£1.20 VAT
4X011		9+9	6.66			
4X012		12+12	5.00			
4X013		15+15	4.00			
4X014		18+18	3.33			
4X015		22+22	2.72			
4X016		25+25	2.40			
5X016	160	25+25	3.20	110x40mm	1.8	EACH £8.88 +£1.40 P&P +£1.54 VAT
5X017		30+30	2.66			
6X016	300	25+25	6.00	110x50mm	2.6	£12.27 +£2.50 P&P +£2.27 VAT
6X017		30+30	5.00			

Notes:
For 110V Primary please insert 0 in place of 'X' in type number.
For 220V Primary please insert 1 in place of 'X' in type number.
For 240V Primary please insert 2 in place of 'X' in type number.

Example 120VA 240V 15+15V. 4A=42013.
Types to customer specification can be supplied to order in quantity. Enquiries invited.

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357

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Prescot Street, Liverpool L7 8XB

Electronics Technician

(Medical Physics Technician Grade III)

To assist with the maintenance / Development of equipment used in the Department of Nuclear Medicine at the above hospital.

Applicants should ideally have approximately 10 years experience (including apprenticeship) in electronics servicing.

Salary Scale: £4,605 to £5,952 per annum.

Further details and application form available from the Personnel Department at the above address. Closing date: 31st July, 1980.

AREA HEALTH AUTHORITY (TEACHING)
liverpool

(513)

UNIVERSITY OF BATH
SCHOOL OF ELECTRICAL ENGINEERING

RESEARCH OFFICERS

LSI MICROELECTRONICS DESIGN

Applications for two positions are invited, to work on a research project concerned with the development of computer-aided-design methods for the custom design of lsi microelectronic circuits. Applicants for the first position should hold or expect to hold a higher degree and be conversant with both logical design and the writing of PDP11/34 system software. Applicants for the second position should hold a good honours degree which includes digital logic design, and preferably knowledge of integrated-circuit technologies.

The project is funded by the Wolfson Foundation with industrial cooperation for a period of three years.

Commencing salaries up to £7000, according to qualifications and experience.

Application forms and further particulars from the Personnel Officer, University of Bath, Bath, BA2 7AY, quoting reference number 80/52R.

(536)

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A major British company is urgently seeking experienced Technical Authors to join a team coping with the requirements of a highly comprehensive project, whose application will have wide ranging effect on the future of telecommunications.

The position will be filled by experienced Senior Authors with a good academic record (HNC/D or Graduate in a numerate or engineering discipline) and real knowledge of producing documentation on computer systems and software. A good creative technical ability is essential, coupled with an inquisitive nature and a forceful personality.

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IPP Information Processing People

58 Pembroke Road, London W8. Telephone (24 hours): 01-603 7335/6. Telex: 261298

(517)

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Two experienced technicians are required by the Croydon Education Service.

One to maintain and prepare language laboratories in schools. A knowledge of other visual equipment would be an advantage.

Salary £4971-£5520 per annum depending on qualifications and experience.

The second technician will maintain and repair a range of audio and video equipment including TV receivers in schools.

Salary £5658-£6174 per annum inclusive according to qualifications and experience.

Apply in writing giving details of age, qualifications, present post, relevant work experience and the names and addresses of two referees to The Superintendent, Education Service Centre, Princes Road, Croydon, Surrey, stating for which post you wish to be considered.

Further information may be obtained from the Superintendent, Mr. A. Bevan, telephone no. 01-684 9393.

(531)

OXFORD UNIVERSITY
DEPARTMENT OF ATMOSPHERIC PHYSICS

Electronics Technician

A vacancy exists for an electronics technician (grade 5) to work on the construction, testing and maintenance of equipment used in the Department's space research programme. The successful applicant will become part of a small, energetic group involved in developing scientific instruments and launching them on Earth satellites and probes to the planets. Training will be given, as necessary. The salary scale, which is under review, is currently £4,257-£4,974 p.a. Applications, giving details of qualifications and experience, and the names of two referees should be sent to Dr. F. W. Taylor, Dept. of Atmospheric Physics, Clarendon Laboratory, Oxford OX1 3PU.

(511)

TECHNICIANS

Technicians are required for this expanding department to be responsible for the maintenance of medical equipment located throughout the West Birmingham Health District.

The successful applicants must have sound knowledge and experience of maintenance of the following equipment:

Post A — Electro-mechanical Technician
Mechanical Services — Anaesthetic Apparatus

Post B — Electro-medical Technician
Therapeutic and Diagnostic Physiological measurement.

Post C — Electro-medical Equipment
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Salary dependent on qualifications and previous experience.

Scales: Technicians Grade II — £5547-£6918
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Application forms and job descriptions from District Works Officer, Dudley Road Hospital, Birmingham, B18 7QH. For further information Telephone Mr. D. L. Hall, District Engineer, 021-554 3801, Ext. 4838.

Please quote Ref: 597/WW.

