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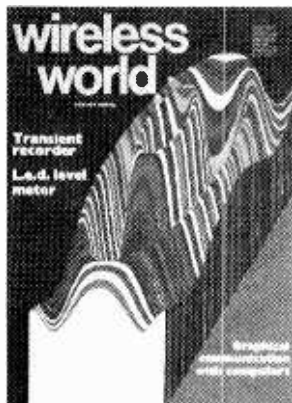
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Front cover is an abstract design by Geoff Harrold, based on an illustration from Ian Witten's article on microcomputers

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.

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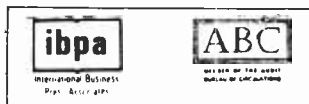
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wireless world

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Out of bounds

A power amplifier has to produce an adequate output voltage. This voltage has to be able to change at a sufficiently high rate to trace accurately any possible programme waveform. It has to be able to do all this independently of the current drawn by the loudspeaker.

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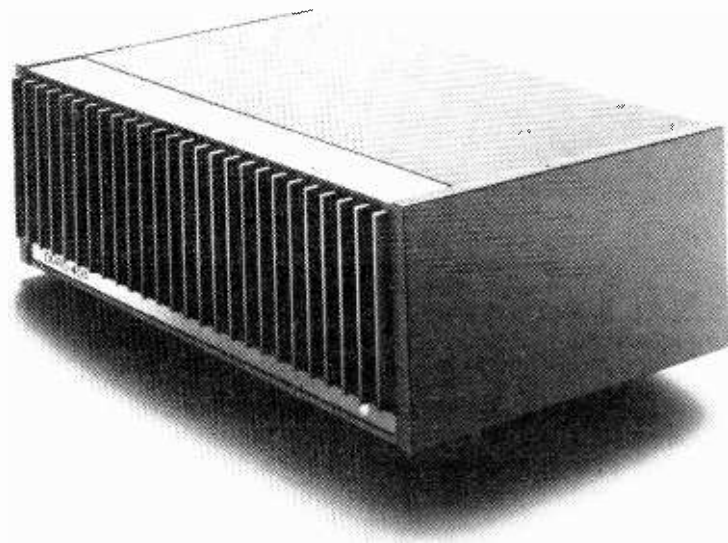
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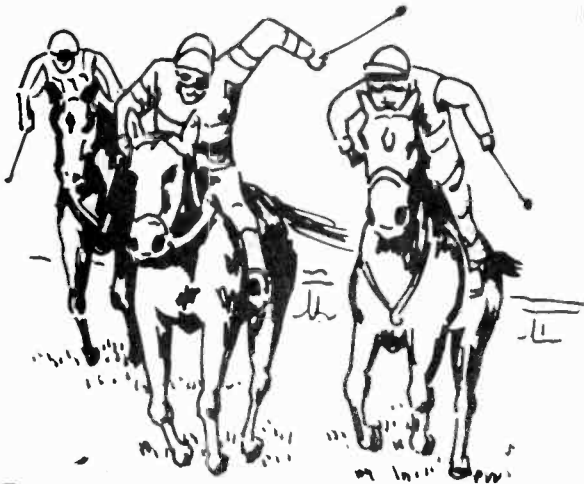
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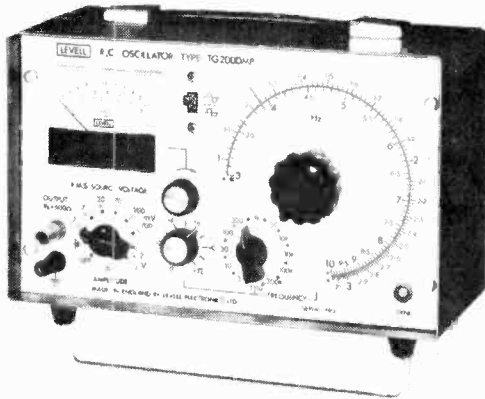


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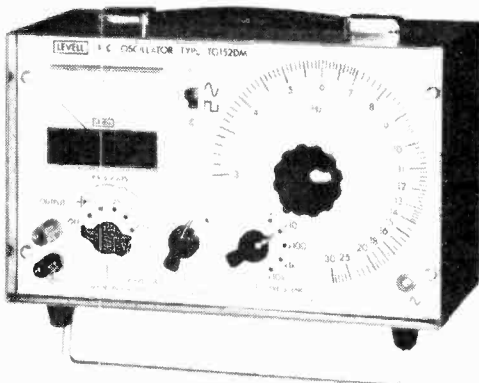


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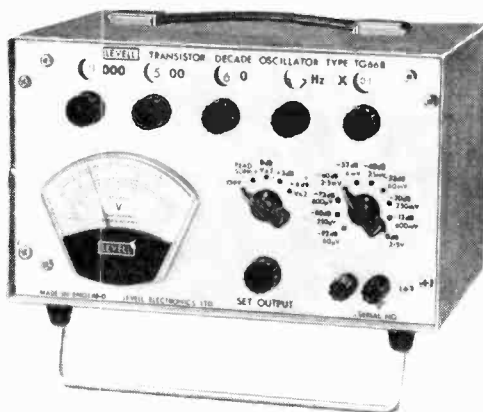
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The ZX80 is programmed in BASIC, and you can use it to do quite literally anything from playing chess to managing a business.

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*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:

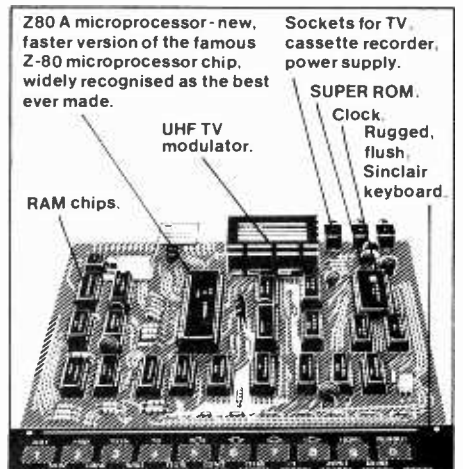
- **Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry 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 to 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.

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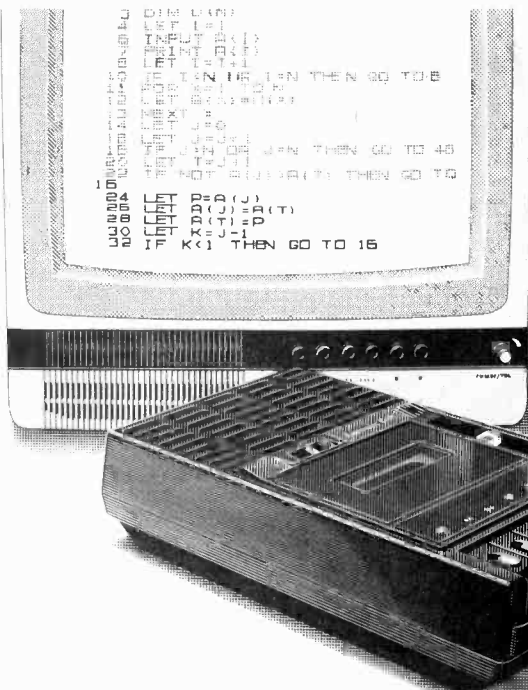
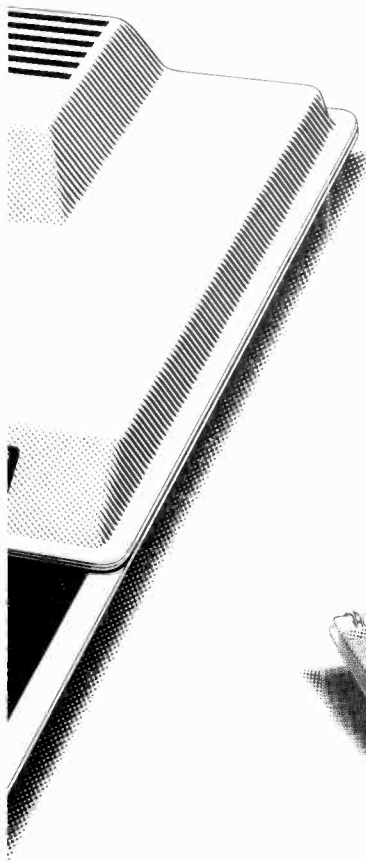
The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly 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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ZX80 software – now available!

See the advertisements in Personal Computer World (June) and Electronics Today International (July).

New dedicated software – developed independently of Science of Cambridge – reflects the enormous interest in the ZX80. More software available soon – from leading consultancies and software houses.



The Sinclair teach-yourself BASIC manual.

If the specifications of the Sinclair ZX80 mean little to you – don't worry. They're all explained in the specially-written 128-page book free with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs. (Available separately – purchase price refunded if you buy a ZX80 later.) A hardware manual is also included with every kit.

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Demand for the ZX80 is very high: use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. We'll acknowledge each order by return, and tell you exactly when your ZX80 will be delivered. If you choose not to wait, you can cancel your order immediately, and your money will be refunded at once. Again, of course, you may return your ZX80 as received within 14 days for a full refund. We want you to be satisfied beyond all doubt – and we have no doubt that you will be.

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ZX80

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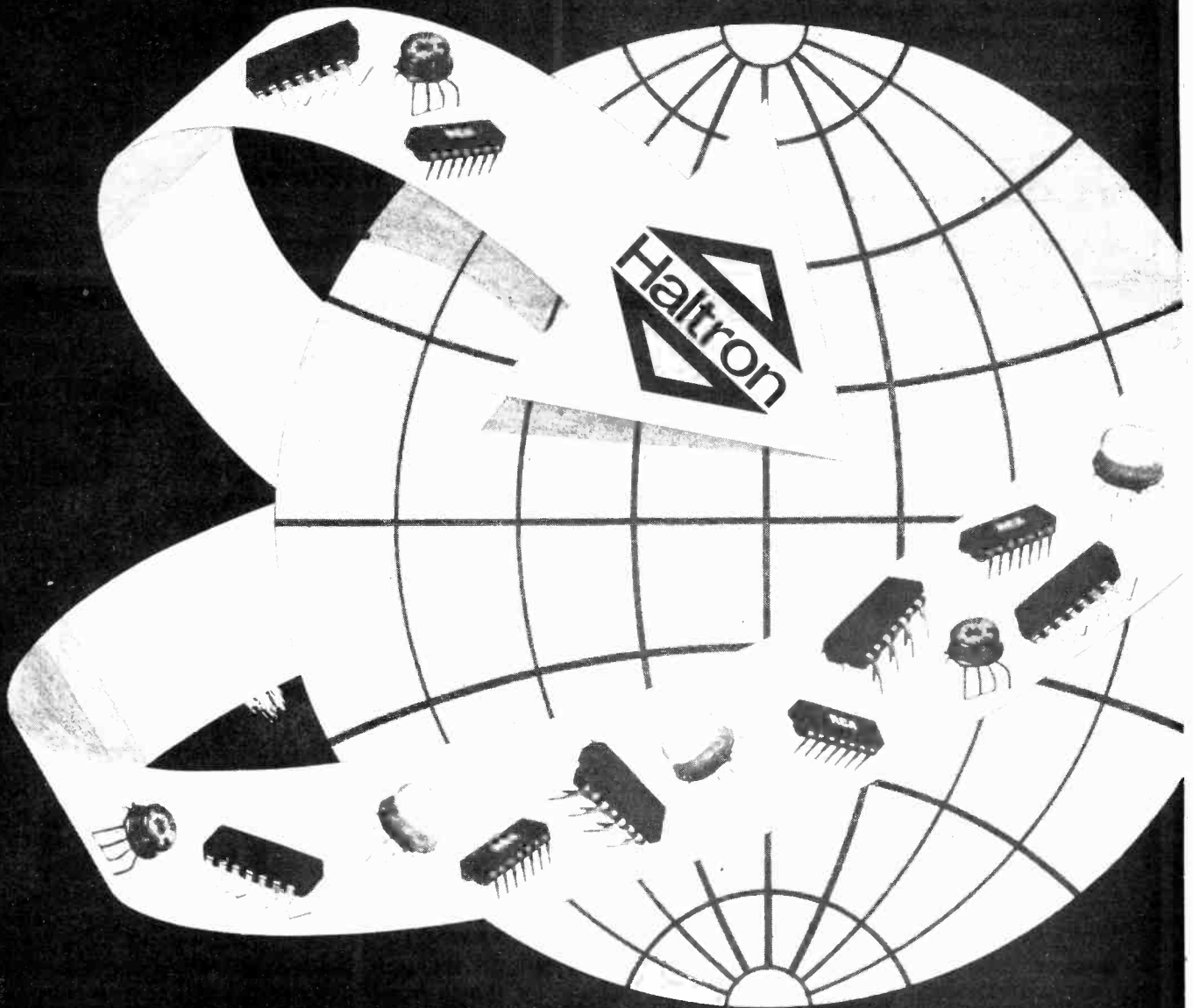
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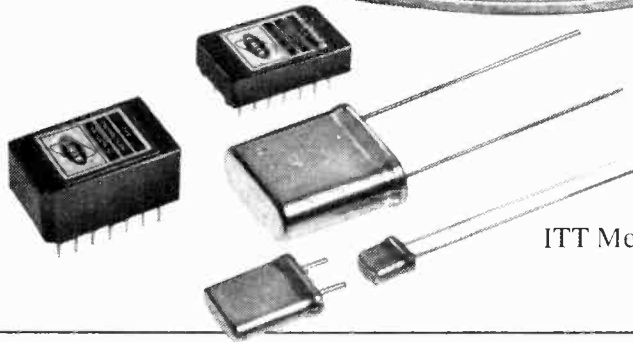
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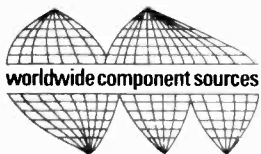
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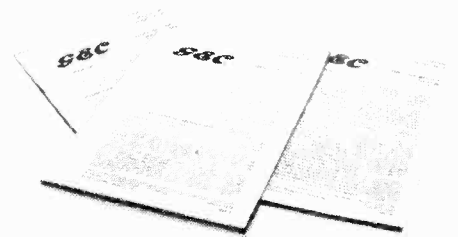