WEST BIRMINGHAM Health District

BIRMINGHAM AREA HEALTH AUTHORITY (Teaching)

(547)

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(538)

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(8994)

UNITED NATIONS

Invites Applications for the following positions at New York Headquarters

1. CHIEF, TECHNICAL SERVICES SECTION (P-5)

Supervises and specifies arrangements for the installation, operation and maintenance of equipment associated with the United Nations conference servicing and radio and television programming operations. This includes a wide range of broadcast standard audio and video equipment, simultaneous interpretation installations and electronic voting equipment.
Responsibilities include directing the work of some 100 personnel, design of and supervision of construction of equipment, advising other divisions on technical matters and preparation of budgets.
Should have advanced university degree in relevant engineering discipline, good electronic knowledge, computer experience and management skills particularly in the fields of budgeting projection and cost control, with 13 years' professional experience.
Level P-5 carries net base salary per annum from US $24,298 (single) and US $26,298 (with dependants) plus post adjustment from US$11,627 (single) and US$12,584 (with dependants) per annum.

VA. 80-D-DAM-109-NY

2. CHIEF, TELEVISION AND FILM UNIT (P-4)

Controls the technical aspects of the United Nations television and film unit which works to full professional broadcast standards.
Is responsible for system development and specifying operational and maintenance techniques and for assessing needs and making recommendations for purchase of equipment.
Supervises the operations in the technical areas and maintains contact with outside TV networks and operators.
Should have advanced university degree in electrical engineering with eight years' professional experience in the operation and maintenance of television and film equipment.
Level P-4 carries net base salary per annum from US$20,209 (single) and US$21,755 (with dependants) plus post adjustment from US$9,779 (single) and US$10,527 (with dependants) per annum.

VA. 80-D-DAM-108-NY

3. ENGINEER (TELECOMMUNICATIONS) (P-4)

Supervises the technical aspects of conference servicing operations with particular regard to simultaneous interpretation, audio distribution systems and electronic voting equipment.
Responsible for system development and design and for the installation of these facilities both at Headquarters and for conferences away from headquarters.
Should have advanced university degree in an engineering discipline, with eight years' professional experience.

VA. 79-D-DAM-357-NY.

APPLICATIONS: Please complete two copies of United Nations Personal History Form (P.11), or send detailed curriculum vitae to: **Professional Recruitment Service, United Nations, New York, N.Y. 10017, USA.** Mention the date of birth and nationality, and quote the Vacancy Announcement number.

(535)

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Please apply for an application form to the Recruitment Officer (Dept.WW1), H.M. Government Communications Centre, Hanslope Park, Milton Keynes MK19 7BH.

186

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£7,287-£8,097 plus

A vacancy exists for an experienced Air Traffic Engineer to fill the post of Senior Technical Officer at Norwich Airport.

The Senior Technical Officer is responsible for the management of and participation in the maintenance, modification and installation of a wide range of navigation, communication and airfield lighting equipment. Equipments already in use include Plessey ACR 430, PLAN 17/18 ILS, Ecko VDF, an off-site Redifon NDB, and VHF/UHF AM/FM transmitters and receivers with associated recorders.

N.J.C Conditions apply, subject to the Norwich City Council's local variations and local agreements. The post is graded PO1, points 1-5, £7,287-£8,097 per annum, and at present the Senior Technical Officer participates in alternating shift working which attracts an addition of 14% of salary, and week-end and Public Holiday working for which the appropriate enhanced payments are made. A pay award is pending commencing July 1980.
Removal and relocation expenses up to £1,150 and temporary housing accommodation in approved cases.

Entry point on the salary scale dependent on qualifications and experience.

Norwich, situated amidst the Norfolk Broads, surrounded by areas of outstanding natural beauty, offers a stimulating mixture of old and new with a thriving commercial/shopping centre and lively arts and theatre.

Application form and fuller details of the job may be obtained from the Administrative Department, Norwich Airport, Norfolk, NR6 6JA, telephone Norwich (STD 0603) 411923; completed form to be returned within 14 days of publication of this advertisement.

(507)

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Brookes & Gatehouse Ltd. are looking for an Electronics Engineer to provide a workshop back-up for a keen young team in their American subsidiary company.

Initial contract minimum one year.

About HNC level with good sound knowledge of transistor circuitry and digital techniques. Experience in the marine field and an interest in sailing would be advantageous. Full training given at our head office in Lymington. Contact Arthur Gale.

BROOKES & GATEHOUSE LTD.
Bath Road, Lymington, Hampshire SO4 9YP
Tel: (0590) 74252

(558)

SENIOR ENGINEER/ SUBSTANTIVE ENGINEER

MME Facilities Limited, have a vacancy for a SENIOR ENGINEER in VTR and a SUBSTANTIVE ENGINEER in the Cassette Department, both to be based in their Broadcast Facility House in the West End.
The equipment line up is, 3 Quad VTR's, a sophisticated cassette duplicating bank and an IKEGAMI EFP/ENG Unit recording onto a 1" VPR20.
Included in our plans for expansion is the installation of a 1" editing suite.
Salaries £11,000 and £9,000 respectively plus profit related bonus and overtime.

All applications to:

Andrew Coppin Esq.
MME FACILITIES LTD.
Enterprise House
9 Great Chapel Street
London, W1V 3AL
01-434 2021

(521)

Radio Technicians

Work in Communications R&D and add to your skills

At the Government Communications Headquarters we carry out research and development in radio communications and their security, including related computer applications. Practically every type of system is under investigation, including long-range radio, satellite, microwave and telephony.

Your job as a Radio Technician will concern you in developing, constructing, installing, commissioning, testing, and maintaining our equipment. In performing these tasks you will become familiar with a wide range of processing equipment in the audio to microwave range, involving modern logic techniques, microprocessors, and computer systems. Such work will take you to the frontiers of technology on a broad front and widen your area of expertise — positive career assets whatever the future brings. In the rapidly expanding field of digital communications, valuable experience in modern logic and software techniques will be gained.