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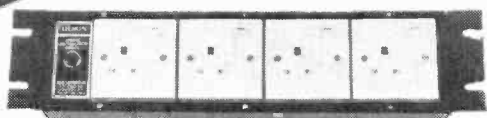


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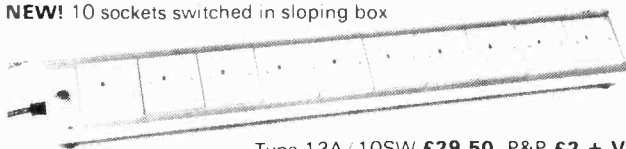


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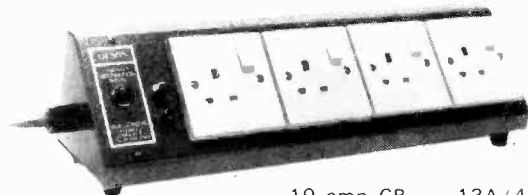
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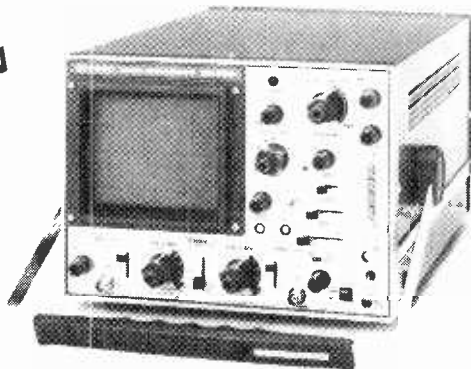
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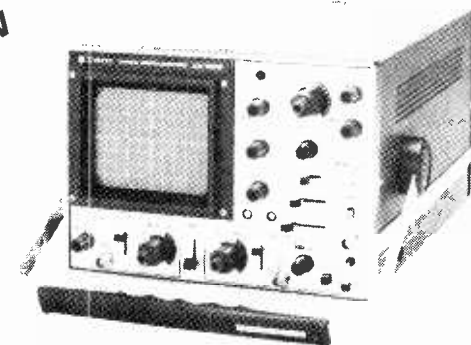
The CS1830 is a completely new 30 MHz dual trace oscilloscope employing a square format, internal graticle, PDA tube for accurate bright display. A new feature is the inclusion of calibrated sweep delay with a range of 1µS-100 mS and trace bright up to show the delay position. As you can see from close study of the photograph, the CS1830 has **all** the facilities you could require in a high performance instrument but for more detail, simply ask us for a comprehensive leaflet.

Brief specification

| | |
|---|------------------------------|
| Rectangular PDA tube 120 x 96 mm P31 phosphor | Overshoot less than 3% |
| Bandwidth DC-30 MHz | Sweep time 200nS/cm-0.5 S/cm |
| Sensitivity 5mV/cm (30 MHz) | Linearity better than 3% |
| 2mV/cm (20 MHz) | Trig. bandwidth DC-30 MHz |
| Input R.C. 1 M / 23 pF | Sweep delay 1µS-100 mS |
| Risetime 11.7 nS | |

CS1830 only £455 + VAT includes 2 probes

NEW



THE CS1572 30 MHz for the VTR Lab. If you are in Video, you need the CS1572

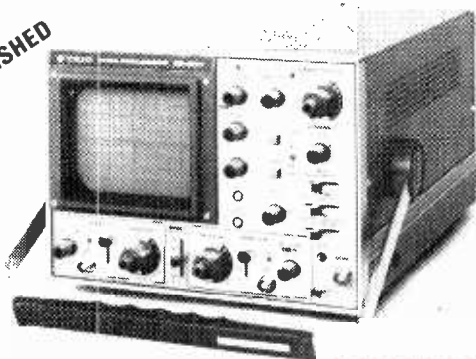
The CS1572 is a dual trace 30 MHz oscilloscope designed for the video tape recorder engineer. Video delayed sweep facilities are provided to allow magnification and analysis of any point in a single video frame together with separation of video odd and even fields. A truly unique tool for anyone concerned with video measurements as well as a top specification dual trace wide band oscilloscope for general lab use. The complete range of video facilities is too great to explain in a small advertisement so why not call us and ask for the full story on the CS1572.

Brief Specification

As for CS1830 except that the sweep delay feature is replaced by comprehensive video sweep delay facilities which allow complete analysis of video wave forms and VTR alignment.

CS1572 only £425 + VAT, includes 2 probes

ESTABLISHED



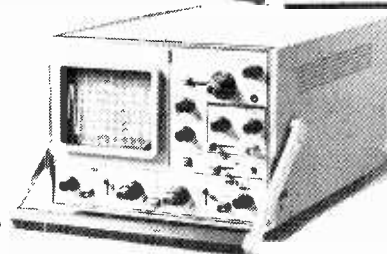
THE CS1577 30 MHz at 2mV + Signal Delay The most popular scope in the range.

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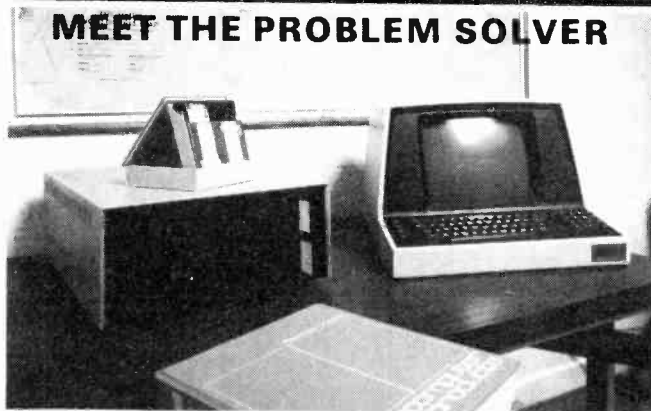
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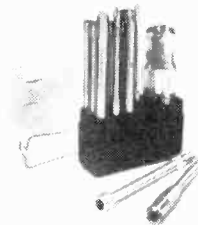
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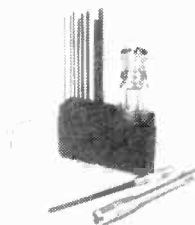
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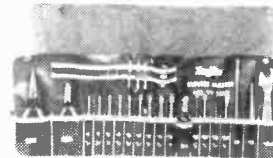
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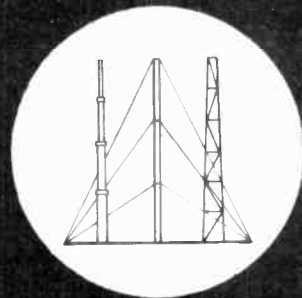
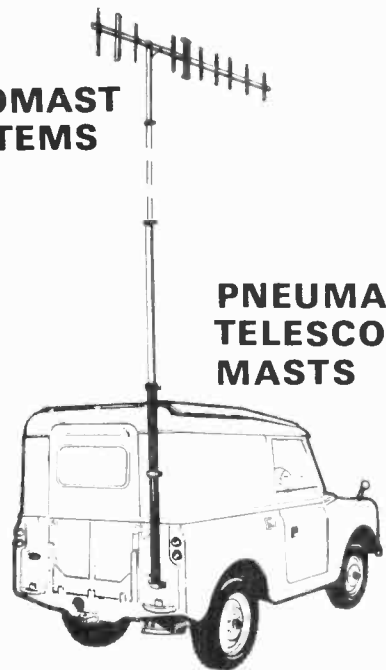
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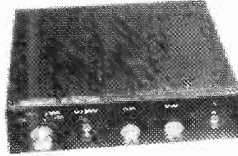
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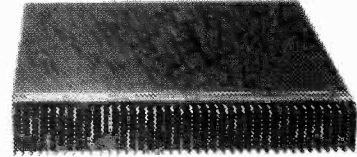
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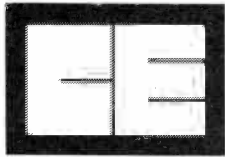
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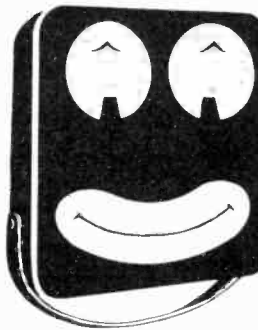
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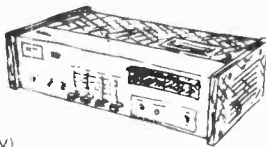
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A40 P.A. CENTRE

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)

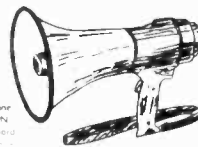


£220.80

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 sleek silver cabinet, with black silver deck and control fascia, housing the 40W mono amplifier, cassette recorder, internal microphone and speaker. Outputs of 8, 10 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: 1/4 mile
Batteries: 6 - 1 1/2 V

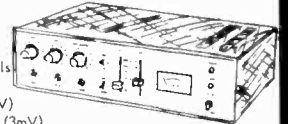


£89.70

Easy to use and hold, this lightweight megaphone has a range approaching a 1/4 mile. Features ON/OFF switch incorporated in pistol grip and forward facing dynamic microphone. Solid state 3 watt conductor circuit, powered by 6 x 1 1/2 batteries. Attractive red and white case with carrying strap.

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)

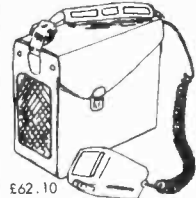


£117.30

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 complemented with a black and silver front fascia panel. 3 low impedance microphone inputs are available. The third of these inputs can alternatively be 'auxiliary' or 'magphonic phono (R.I.A.A.)' inputs via selector switch. A 3 position switch makes MUSIC SPEECH provided to give 'Box 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 SHOULDER P.A. SYSTEM

Power: 5W RMS, Range 1/4 mile
Batteries: 6 - 1 1/2 V

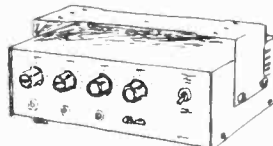


£62.10

This is a versatile, complete P.A. system essential for counters and guides, public speeches, traffic and parking controllers, showground and display attendants and for countless publicity and promotion activities. The neat, leather-rang case with adjustable shoulder strap houses a solid-state amplifier, loudspeaker and storage for the pre-stationed 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, crossovers, 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.

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)
1 - Aux (200mV)



£276.00

Designed and developed to meet - and surpass - European performance standards, this P.A. amplifier boasts a power handling of 175W (R.M.S.). It is protected against a short-circuit output and incorporates battery connections. Each of the four input channels has stereo-stereo gain control and individual slide switch operating FLAT/LO filters. Overall Bass and Treble levels are set by slide controls, overall volume level is obtained by observing the meter V.U. meter and operation of the extra large Master control. Operation from A.C. mains or from 24V D.C. 4 inputs are low impedance with a 2mV sensitivity, magnetic phono input with R.I.A.A. equalisation provided through a 5-pin DIN socket (3mV). An additional input accepts signals from tuners, tape recorders etc. (250mV). Output matching is to 4, 8 and 16 ohms, 70V and 100V lines plus booster amplifier socket. The casing incorporates front grab handles and protective feet, and can be used free standing or rack mounted.

L83 MEGAPHONE (SEP. MIKE)

Power: 16W, Range: 1/2 mile
Batteries: 8 - 1 1/2 V



£69.00

High powered, yet compact and easy to carry and use, this solid state megaphone has a range of 1/2 mile. The noise cancelling microphone clips onto the base, has a convenient pre-stationed switch and volume control and is fitted with a self-coiling lead extending to over 12 metres. This sturdily constructed megaphone can be operated from a stand using the lapped hole provided, free standing on table and floor, and partially shoulder slung, or strap carried.

MICROPHONES - supplied c/w lead, jack plug, busby, U-bracket (if appropriate)

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| M12 | CONDENSOR CARDIOD - 600 OHM | £26.43 |
| M20 | ELECTRET CONDENSOR, OMNI-DIRECTIONAL - 600 OHM | £13.80 |
| M21 | ELECTRET CONDENSOR, UNI-DIRECTIONAL - 600 OHM | £19.32 |
| M30 | DYNAMIC CARDIOD, BALL WINDSHIELD - 50K/600 OHM | £28.98 |
| M48 | ELECTRET PAGING, CARDIOD. (CAST BASE) - 600 OHM | £26.22 |
| M50 | COMMUNICATIONS, OMNI-DIRECTIONAL. (HAND HELD) - 600 OHM | £ 6.90 |

MICROPHONE STANDS

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| M121 | BANQUET STAND, CAST BASE - 11" TO 18 1/2" | £ 7.66 |
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| M124 | FOLDING FLOOR STAND - UP TO 60" | £14.49 |
| M125 | STUDIO FLOOR STAND, SCREW IN LEGS - UP TO 63" | £20.70 |
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| M170 | GOOSENECK FLANGE ADAPTOR - BLACK SPRAYED CASTING | £ 2.14 |
| M1040 | WINDSHIELD COVER (BUSBY) - MEDIUM (ENTRY 17MM DIA.) PER PAIR | £ 1.59 |
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MIXER

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| M104 | SIX CHANNEL STEREO MIXER AND PRE-AMPLIFIER - BATTERY POWERED (accepts high & low impedance microphones, and has R.I.A.A. input) | £62.10 |
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SPEAKER SYSTEMS - CABINETS

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| L106 | 10W, 8 OHM - BLACK FOAM FRONT, 'TEAK' FINISH, B" DRIVER. PER PAIR | £35.19 |
| L110 | 40W, 8 OR 16 OHM (SPECIFY WHICH) - BLACK 'VYNYDE' COVERING (fitted with metal corner protectors and complete with a slip-on cover) | £89.70 |