Training is comprehensive: special courses, both in-house and with manufacturers, will develop particular aspects of your knowledge and you will be encouraged to take advantage of appropriate day release facilities.

You could travel — we are based in Cheltenham, but we have other centres in the UK, most of which, like Cheltenham, are situated in environmentally attractive locations. All our centres require resident Radio Technicians and can call for others to make working visits. There will also be some opportunities for short trips abroad, or for longer periods of service overseas.

You should be at least 19 years of age, hold or expect to obtain shortly the City and Guilds Telecommunications Technician Certificate Part I (Intermediate), or its equivalent, and have a sound knowledge of the principles of telecommunications and radio, together with experience of maintenance and the use of test equipment. If you are, or have been in HM Forces your Service trade may allow us to dispense with the need for formal qualifications.

Registered disabled people **may** be considered.

Pay scales for Radio technicians start at £4640 per annum, rising to £6525, and promotion will put you on the road to posts carrying substantially more; there are also opportunities for overtime and on-call work, paying good rates.

Get full details from our **Recruitment Officer, Robby Robinson, on Cheltenham (0242) 21491, Ext 2269,** or write to him at **GCHQ, Oakley, Priors Road, Cheltenham, Glos GL52 5AJ.** We will invite suitable applicants (expenses paid) for interview at Cheltenham.

GCHQ

Recruitment Office

Government Communications Headquarters

Oakley, Priors Road, Cheltenham GL52 5AJ

(9483)

CAPITAL APPOINTMENTS LTD.

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29-30 WINDMILL STREET
LONDON W1P 1HG
TEL: 01-637 5551

THE UK's No. 1 ELECTRONICS AGENCY

Design, Dev. and Test to £9,000
Ask for Brian Cornwell

SALES to £12,000 plus car
Ask for Ken Sykes

FIELD SERVICE to £8,000 plus car
Ask for Maurice Wayne

We have vacancies in ALL AREAS of the UK

Telephone: 01-637 5551 (3 lines)

(291)

SENIOR TEST ENGINEER

£7,000+

We require a test engineer to test and commission a new range of sophisticated phototypesetting terminals.

QUALIFICATIONS

HNC or Degree in Electronics with at least 5 years' experience in the testing of Digital Electronic equipment. Conversant in the latest TTL MSI. Knowledge of microprocessors or a background in phototypesetting would be an advantage.

This is an interesting and rewarding position with all the benefits of a small company. Some foreign travel envisaged.

Please telephone Mike Reynolds on 01-961 5425 or write for an application form to:

HEIGHLIN LIMITED
2 Morland Gardens, Stonebridge Park, London NW10 8DY

(518)

When the ship comes home, why not settle down?

We're British Telecom Maritime Service and we have everything in a job that you'd want: the kind of work you're trained to do, good pay, job security and all the comforts of home where they really count – at home!

Radio Officers

Vacancies exist at several coast stations for qualified Radio Officers to carry out a variety of duties that range from Morse and teleprinter operating to traffic circulation and radio telephone operating. And for those with ambition, the prospects of promotion to senior management are excellent.

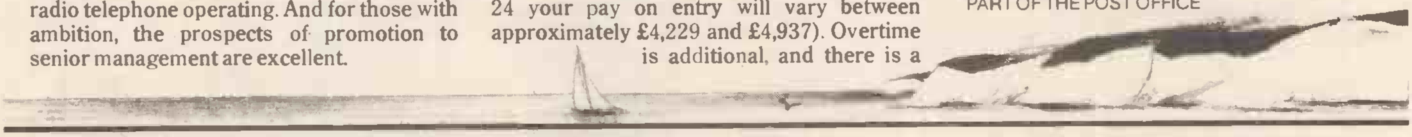
You must have a United Kingdom Maritime Radio Communication Operator's General Certificate or First Class Certificate of proficiency in Radio-telegraphy or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic. Preferably you should have some sea-going experience.

The starting pay at 25 or over will be about £5,381; after 3 years service this figure rises to around £7,087. (If you are between 19 and 24 your pay on entry will vary between approximately £4,229 and £4,937). Overtime is additional, and there is a good pension scheme, sick-pay benefits and at least 4 weeks' holiday a year.

For further information, please telephone Kathleen Watson on Freefone 2281 or write to her at the following address:
IE Maritime Radio Services Division (WWA), IS8.1.1.2, Room 304, Landsec House, 23 New Fetter Lane, London EC4A 1AE.

British TELECOM
PART OF THE POST OFFICE

(524)



Senior Test Technician/Engineer

£5000 – £6000 **Greenford**

At Ultra Electronics we manufacture highly sophisticated communication systems and are Europe's leading supplier of sonobuoys.

We now require an engineer aged 25+ who has had at least 5 years practical test and fault finding experience on VHF low power AM/FM transmitters, audio circuits low and high power timing and pulse circuits.

You should have an engineering qualification coupled with the ability and initiative to gain promotion in a forward thinking and progressive company.

In addition to a salary of £5000 – £6000 there are excellent benefits that include 22 days holiday, sports and social club, subsidised canteen and contributory pension scheme.

For further details please write to or telephone
Mrs J Foreman, on 01-578 0081.

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Electronic Communications Ltd

Ultra Electronic Communications Ltd.,
419 Bridport Road,
Greenford Trading Estate,
Greenford, Middx.

(500)

£25 REWARD

for anyone who can re-christen our hard-working computer. "Einstein" isn't quite right. Our scientific researcher has suggested "Lovelace," confident that all readers of this magazine will immediately think of Charles Babbage's assistant, the Hon. Ada Augusta — not the dreaded Linda. Our Einstein is indispensable, but what a prima donna — gets the vapours in hot weather! Further details of his performance are very wittily reviewed by David Tebbutt in the June issue of Personal Computer World.

Current vacancies include:

SENIOR SEMI-CONDUCTOR PROCESS ENGINEERS, to £14,000. **SEMI-CONDUCTOR QUALITY ENGINEERS,** to £11,000. **L.S.I. DESIGNERS,** to £12,000 (Scotland).

DIGITAL DESIGN/RESEARCH ENGINEERS, to work on a new generation of data acquisition/recording instruments and special-purpose displays. Equipment based on 8048/8085 and 6800/6802. To £10,000 (South Coast).

P.D.S. ENGINEER for mobile radio. To £8,000 (West Country).

SOFTWARE ENGINEERS for a wide range of device, i.e. PROM programmers, mpu programmers, programmable array units and mpu test equipment. To £8,000 (Herts.).

TEST ENGINEERS for a wide range of RF and microwave navigational beacons. Very progressive firm with lots of chance to progress. To £7,000 (West Country).

MICROWAVE ENGINEERS for test equipment design and application of special-purpose components to standard range of test equipment. To £7,000 (West Country).

JUNIOR ENGINEERS to join a team working on the application of mpu's including 16-Bit devices to aircraft data recording systems and environmental control systems. Salary confidential (West Country).

P.D.S. ENGINEER for mobile radio. To £8,000 (West Country).

SOFTWARE ENGINEERS for a wide range of device i.e. RPOM programmers, mpu programmers, programmable array units and mpu test equipment. To £8,000 (Herts.).

TEST ENGINEERS for a wide range of RF and microwave navigational beacons. Very progressive firm with lots of chance to progress. To £7,500 (West Country).

MICROWAVE ENGINEERS for test equipment design and application of special purpose components to standard range of test equipment. To £7,000 (West Country).

For further details of these and other vacancies, please ring:

(532)

Charles Airey Associates

4 Hammersmith Grove, London W6 0NA. Tel: 01-741 4011

"PROBABLY THE BEST KNOWN SUPPLIER OF ELECTRONIC ENGINEERS IN THE COUNTRY" -Financial Times.

STRATHCLYDE REGIONAL COUNCIL

GLASGOW Sub-Region
STRATHCLYDE POLICE

WIRELESS TECHICIAN

Wireless Workshop, Helen Street, Glasgow.

Salary Scale: Tech. 'D' — £5268-£5973.

Duties will be the servicing of VHF and UHF radio equipment. A City & Guilds Certificate in telecommunications or equivalent is desirable but not essential.

Applicants must have a current driving licence.

Application forms may be obtained from The Assistant Director of Manpower Services, 21 Gordon Street, Glasgow, G1 3PS, to whom completed forms, quoting Ref. G2518, should be returned by 30th July, 1980.

R. M. O. McCULLOCH
Director of Manpower Services

(515)

MICRO ENGINEER

MIDDX/SURREY **£6½-£8½K**

Computer Equipment manufacturer — leading Micro Boom — is expanding its design team for new Products/Markets/Applications. Using 'State of the Art' techniques.

Imagine a career path that includes:

- Training in hybrid hardware/software design
- Challenge and reward
- Your skills and ideas matter
- Friendly go ahead management
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- 1st class salary and regular reviews.

If you are an ambitious graduate or have sound technical experience already then ring **Richard Butcher** our Micro Specialist now! Ref ER 110.

01-549 6441 (Day) 01-644 3595 (after 7.30pm)

A.B. Executive (Kingston) Ltd.

(514)

CHELSEA COLLEGE
University of London
BASIC MEDICAL SCIENCES GROUP

GRADE 5 ELECTRONICS TECHNICIAN

We are seeking an experienced technician to join the Electronics Workshop of the Basic Medical Sciences Group. Experience of and interest in solving biological problems using electronic devices is essential. A flair for digital electronic design and an ability to communicate with medical scientists with research problems would be useful. In addition, there will be every opportunity to collaborate with the teaching and research programs of the microprocessor/microcomputer applications group of the Basic Medical Sciences Group.

Salary: £5037-£5754 per annum inclusive (under review). 5 weeks' annual leave plus Public Holidays and other concessionary days.

Application forms from the Personnel Officer, Chelsea College, Friese Greene House, Chelsea Manor Street, London SW3 3TW.

Closing date: 1st August, 1980.

(502)

AGRICULTURAL RESEARCH COUNCIL
LETCOMBE LABORATORY

ELECTRONICS

Applications are invited for three posts at the Laboratory which is located in a downland village near Wantage. The work is within a section which develops, constructs and maintains a wide range of electronic instruments, including microprocessors, for laboratory and field experiments in agricultural research.

Appointments will be made according to qualifications and experience as follows:

POST A: HIGHER SCIENTIFIC OFFICER, minimum qualification degree or equivalent plus 5 years' post qualifying experience. Salary in Scale £5,097-£6,737.

POST B: SCIENTIFIC OFFICER, minimum qualification degree, H.N.C. or equivalent. Salary in Scale £3,591-£5,486.