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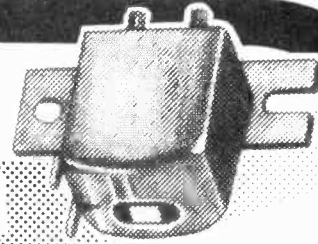
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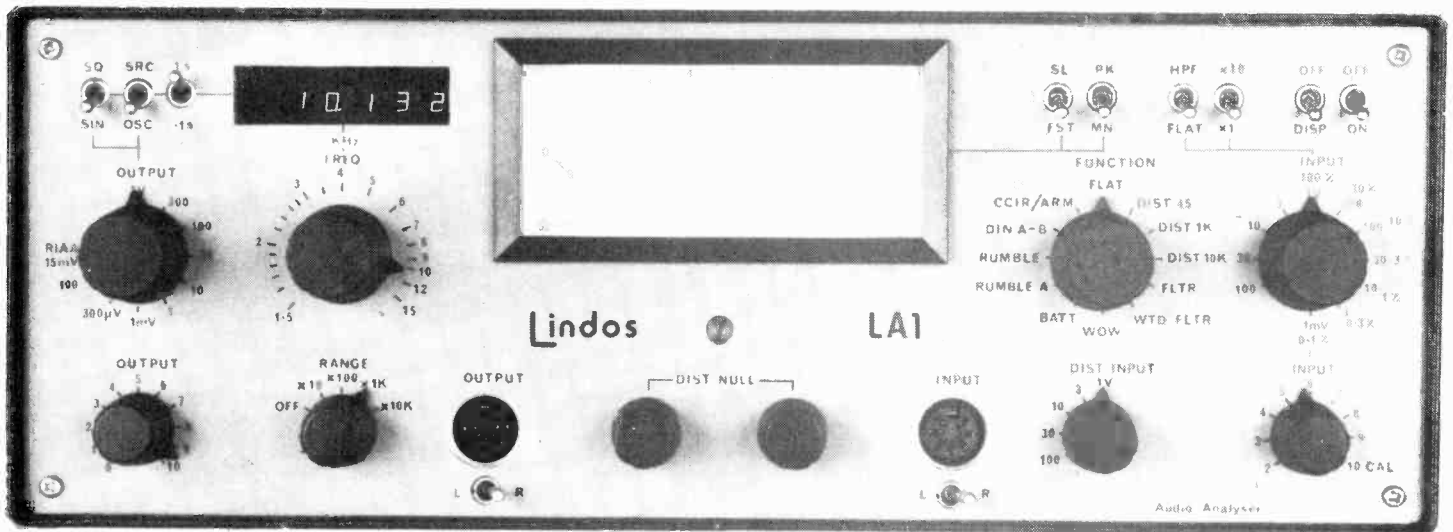
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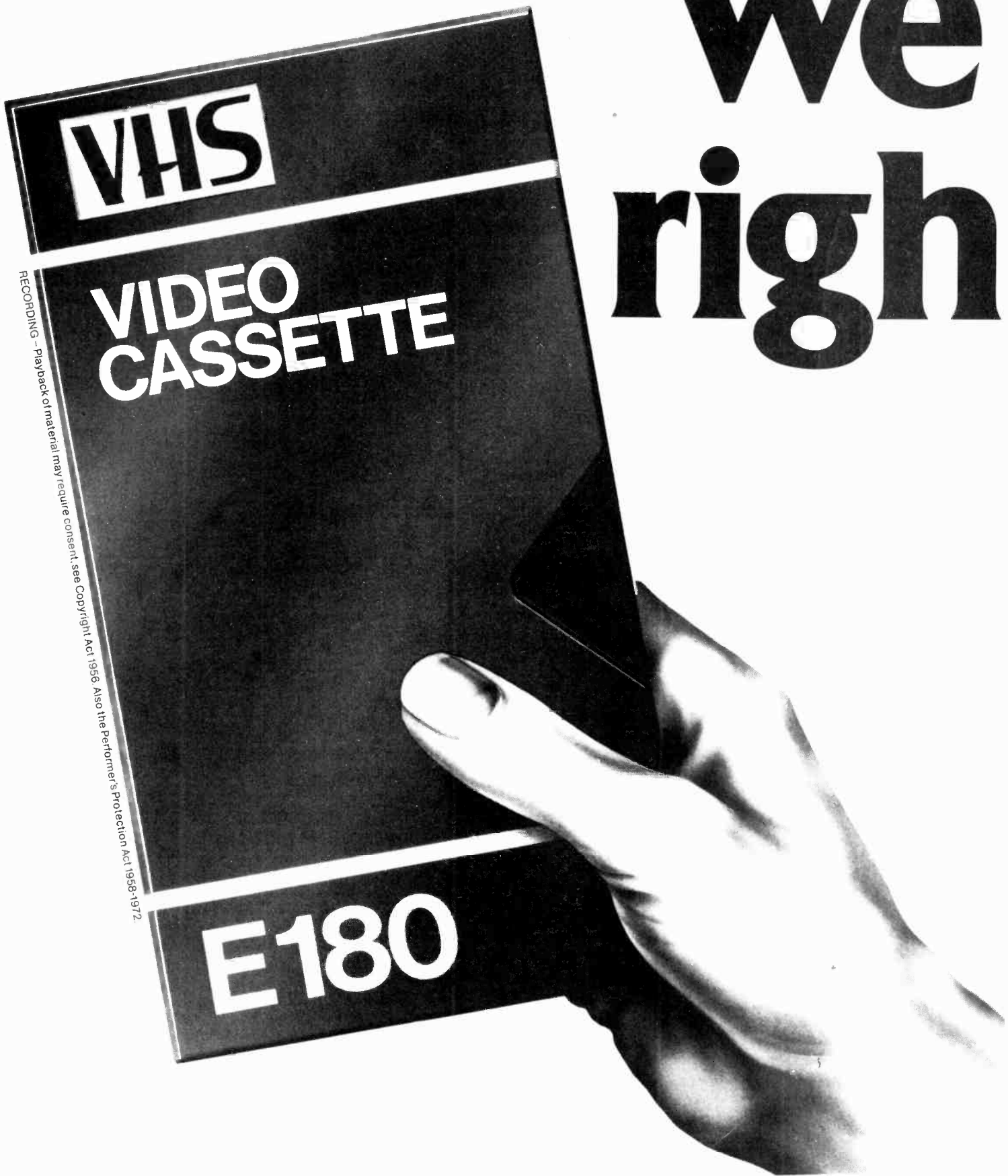
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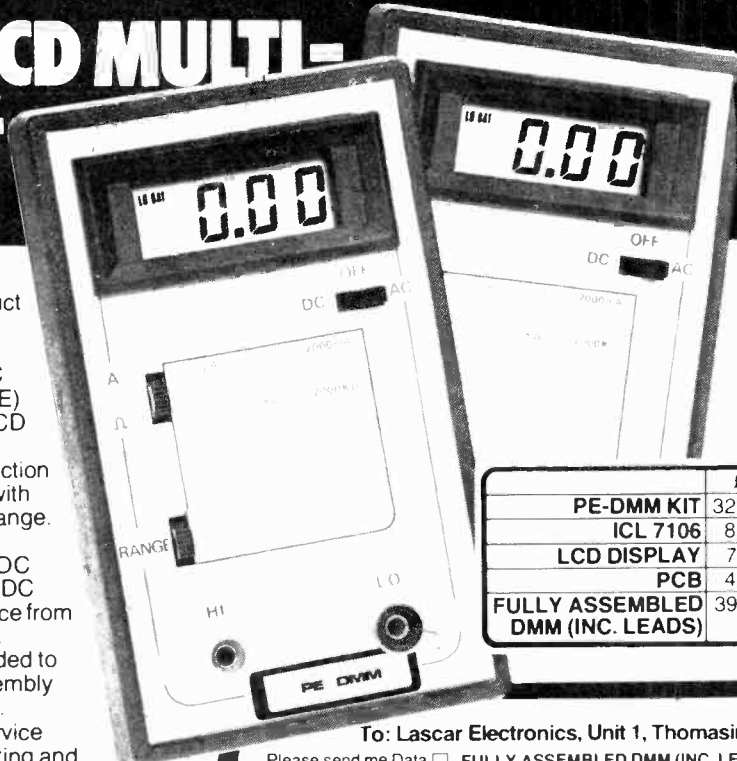
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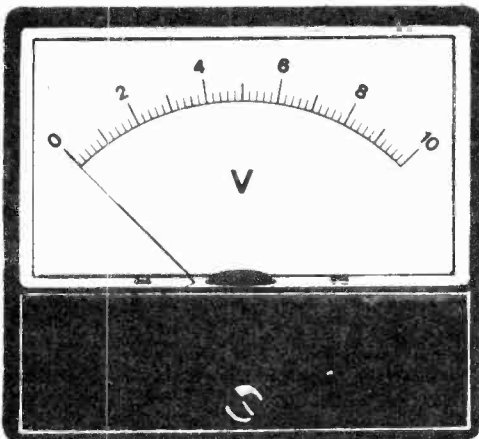
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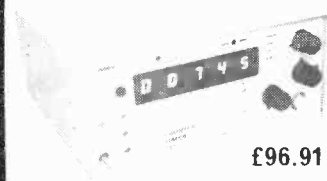
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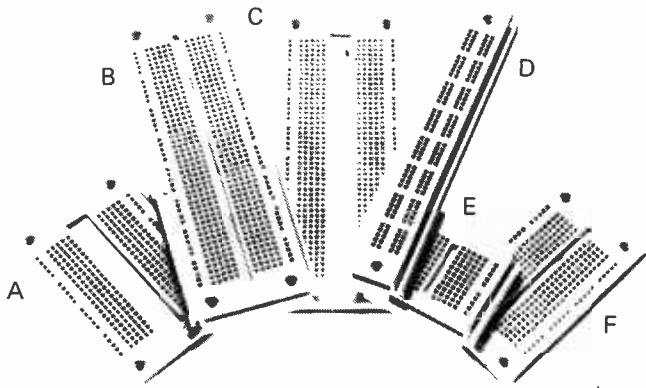
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wireless world

Are engineering ethics possible?

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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

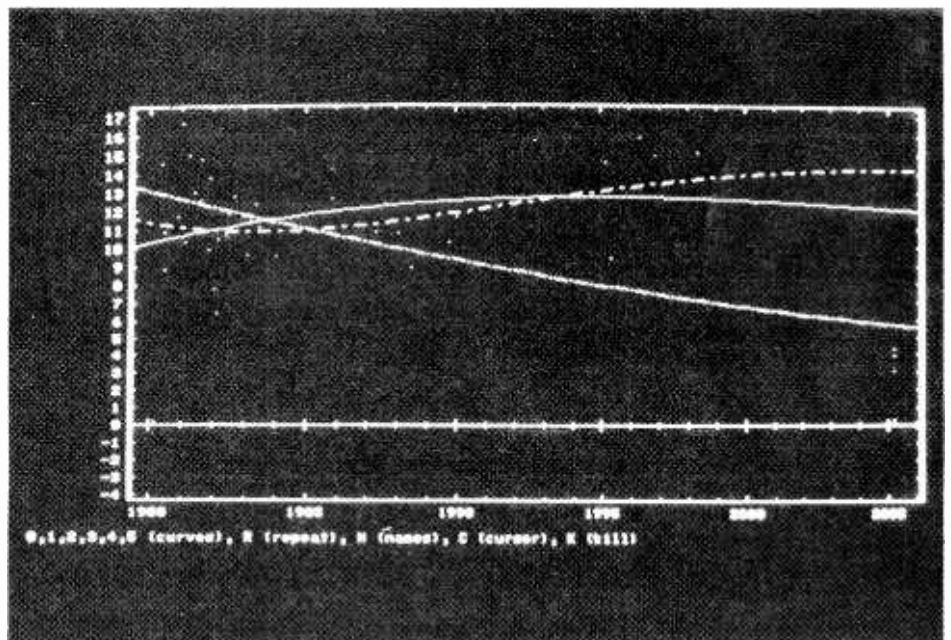


Fig. 1 Stock prices, with a trend curve.

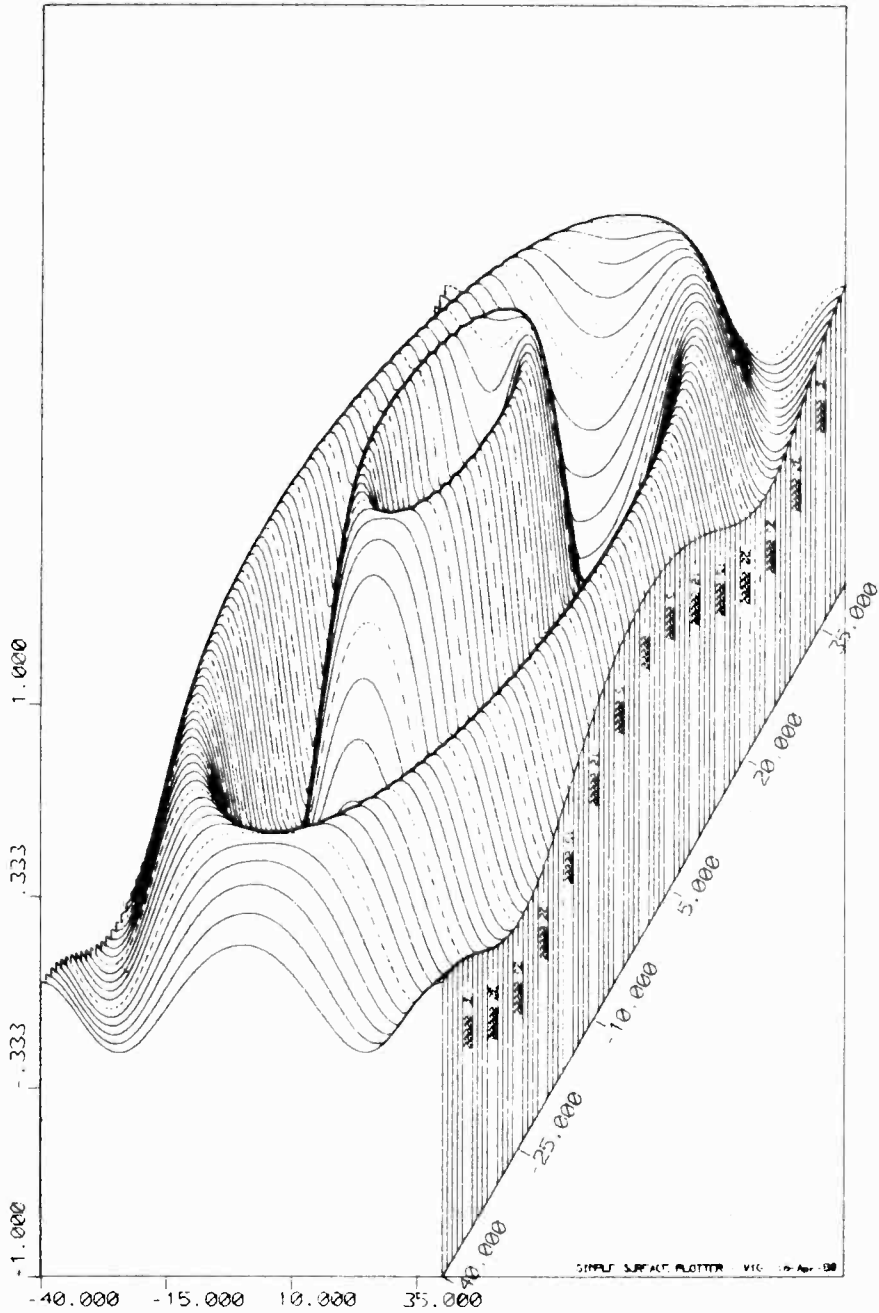


Fig. 2. A three-dimensional surface, with hidden lines removed.