POST C: PROFESSIONAL & TECHNOLOGY OFFICER GRADE IV, minimum qualification ONC, City & Guilds or TEC/SCOTEC in Electrical Engineering/Electronics. Salary on entry £5,500 p.a. rising by annual increments to £6,300.

Non-contributory Superannuation.

Further particulars and application forms can be obtained from the Secretary, Agricultural Research Council, Letcombe Laboratory, Wantage, Oxon, OX12 9JT. Closing date 30th July 1980. Quote Reference No. 80/2.

(505)

ARAMCO

TUNE IN TO A NEW CHALLENGE

Good communications play a significant role in every business. In a Company the size of ARAMCO good communications are vital.

Aramco currently employ over 40,000 people in Saudi Arabia and the scale and diversity of operations is impressive.

On behalf of the Saudi Arab government, Aramco are involved in a massive gas gathering and processing programme, have built the biggest seawater desalination plant in the world and are committed to several other major, on going projects. All this as well as being the largest oil production company in the world.

These extensive investments within the Eastern Province of Saudi Arabia needs a good communications network to ensure the smooth and efficient running of the various operations organisations.

Salaries are as you would expect with a world leader.

ENGINEERS £11,450 to £19,200 TECHNICIANS £10,100 to £14,500

per contract year after tax.

THE COMMUNICATIONS PROJECTS MANAGEMENT DEPARTMENT

require Engineers and Field Technicians in the following skills:–

ENGINEERS & TECHNICIANS for the installation and commissioning of telemetry systems. Field work covers substations, remote terminal units, pipelines etc. You will be involved at module, unit and systems levels using a range of test equipment, digital diagnostic test procedures and control systems.
Engineers should have B.Sc or HNC in Electrical or Electronic Engineering plus minimum of 4 years relevant experience. Technicians should have apprenticeship plus at least 3 years relevant experience.

DATA ENGINEERS with at least 5 years experience in systems engineering on data terminalling equipment and analogue systems. A degree in electrical engineering or computer science is required for these positions.

COMMUNICATIONS ENGINEERS to act as technical consultants and systems planners on specification and design. Degree plus 5 years experience is required.

COMMUNICATIONS ENGINEERS for communications hardware and systems including local distribution and coaxial versus paired cables, multiplexers, multichannel radio bears, VHF/UHF/HF/MF equipment, outside telephone cable plant and telephone/electronic switching.

Contracts are single status and renewable yearly with air conditioned accommodation and free medical care provided. Good recreation facilities include libraries, cinema, TV, swimming pools etc. Married men receive leave after each 4 month period on a 14, 14 and 25 cycle. Single men receive 30 days leave at end of each year. Fares paid.

A valid UK driving licence is required for all the above positions.
Certain senior positions will qualify for married status after satisfactory completion of one year's employment.

Please write with brief career details etc. quoting ref: WW/16/7 to:–

(537)

PMC INTERNATIONAL RECRUITMENT
5 EAST PARADE,
HARROGATE,
NORTH YORKSHIRE HG1 5LF

Radio Communications Electronics Engineers and Software Designers

Mid-Sussex—S.W. London **Salaries up to £8,000**

To join our expanding R&D Laboratories covering a wide range of R.F. spectrum, from L.F. to V.H.F. Equipments include transmitters and receivers for marine- and land-based use, radio navaids and radio monitoring remote computer-controlled systems.

Electronics Engineers should have experience in transmitter or receiver design, analogue or digital circuit design, microprocessor applications. Software Designers should be experienced Programmers with an interest in control, signal processing or navigational software.

Attractive sala ies are complemented by excellent prospects and generous benefits.

Contact: **David Bird, Redifon Telecommunications Limited, Broomhill Road, Wandsworth, London, S.W.18. Phone: 01-874 7281** (reverse charges).

(9938)

ELECTRONICS ENGINEER

CENTRAL LONDON **£5,250 +**

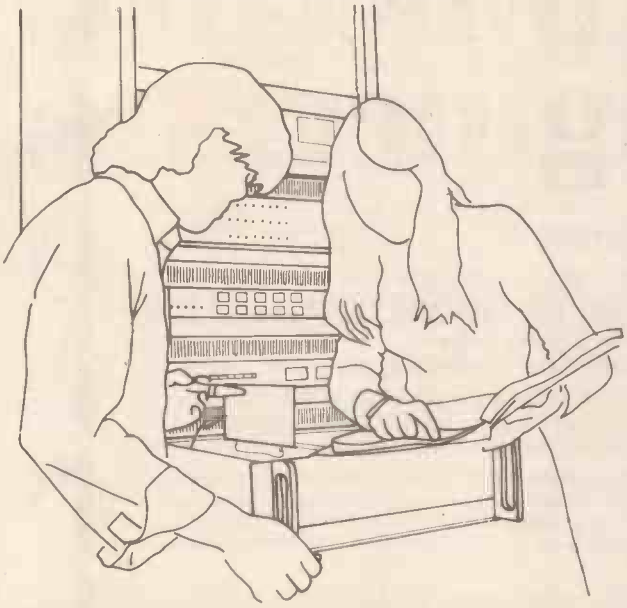
Electronics Engineer with good knowledge of digital electronics wanted for fault finding and repair work on microcomputer systems.

2 years' experience with digital systems or a good apprenticeship background are the minimum qualifications. Possession of a driving licence would be an advantage.

Phone Brian Levison **01-729 4483**

(523)

Professional Careers in Electronics



All the others are measured by us...