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

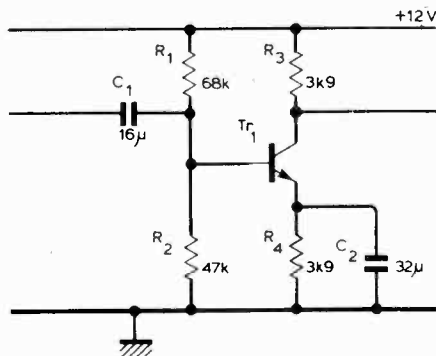


Fig. 3. Electrical circuit diagram.

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



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

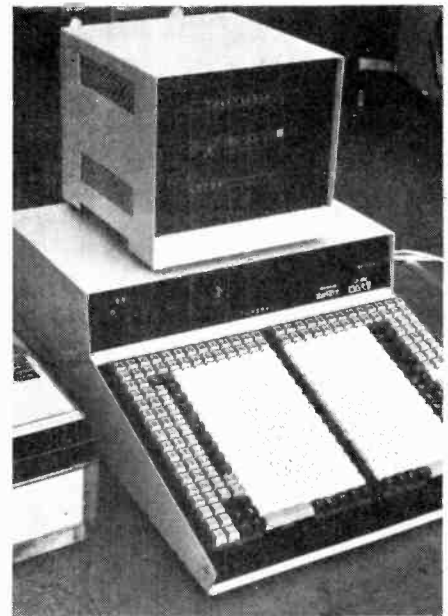


Fig. 5. Chinese text.

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.

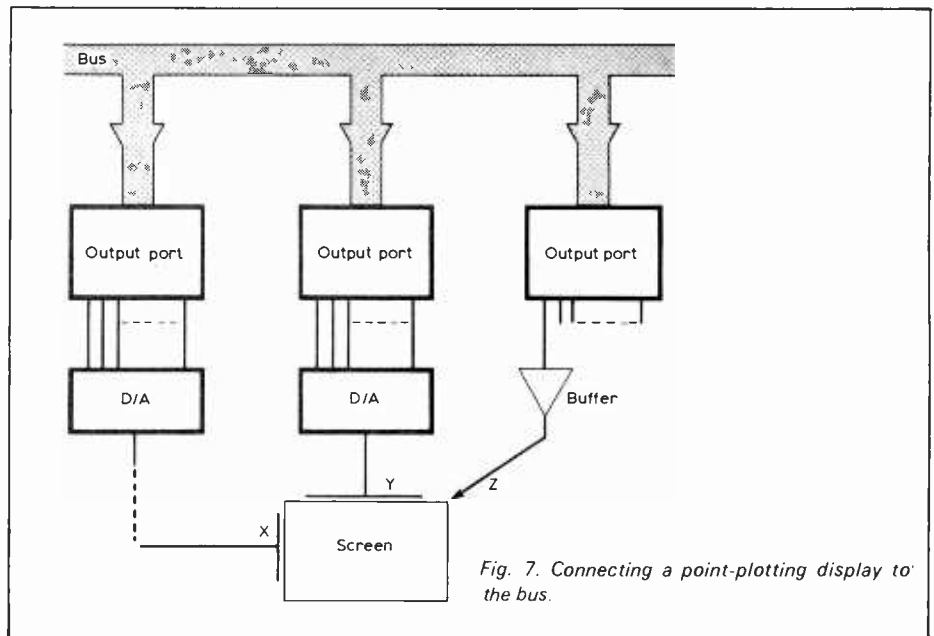


Fig. 7. Connecting a point-plotting display to the bus.

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 mil-

lion 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.

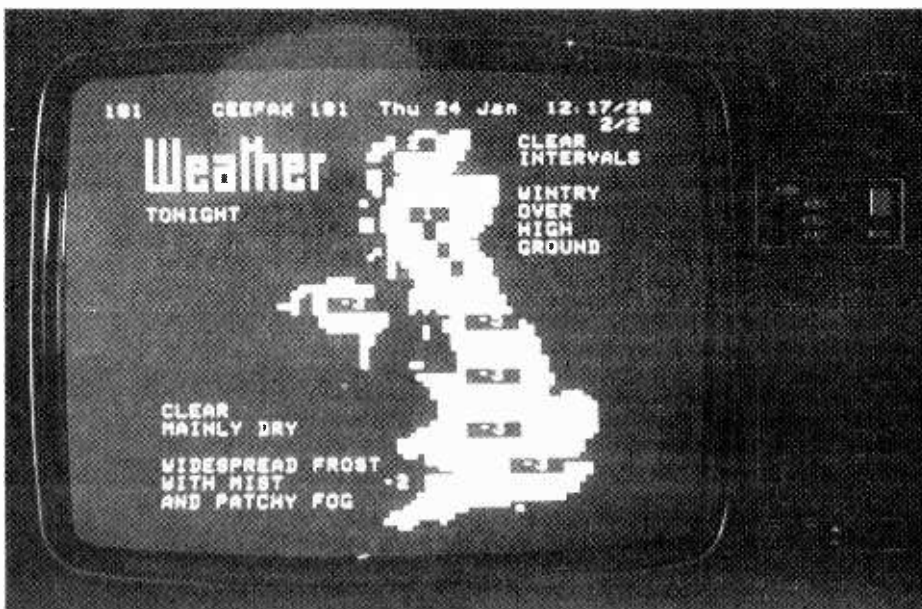


Fig. 6. A teletext weather map.

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: Coordin-

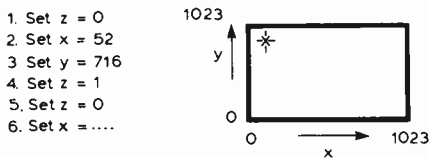


Fig. 8. Part of a program to drive the display.

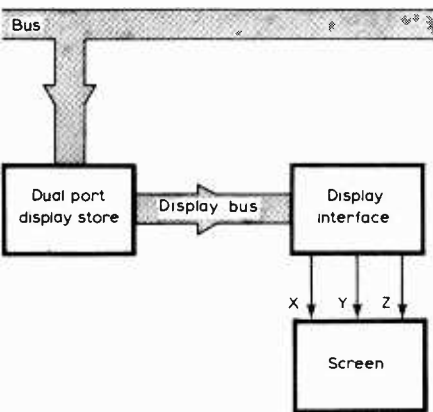


Fig. 9. A display scheme with a dual-port store.

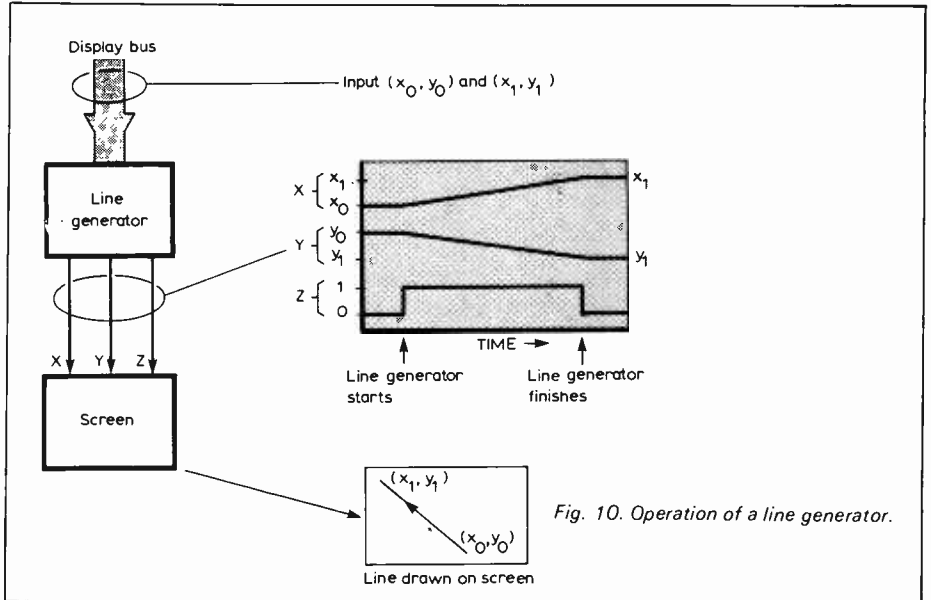


Fig. 10. Operation of a line generator.

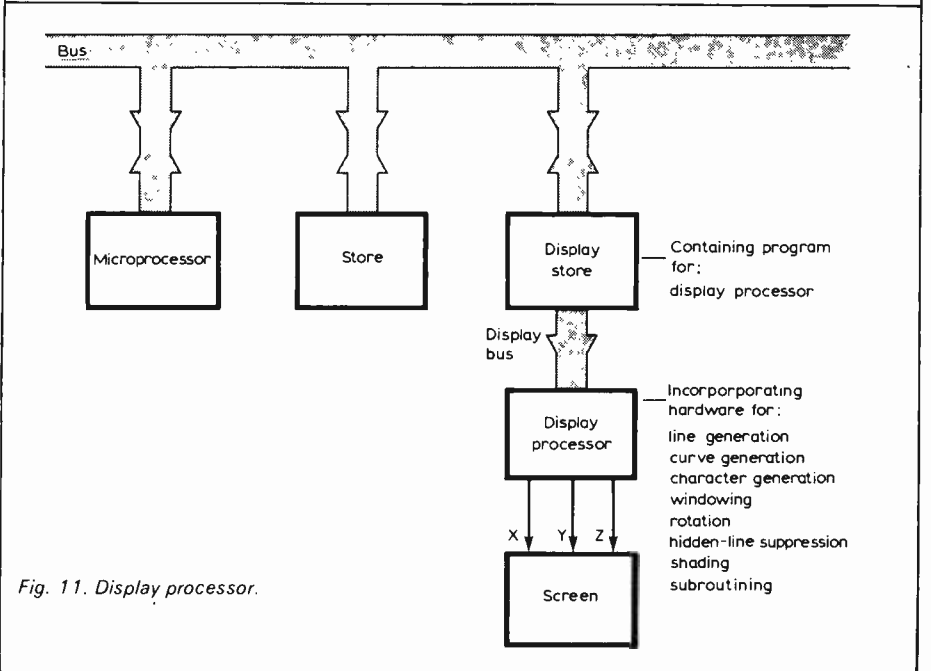


Fig. 11. Display processor.

ates 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

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 θ 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 pro-

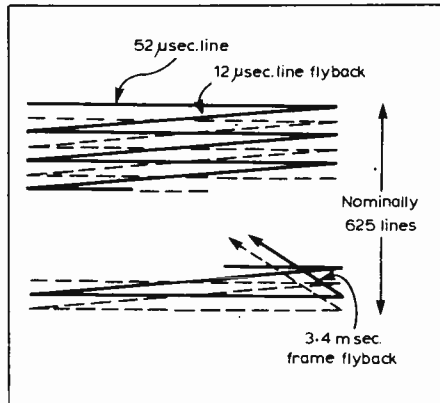


Fig. 12. Television raster-scan, with interlace.

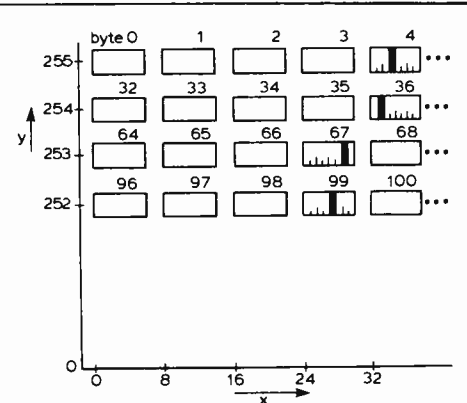


Fig. 13. Memory-mapped bit-per-point display system.

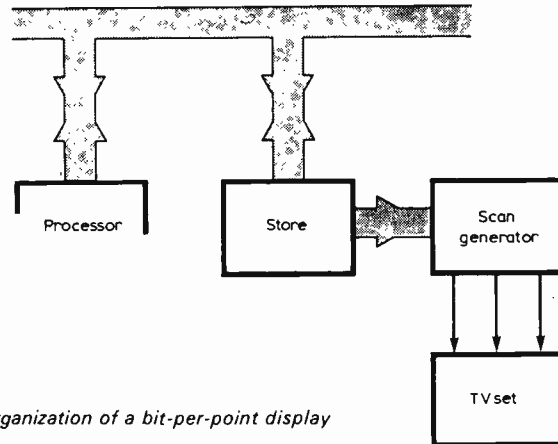


Fig. 14. Organization of a bit-per-point display system.

duction, 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.

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.d.s. 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 R₁₉. The components around IC₁ form a conventional full-wave precision rectifier; R₁ to R₅ should be close tolerance for symmetrical rectification. The overall gain is set by R₆ 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 C₅ 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 R₂₀, R₉, R₁₀, D₃ and D₄ 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, D₄ 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 C₂ should be a low leakage, polycarbonate type.