At Marconi Instruments we ensure that the very best of innovative design is used on our range of communications test instruments and A.T.E. We have a number of interesting opportunities in our Design, Production and Service Departments and we can offer attractive salaries, productivity bonus, pension and sick pay schemes together with help over relocation.
If you are interested to hear more, please fill in the following details:-

Name ______________________ Age ________

Address ______________________________

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Telephone Work/Home (if convenient) ________

Years of experience	0-1	1-3	3-6	Over 6
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Present salary	£3,500-4,500	£4,500-5,500	£5,500-6,500	over £6,500
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Qualifications	None	C & G	HNC	Degree
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Present job ______________________________

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Return this coupon to John Prodger, Marconi Instruments Limited, FREEPOST, St. Albans, Herts, AL4 0BR. Tel: St Albans 59292

Marconi Instruments

A GEC MARCONI ELECTRONICS COMPANY

(9200)

Royal Observatory, Edinburgh

Professional and Technology Officer

GRADE II

There is a vacancy in the Technology Unit of the Royal Observatory for an electronics engineer to work on the development of prototype astronomical instruments such as photometers, polarimeters, measuring machines and guidance and acquisition systems.

The Technology Unit provides technological support to the three national facilities for which the Observatory is responsible: the UK Infrared Telescope in Hawaii, the UK Schmidt Telescope in Australia and the COSMOS Measuring Machine in Edinburgh.

The successful candidate will work as a member of a small team engaged on the design, development, commissioning, documentation and support of the hardware and software for astronomical instruments. These instruments will typically involve control functions using microprocessors, detectors such as CCD arrays, TV cameras or photomultipliers, and a variety of mechanical and optical devices.

The successful candidate may be required to work abroad on short-term detached duties or on postings of up to three years. It will be a pre-requisite of working in Hawaii that a special high-altitude medical examination be taken and passed.

Applicants should have qualifications at degree level in an appropriate subject and several years' experience of design and development involving analogue, digital microprocessor and software techniques.

Starting salary would be in the range £7000-£81000 per annum. There is a non-contributory superannuation scheme.

Application forms from: The Personnel Officer, Royal Observatory, Blackford Hill, Edinburgh, EH9 3HJ. Telephone 031-667 3321.

Closing date for return of application forms:
August 1, 1980

(546)

Broadcast Engineer

TEST AND SERVICE

Seltech Equipment Limited is a leading supplier of broadcast equipment and its increasing share of the market requires a major expansion programme which has involved moving to large modern premises and the employment of additional engineering staff.

The position offered will involve testing and servicing a full range of broadcast products including switching, pulse generation, time code, clock and audio systems, utilising the latest technology.

The successful applicant will probably be qualified to HNC level but broadcast related experience is of prime importance.

The position is based in the company's new premises at Bourne End, Bucks. Limited travel will be required.

Salary and conditions will be in keeping with the position offered.

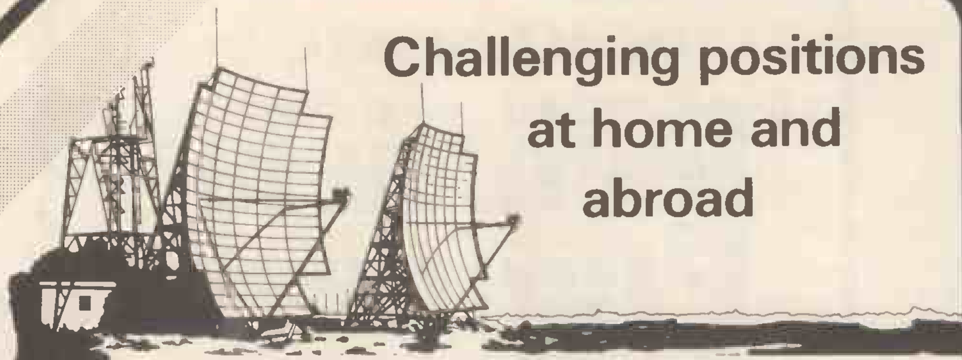
In the first instance apply to D. Craddock, General Manager.

SELTECH

SELTECH EQUIPMENT LTD
Rose Industrial Estate,
Cores End Road,
Bourne End, Bucks. SL8 5AT
Tel: Bourne End (06285) 29131

(525)

Challenging positions at home and abroad



RADIO TECHNICIANS COMMUNICATIONS ENGINEERS

Plessey EAE design, install and maintain communications systems for the oil industry, at home and abroad.

Due to rapid and continuing expansion in our activities, we constantly require Radio Technicians, with experience of HF, MF, VHF and UHF, and Engineers (preferably qualified to HNC level or above) in the fields of Microwave, Multiplex and Tropospheric Scatter.

In the North Sea, earnings are in the range £9,000 to £12,000 p.a. Overseas earnings could be up to £20,000 – plus tax concessions and generous home leave.

The work is demanding, but rewarding, offering you the chance to use your skills and your initiative to the full.

The company is based in Great Yarmouth, with offices in Aberdeen and Lerwick – but where relocation is necessary, we will give generous assistance with removal, legal and temporary accommodation expenses.

Please apply, with details of your career to date, to: Personnel Manager, Plessey EAE Limited, Dept WW, Offshore House, 284/285 Southtown Road, Gt. Yarmouth, Norfolk NR31 0JB Telephone 0493 58541

(530)

PLESSEY EAE

CHARING CROSS HOSPITAL (FULHAM)

ELECTRONIC TECHNICIAN ENGINEER

with, ideally, at least 2 years' experience in the maintenance of electronic equipment — not necessarily in a Hospital — and ONC qualified or equivalent, to join the electronics team.