The original design used the Siemens JAA180 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

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)

Continued over page 33

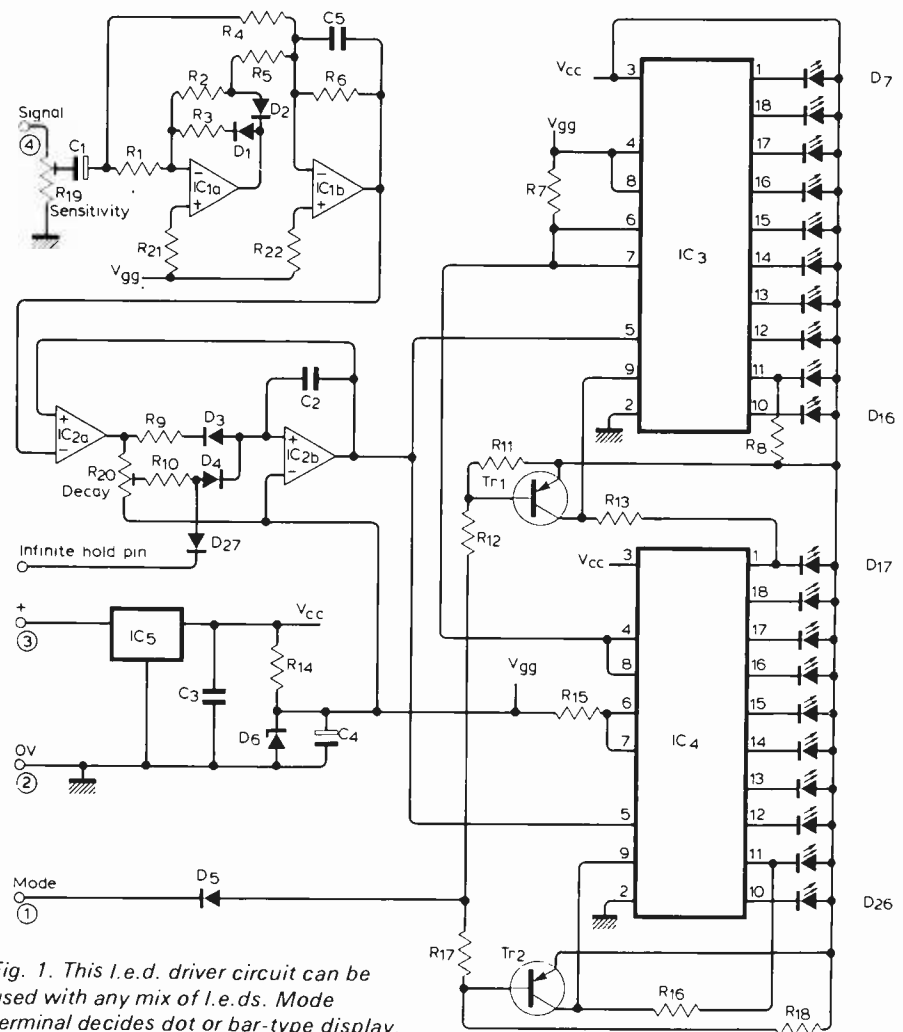
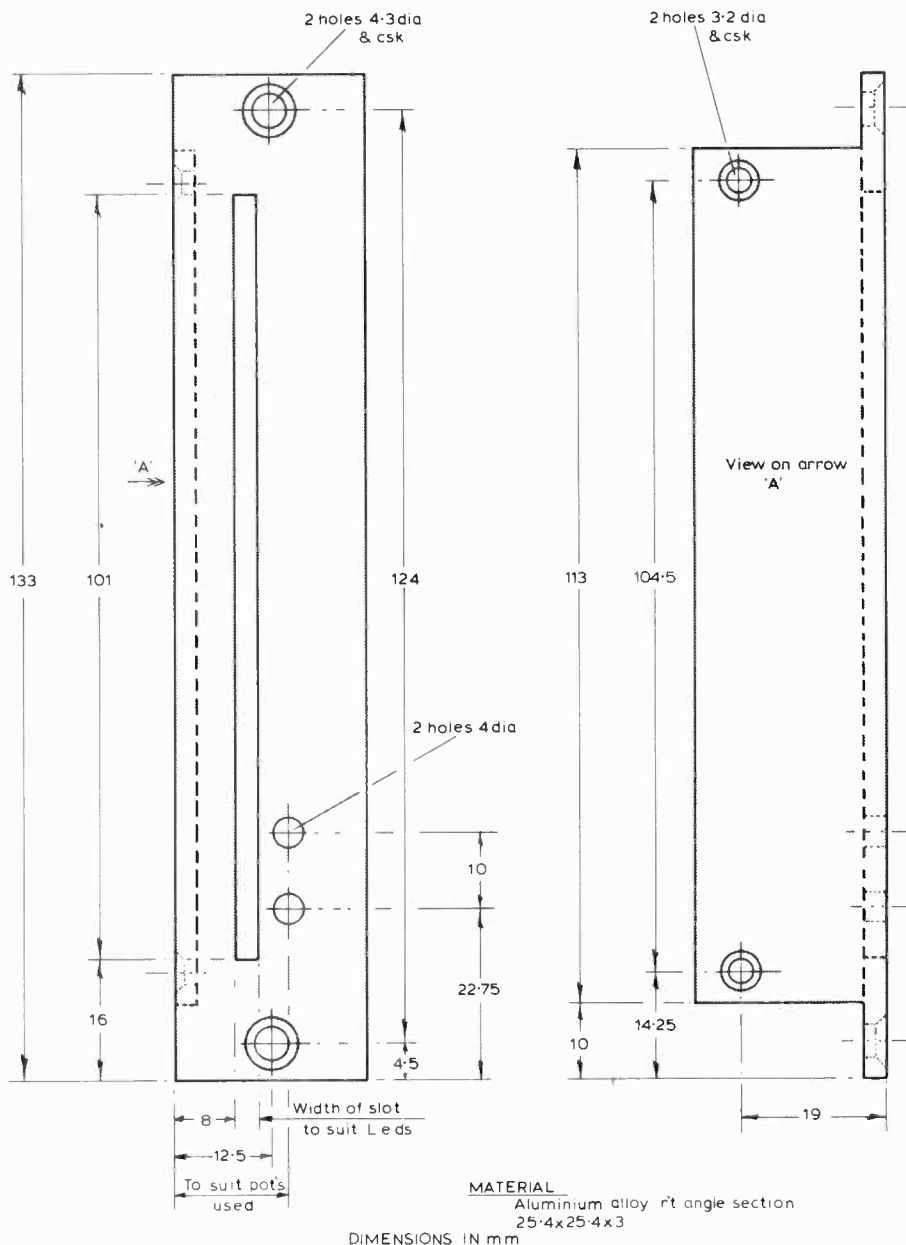
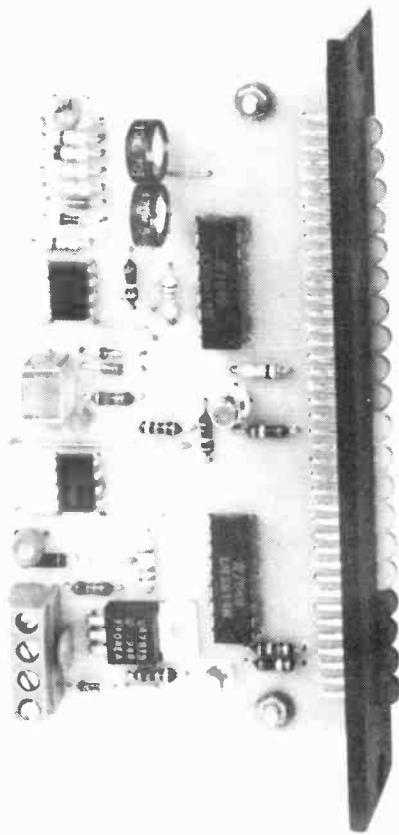
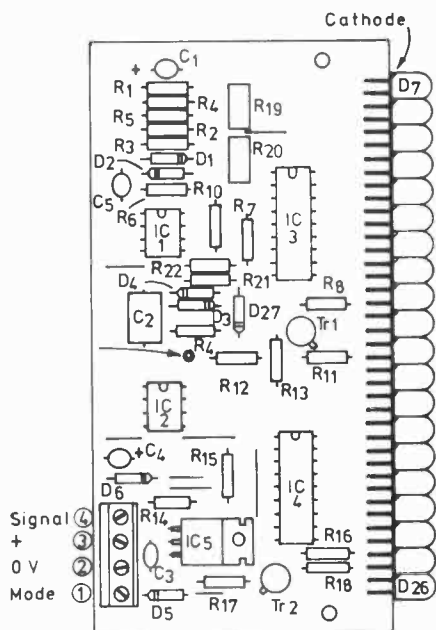
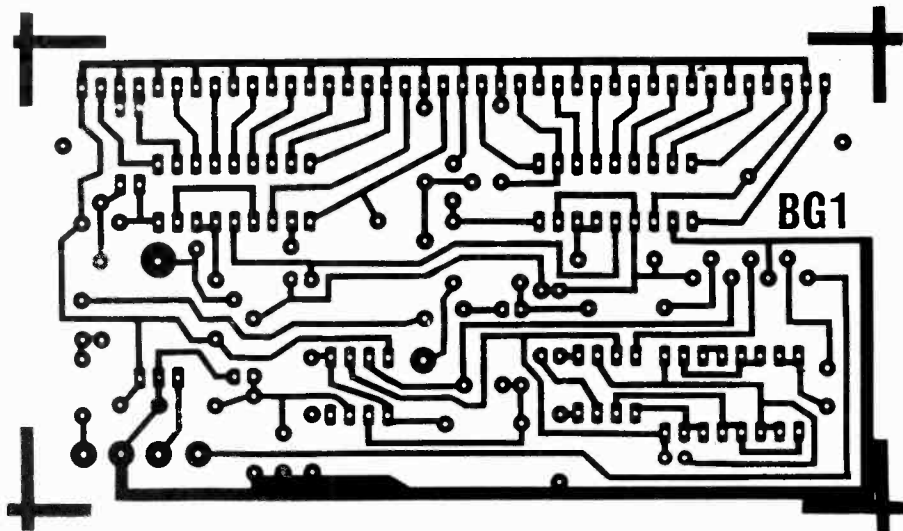


Fig. 1. This l.e.d. driver circuit can be used with any mix of l.e.d.s. Mode terminal decides dot or bar-type display.

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 R₆. 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 IC₁ and link the wiper of R₁₉ to the position of pin 7 of IC₁. Take pin 4 of IC₂ to a -15V supply. Omit R₁₄, D₆ and C₄ and link across D₆. If peak detection is not required, omit IC₂ and its associated components and link the wiper of R₁₉ to the position of IC₂ pin 1. This gives a full-scale deflection of 2.4V. If a conventional analogue meter is used, connect this across IC₂ pin 5 and V_{reg}. The meter law can be varied by replacing R₆ with a resistor-diode network.

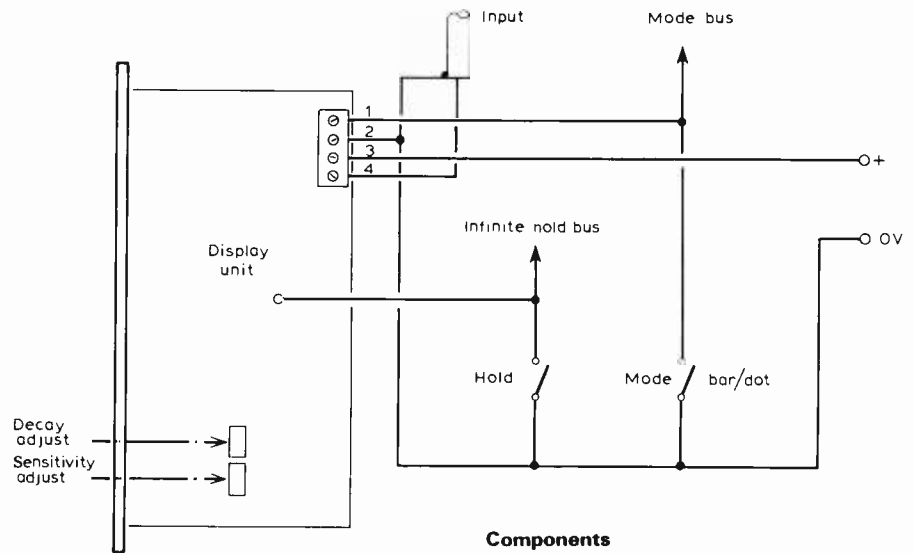


Fig. 2. The decay can be externally switched off into the infinite hold mode by taking the hold terminal to 0V. This can be bussed, together with bar/dot mode selection, as shown.

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.)

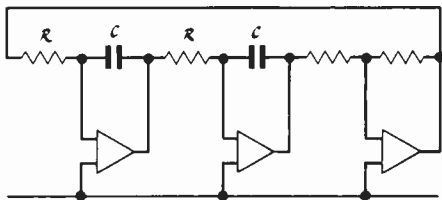


Quentin Rice is self-taught in electronics, starting as an inspector five years ago before going onto R&D two years later. Now working for Morfax in industrial and military development, his current activities include high density multiplexing and music synthesis. Other pastimes are art, music, literature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

Digital control of analogue functions

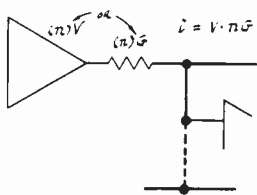
by Peter Williams, Ph.D. Paisley College of Technology

FREQUENCY OF TWO-INTEGRATOR LOOP



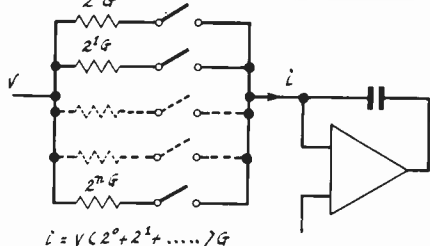
$\omega_0 = \frac{1}{RC} = \frac{G}{C}$ Hence if both conductances are varied $\omega_0 \propto G$

BASIC PRINCIPLE

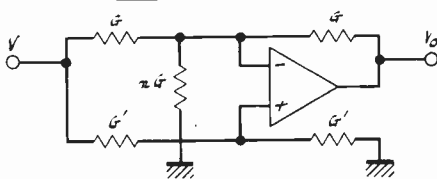


Add some circuit that varies 'n' according to some analogue or digital control signal

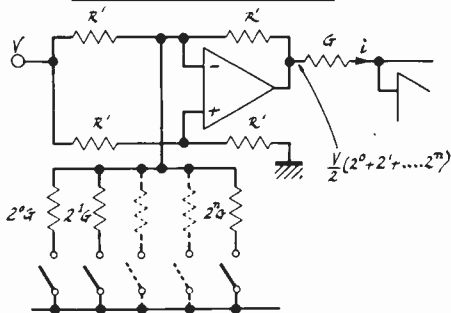
DIRECT DIGITAL CONTROL



GAIN CONTROL BY GROUNDED 'G'



DIGITAL GAIN CONTROLLED AMPLIFIER



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.

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.

The most obvious digital method corresponds to the weighted resistor d. to a. convertor. Sets of resistors of value $2^0 G \dots 2^n G$ 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 $(2^0 + 2^1 + \dots + 2^n)$. 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.

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 resistance 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 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.

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

$$S^2 + \frac{\omega_0 S}{Q} + \omega_0^2 \quad \text{where}$$

$$\omega_0^2 = \left(\frac{1}{RC}\right)^2 = \left(\frac{G}{C}\right)^2 \quad \text{i.e. } \omega_0 = \frac{G}{C}$$

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 $\omega_0 \rightarrow \omega_0'$, where $\omega_0' = n\omega_0$.

The same effect is achieved by preceding 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 $i/v = nG$ where n may be raised by any desired means.

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

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

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

$$\frac{v G + v_0 G}{(2 + n)G} = \frac{v}{2}$$

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

$$v_0 = n \frac{v}{2}$$

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 resistors 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 10k Ω , 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.

$$v_o = v \left(\frac{-1/sC}{R} \right) \left(\frac{-1/sC}{R} \right) (-1) \\ = - \frac{1}{(sCR)^2}$$

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

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

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

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

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

Let the inverter gain be $-K$.

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

$$\text{For } \frac{v_o}{v} = 1, \frac{-K}{s^2 C_1 C_2 R_1 R_2} = 1$$

$$\therefore \frac{\omega^2 C_1 C_2 R_1 R_2}{K} = 1$$

$$\omega = \sqrt{\frac{K}{C_1 C_2 R_1 R_2}}$$

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 100 μ s, R 10k Ω

Let the input and output voltages be v, v₀.

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

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

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 32.100 μ s, 16.100 μ s and 2.100 μ s respectively \approx 312.5 Ω , 625 Ω , and 5k Ω .

The errors are mainly in the low resistance switch where $r_{on} \approx 3\Omega$ would reduce the gain due to this term by $\sim 2/3\%$. Similarly for the next most significant term the contribution would be $1/2 \times 1/3\%$. 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. Unfortun-

ately, 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 leading 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 0.01 μ F, 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 1k Ω 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 100 Ω 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 failure 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.t.s 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 Darling-ton-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 | $\frac{9}{8}$ | $\frac{10}{9}$ | $\frac{16}{15}$ | $\frac{9}{8}$ | $\frac{10}{9}$ | $\frac{9}{8}$ | $\frac{16}{15}$ | |
| Reltive freq. | 1 | $\frac{9}{8}$ | $\frac{5}{4}$ | $\frac{4}{3}$ | $\frac{3}{2}$ | $\frac{5}{3}$ | $\frac{15}{8}$ | 2 |

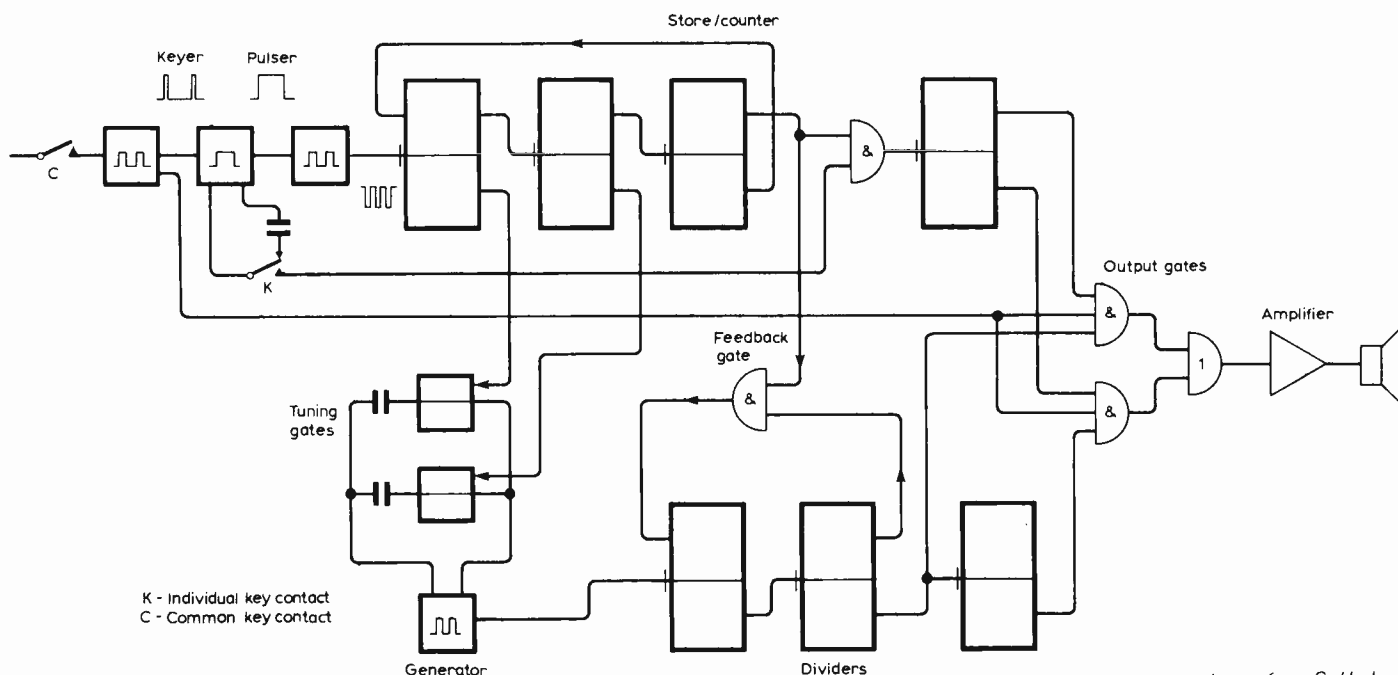
Messrs Robins (Letters, November 1979 and March 1980) and Tipping are attempting to solve the wrong problem or, at least, an intractable one? Perhaps what is needed is equal temperament for successive notes but just (natural) temperament of chords. This would give smooth harmonies, without difficulties 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 $= 1/\omega^2 C^2 R$ 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 impedance 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.c.s 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 frequencies.

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

E. V. Hurrin
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.t.s (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 obsolescence.

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 disconnection 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. 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.

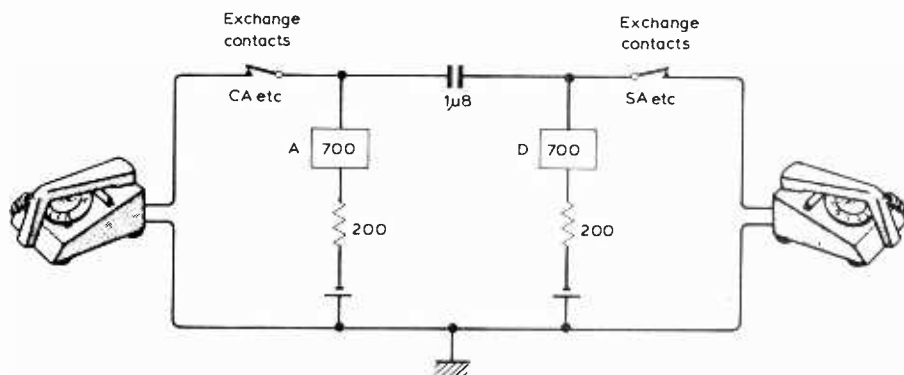
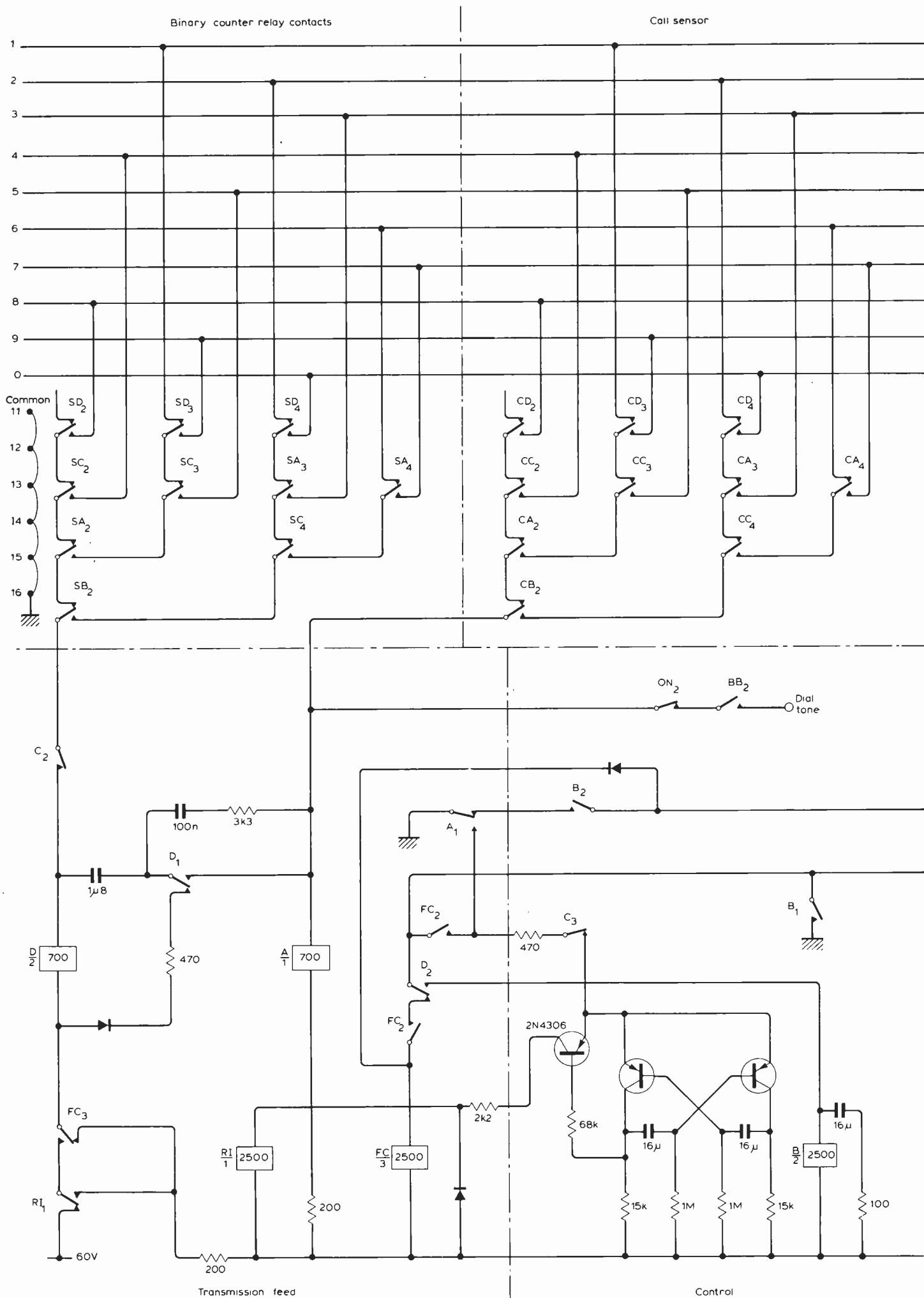
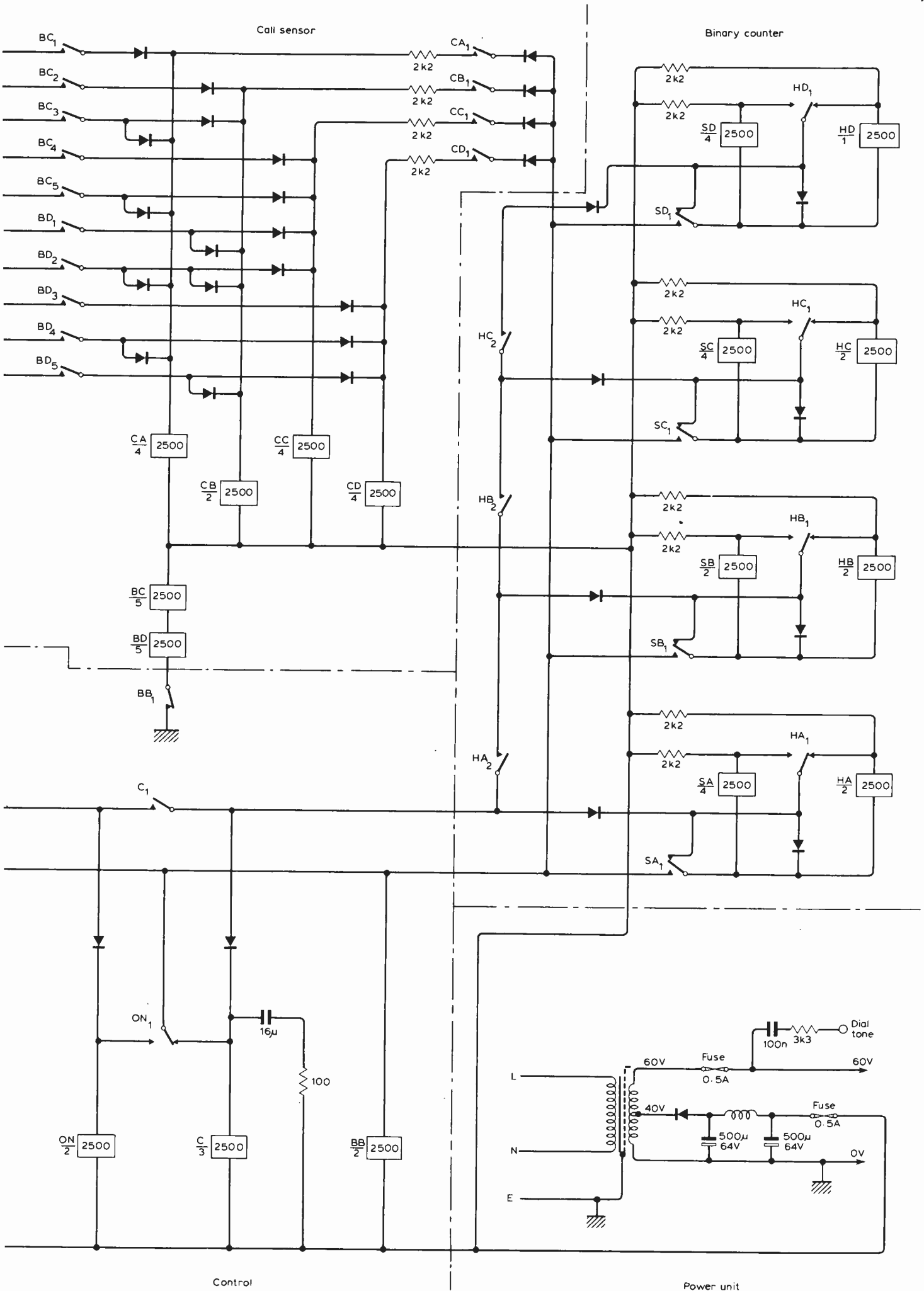


Fig. 2 (over page). Complete circuit diagram of the exchange. Resistors of 200Ω in series with A and D relays are 1W; 100Ω resistors across B and C relays are ½W; all rest are ¼ types.