The work involves maintenance, calibration, and Electrical safety testing of a large range of electronic equipment used throughout the Hospital with particular emphasis on Patient care and monitoring in the Intensive Care Units and the Operating Theatres. Design and development of special equipment, both digital and analogue and microprocessor-controlled is undertaken.

Inclusive salary scale: £4280-£5504 (MPT IV grade).

Lesser qualified applicants may be considered for entry on Junior Scales: £3119-£3920. Salary scales subject to review from 1st April, 1980.

For further information and an application form, please contact Miss J. Newbigin, Personnel Department, Brandenburgh House, 116 Fulham Palace Road, London W6. Telephone: 01-748 2040 Ext. 2992.

(501)

UNIVERSITY OF LONDON INSTITUTE OF EDUCATION

ELECTRONICS TECHNICIAN GRADE 5

The Department of Child Development and Education Psychology seeks a second technician to take charge of and develop a modern electronics workshop. Varied interesting work includes liaison with staff and students researching with children, and video work. Experience in maintaining psychological and/or physiological equipment together with ability to advise on and construct special purpose apparatus is necessary. Salary range £4257-£4974 (under review) plus £780 London Allowance.

Please telephone Mary Griffin on 636 1500 extension 254 or write to her at University of London Institute of Education, 20 Bedford Way, London WC1H OAL for an application form.

(508)

BRIGHTON POLYTECHNIC
LEARNING RESOURCES

VIDEO RECORDING & STUDIO ENGINEER

£6636-£7722

To be responsible for a newly established production centre equipped with state of the art facilities, including Plumbicon studio and telecine cameras, a wide range of video recorders and a video editing area based on Ampex one-inch broadcast VTRs. The two studios cover straight production, multi-track audio and advanced video post-production facilities. Active participation in related engineering developments is required. Operational experience of sound and colour video systems (preferably in a broadcasting or educational institution) and a degree or equivalent educational qualification are desirable.

ELECTRONIC ENGINEER

£5268-£6381

To work with a team of experienced engineers and technicians developing colour television and other audio visual facilities throughout the Polytechnic. The systems developments range from simple sound and T.V. production equipment to video recording and editing to near broadcast standards.

The Electronics Engineer will apply digital and analogue techniques to develop and install new equipment, up-grade existing facilities, and assist with its maintenance. Formal training to degree or equivalent standard will be expected but proven ability and experience in electronic design and construction (preferably including television) will be rated even more highly.

Further details and application forms from the **Personnel Officer, Brighton Polytechnic, Moulsecoomb, Brighton BN2 4AT. Telephone: Brighton 693655, Ext. 2536.**

(545)

BCL. The leading supplier of Reagents and Research Biochemicals to Hospitals and Universities is expanding.

If you live within easy access to London, have a good electro-mechanical analogue digital background and think you could do field service work, read on:

We require a

FIELD SERVICE ENGINEER

Male or Female to service our equipment in hospitals throughout London and the South East of England.

Good salary/car/expenses/pension scheme.

Interested?
For more information and application form contact:
Chris Williams, Service Manager
BCL LTD., Bell Lane, Lewes BN7 1LG, East Sussex
Tel: Lewes (07916) 77811

(554)

TESTERS, TEST TECHNICIANS, TEST ENGINEERS. Earn what you're **really** worth in London working for a World Leader in Radio & Telecommunications. Phone Len Porter on 01-874 7281, or write: REDIFON TELECOMMUNICATIONS Ltd., Broomhill Road, Wandsworth, London, SW18. (9856

RF CALIBRATION / communication engineer; MoD timeserved, HNC, experience with DC to 40Ghz, radio amateur, 25 years old, seeks interesting and rewarding job incorporating world travel. Box No. 549. (549

TOP JOBS IN ELECTRONICS

Posts in Computers, Medical, Comms, etc. ONC to Ph.D. Free service.

Phone or write: **BUREAUTECH, AGY, 46 SELVAGE LANE, LONDON, NW7. 01-906 0251.**

(8994)

ELECTRONICS TECHNICIAN Grade 6 required by Department of Physiology, UCL, to work in the Electronics Workshop. Duties would include the design, construction and maintenance of a wide range of sophisticated equipment used in teaching and research laboratories. Candidates should hold HNC or equivalent and have a good knowledge of electronics, including digital circuitry. Experience in a University or similar institution would be an advantage. Salary in range £5,664 - £6,612 inclusive of London Weighting. Application form from Personnel Officer (Technical Staff FF29), University College, London, Gower St, London WC1E 6BT. (447

TESTERS, TEST TECHNICIANS, TEST ENGINEERS. Earn what you're really worth in London working for a World Leader in Radio & Telecommunications. Phone Len Porter on 01-874 7281, or write: REDIFON TELECOMMUNICATIONS Ltd., Broomhill Road, Wandsworth, London, SW18. (9856

Electronic Engineers –
What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £4000 to £8000 p.a.

If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you.

All applications are treated in strict confidence and there is no danger of your present employer (or other companies you specify) being made aware of your application.

TJB ELECTROTECHNICAL PERSONNEL SERVICES,
12 Mount Ephraim,
Tunbridge Wells,
Kent. TN4 8AS.