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 R11; 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 R11 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.

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 on 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, 500 μ F, 64V.

Photograph shows one form of the exchange, built in case measuring 10x4½x3in. 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.

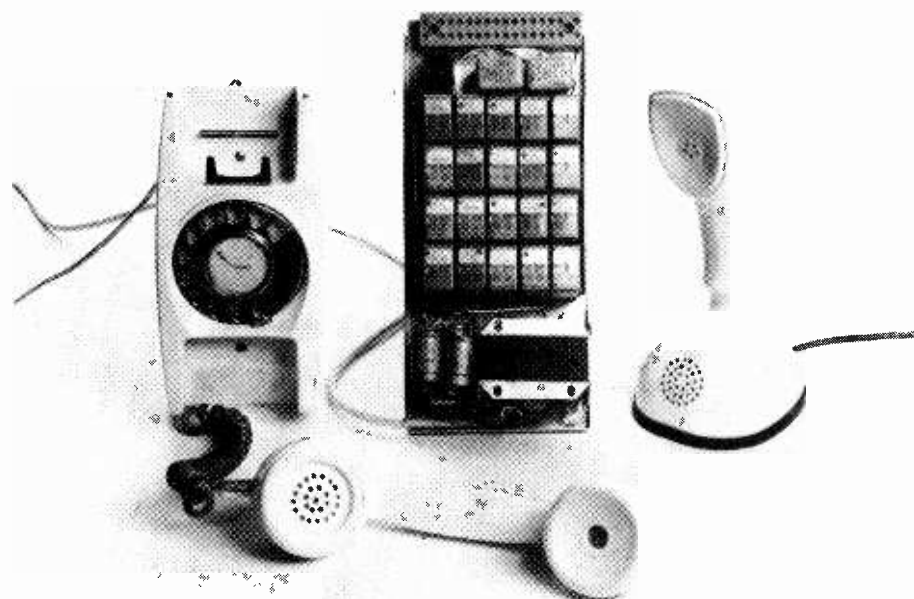


Table 1 — Relay combinations in line sensor

| 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, 2500 Ω , 4 changeover 2, 2500 Ω , 6 make 2, 700 Ω , 2 change-over | all relays other than those below relays BC and BD. relays A and D |
| Suitable types are made by Plessey, Thorn, Varley and Siemens-Halske. | | |
| Capacitors: | 2 0.1 μ non-electrolytic 1 1.8 μ non-electrolytic 2 16.0 μ electrolytic 2 500.0 μ electrolytic 2 16.0 μ electrolytic | 250V dial and ringing tones 250V speech path. 64V shunts for relays B and C to give slow release feature. 64V smoothing — power supply. 50V ringing interrupter circuit. |
| Resistors: | 12 2200 $\frac{1}{4}$ W 2 3300 $\frac{1}{4}$ W 2 470 $\frac{1}{4}$ W 2 15k $\frac{1}{4}$ W 2 1M $\frac{1}{4}$ W 1 68k $\frac{1}{4}$ W 2 200 1W 2 100 $\frac{1}{2}$ W | call sensor and binary counter. dial and ringing tones. D relay shunt. Feed to ringing interrupter circuit. ringing interrupter circuit. ringing interrupter circuit. ringing interrupter circuit. series with A and D relays shunts of B and C relays. |
| Diodes: | 42 30mA, 100V 1 1000mA 150V | any fast switching silicon type. 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 \times 4.5 \times 3in, but other examples have been constructed to fit into cases 8 \times 6 \times 2.5in

Literature Received

Technical information booklet from Mullard is entitled "Applications of **field-effect transistors**". Use of f.e.t.s 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

Verov 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 **micro-computer** 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 catalogue 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

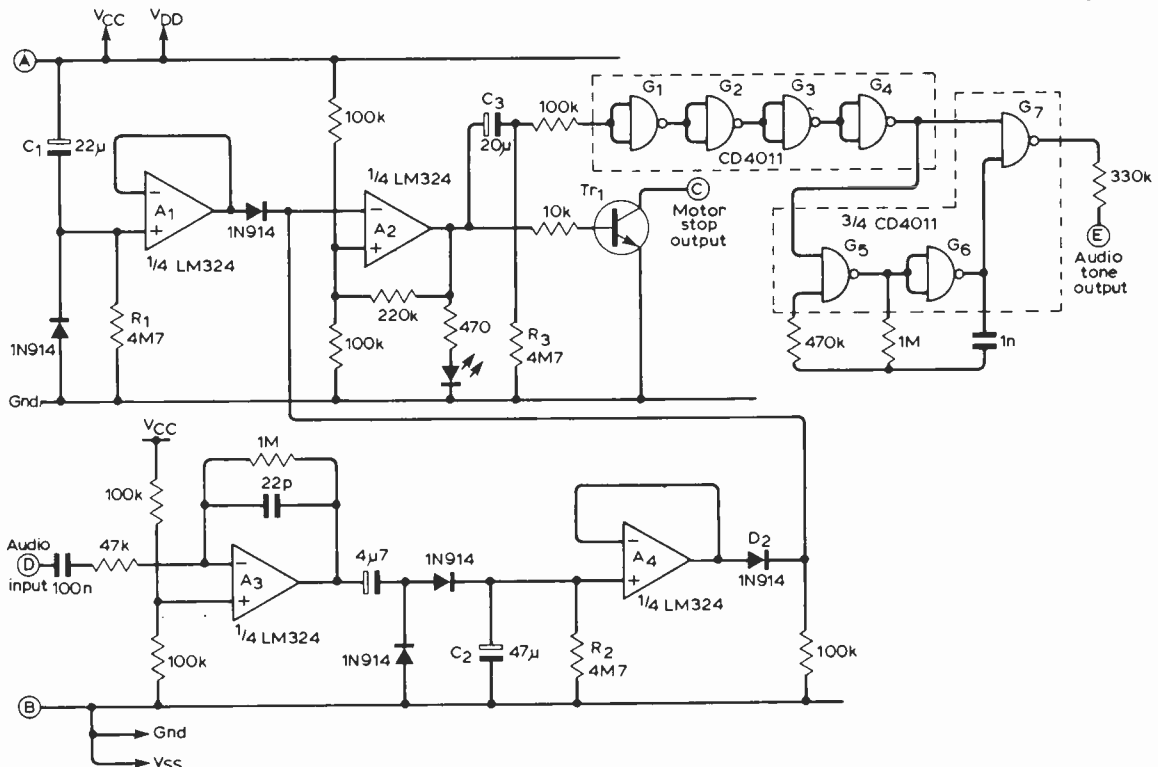
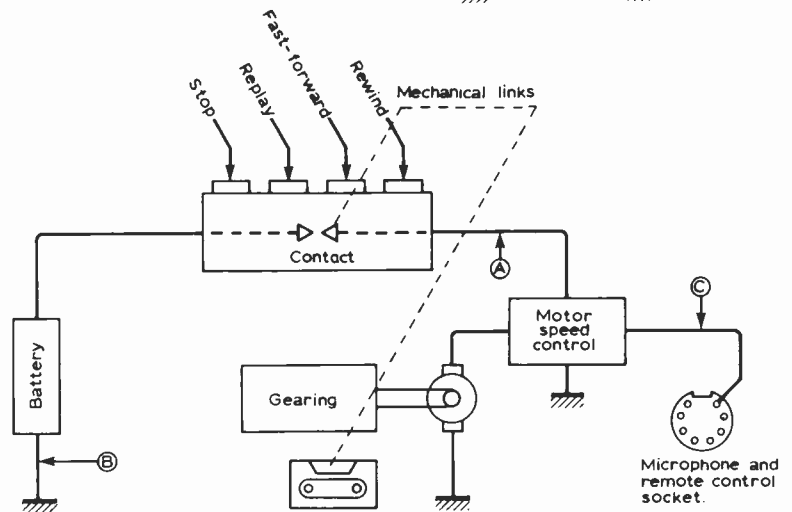
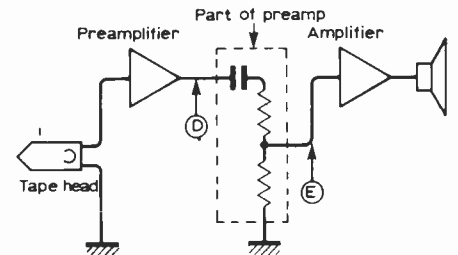
Many domestic cassette recorders do not have an automatic stop mechanism on replay, but use a friction clutch so that the motor can keep running at the end of a tape without causing damage to the motor or drive mechanism. However, this system does not protect the tape because the revolving capstan wears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

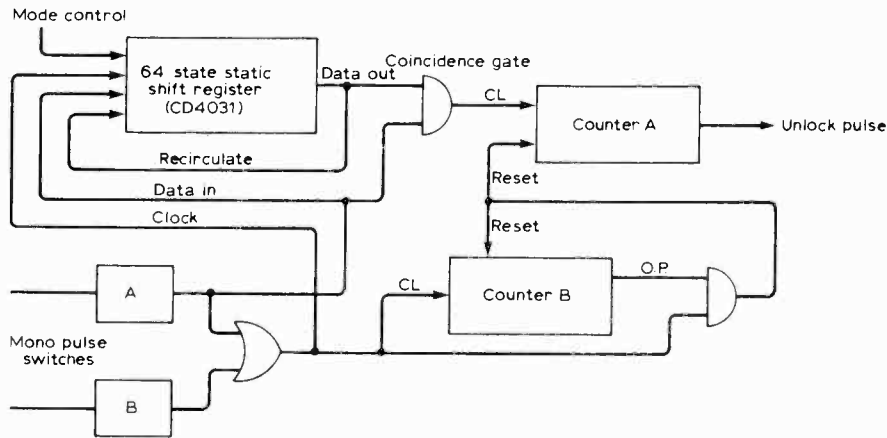
and a 4011 whose output turns on an audio oscillator and gates the output to point E. This tone sounds for one minute and is then turned off by C_3R_3 .
M. Holmes
Newbury
Berks



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

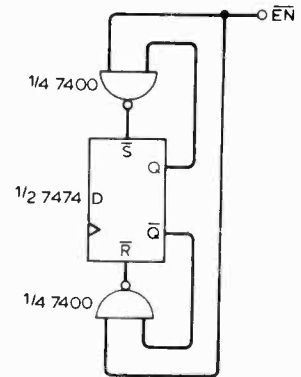
simultaneously clocked by the switches. Counter B resets itself and resets counter A after the 65th clock pulse so, if the code is incorrectly entered, counter A is reset before an unlocking pulse is produced, and the code has to be repeated. If a complex code is not required, different counters and 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 EN line is high, the flip-flop is held in one state by the asynchronous \bar{S} , \bar{R} line, and clock transitions have no effect. When the 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

$$V_y = \frac{R_2}{R_2 + R_3} V_c +$$

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

Because

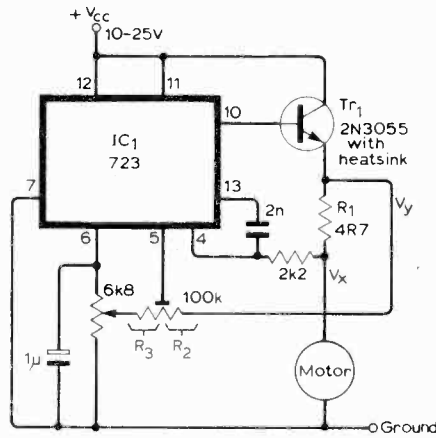
$$V_x = V_y, V_b =$$

$$V_c + I_a [(R_a + R_1) R_3 - (R_2 + R_3) R_a]$$

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.

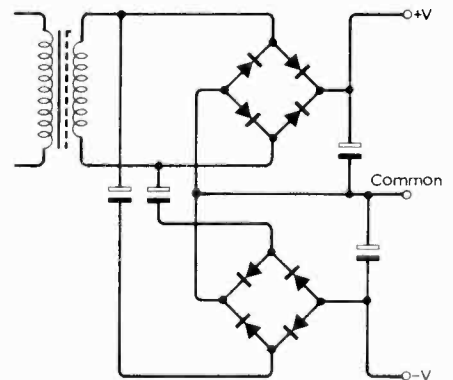
The circuit has been used with a domestic cassette recorder and has improved the motor performance with C120 tapes. Note that motor speed is not dependent on the supply voltage.