Tel: 0892 39388

TJB

Please send me a TJB Appointments Registration form:

Name ....

Address ....

....

(9238)

ALCAN LABORATORIES LIMITED ATLANTIC REGION RESEARCH CENTRE

ALCAN

INSTRUMENT TECHNICIAN

Alcan Laboratories Limited require an Instrument Technician at their Research Centre in Banbury, Oxfordshire. The work will be concerned mainly with the development of electronic measurement and control equipment which will be used in the Laboratory and in Alcan factories.

The Research Centre, which is one of Europe's leading metallurgical laboratories, carries out Research and Development work for associated Group companies in the U.K., Europe, Africa and South America; it is part of the Canadian-based Alcan Aluminium Limited Group, which is one of the world's major aluminium producers.

Candidates will be required to work largely on their own initiative; they should have an HNC in Electronic Engineering followed by several years' experience in the development of prototype electronic equipment.

The Company offers excellent working conditions, progressive salary scales, flexible working hours and a contributory pension scheme. Assistance with the cost of moving house will be given where appropriate.

Application forms can be obtained from: **Miss G. Rogers, ALCAN LABORATORIES LIMITED, Southam Road, Banbury, Oxon. OX16 7SP. Tel. Banbury (0295) 2821.**

(441)

BRIGHTON POLYTECHNIC
LEARNING RESOURCES

VIDEO RECORDING & STUDIO ENGINEER

£6636-£7722

To be responsible for a newly established production centre equipped with state of the art facilities, including Plumbicon studio and telecine cameras, a wide range of video recorders and a video editing area based on Ampex one-inch broadcast VTRs. The two studios cover straight production, multi-track audio and advanced video post-production facilities. Active participation in related engineering developments is required. Operational experience of sound and colour video systems (preferably in a broadcasting or educational institution) and a degree or equivalent educational qualification are desirable.

ELECTRONIC ENGINEER

£5268-£6381

To work with a team of experienced engineers and technicians developing colour television and other audio visual facilities throughout the Polytechnic. The systems developments range from simple sound and T.V. production equipment to video recording and editing to near broadcast standards.
The Electronics Engineer will apply digital and analogue techniques to develop and install new equipment, up-grade existing facilities, and assist with its maintenance. Formal training to degree or equivalent standard will be expected but proven ability and experience in electronic design and construction (preferably including television) will be rated even more highly.

Further details and application forms from the **Personnel Officer, Brighton Polytechnic, Moulsecoomb, Brighton BN2 4AT. Telephone: Brighton 693655 Ext. 2536. Closing date: June 27th.**

(400)

UNIVERSITY OF OXFORD ELECTRONICS TECHNICIAN

An electronics technician is required for work on mass spectrometers and other equipment in the Department of Geology and Mineralogy, under the technical direction of the Electronics Group in the Physics Department. Applicants should have wide experience in fault-finding and building of modern electronic equipment.

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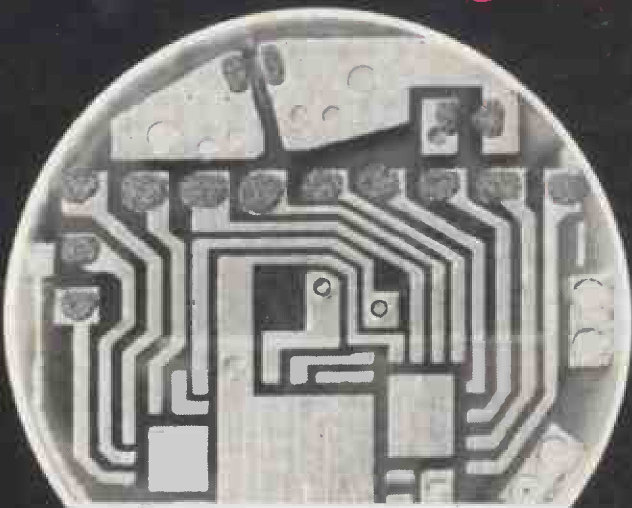

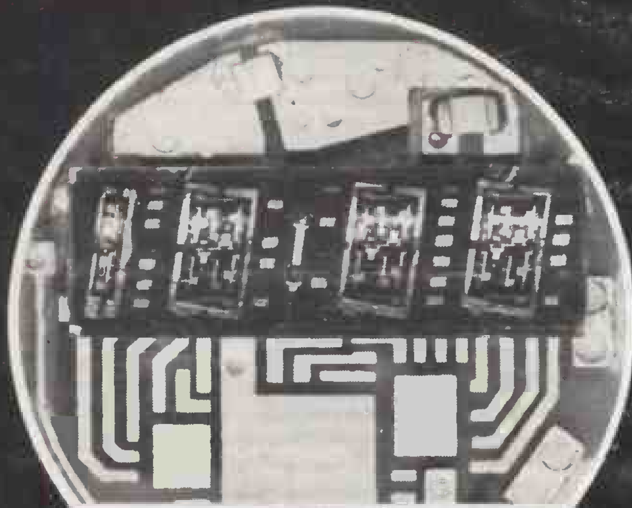

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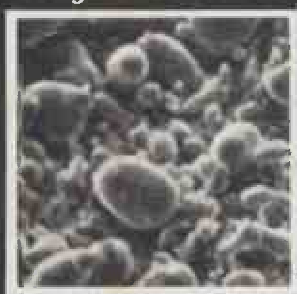

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