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

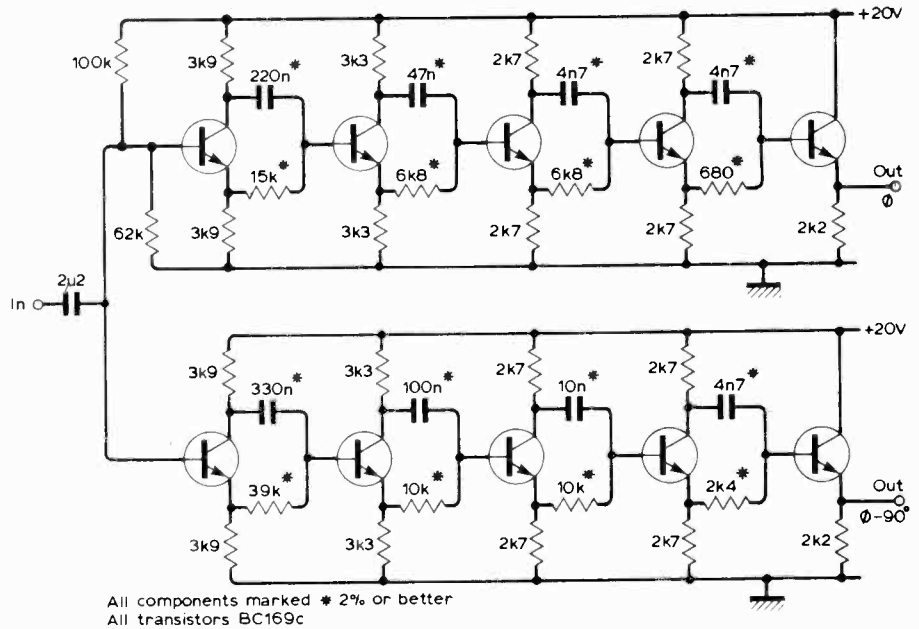


Wide band phase-shift network

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

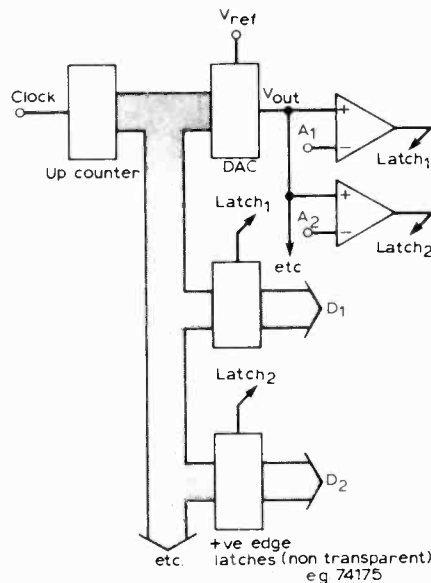
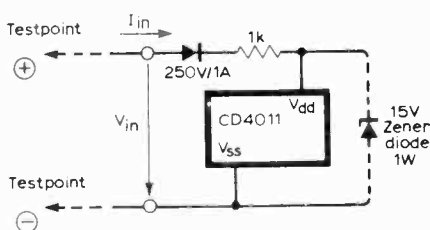
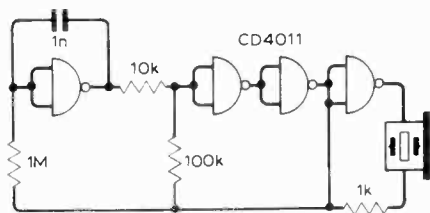


Acoustic level-indicator

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.

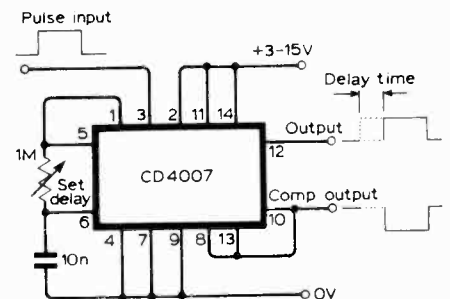
Gain and level shifting can be applied to the analogue inputs to provide a.d.c.s with different ranges. Also, the comparator latch commands can operate sample-and-hold circuits at the inputs to signal Data Ready, and to inhibit further latching.

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 Valan 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 methods². 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 turn².

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 explicitly 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.

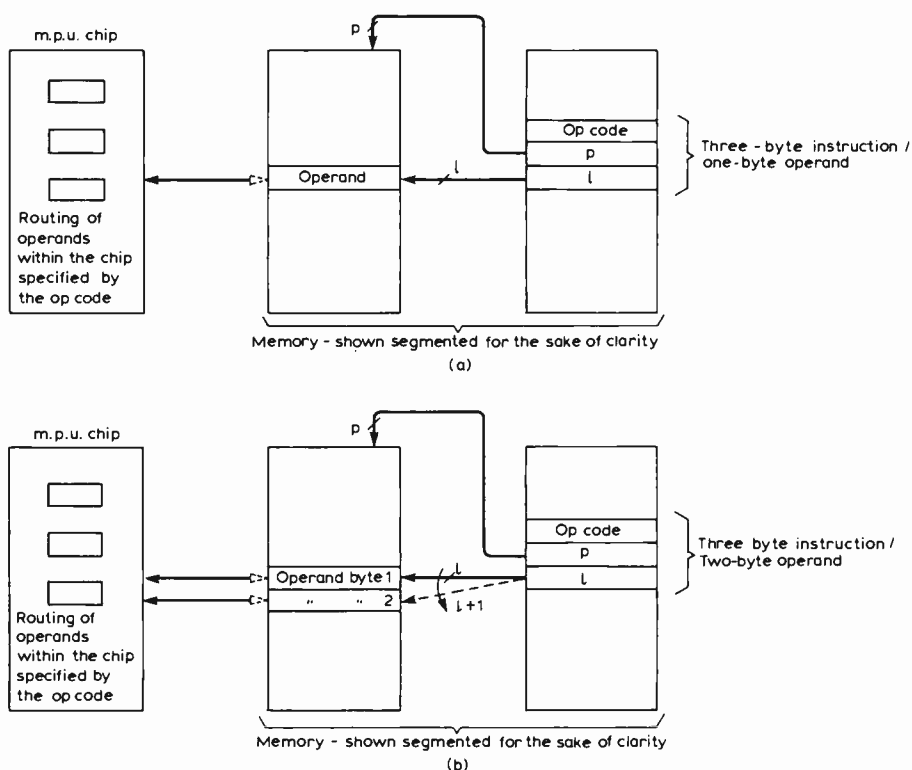


Fig. 1. Process of direct addressing, (a) for one-byte operand and (b) for a two-byte operand.

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 (p₁ and l₁ 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

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

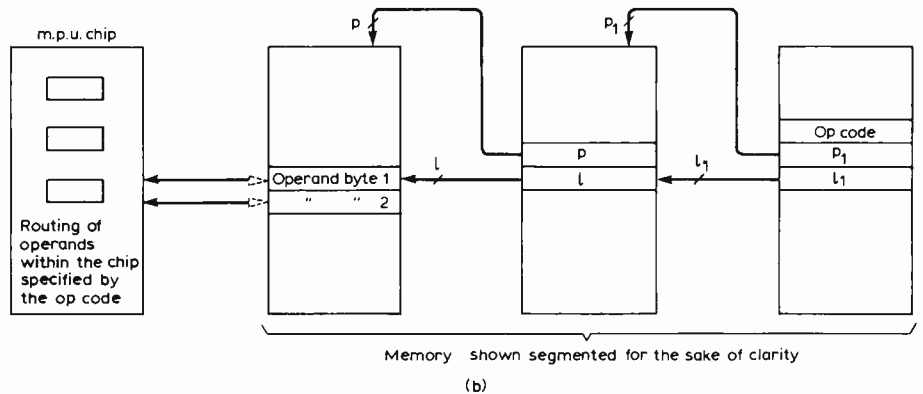
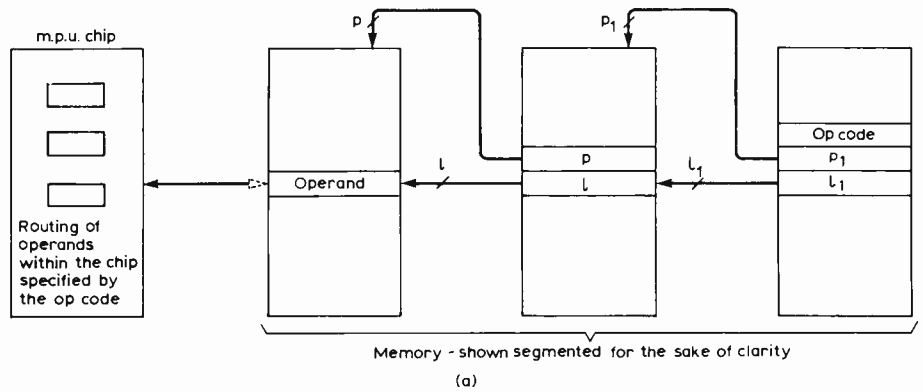


Fig. 2. Memory indirect addressing, (a) for a one-byte operand and (b) for two-byte operand.

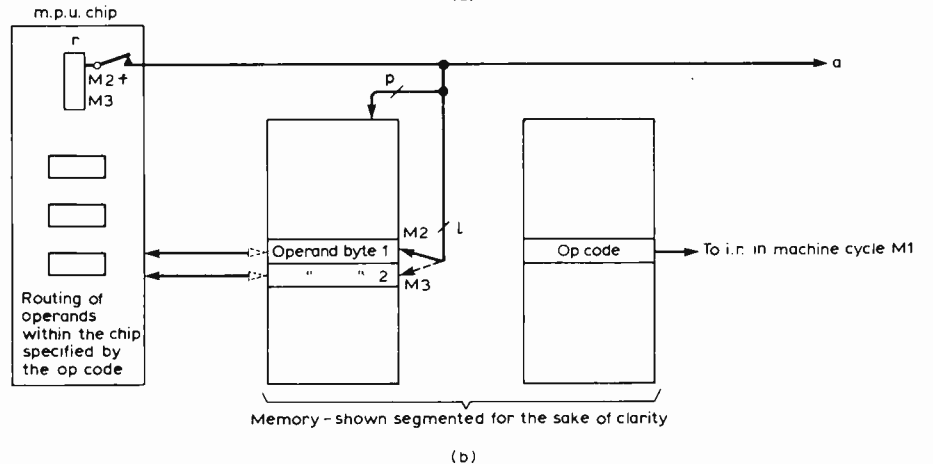
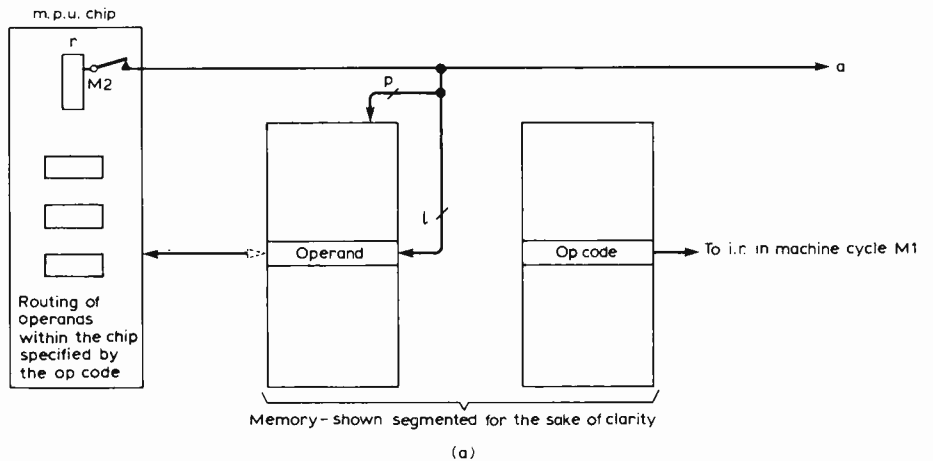


Fig. 3. Register indirect addressing, (a) for a one-byte operand and (b) for a two-byte operand.

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

+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).

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.

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 **00** 1111 (4F) increments accumulator A, whereas

01 **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

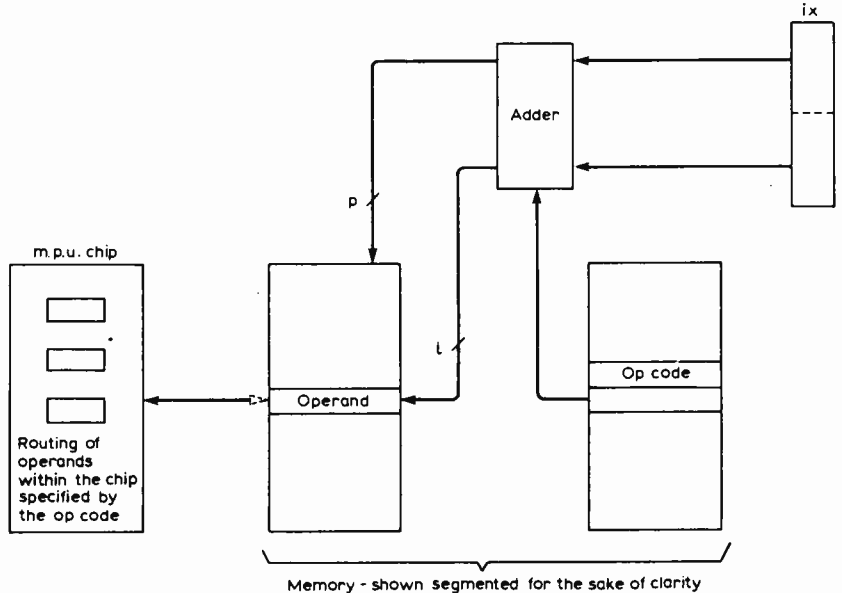


Fig. 4. Indexed addressing.

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

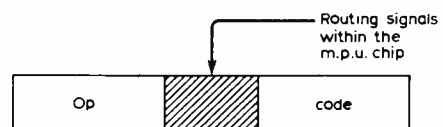
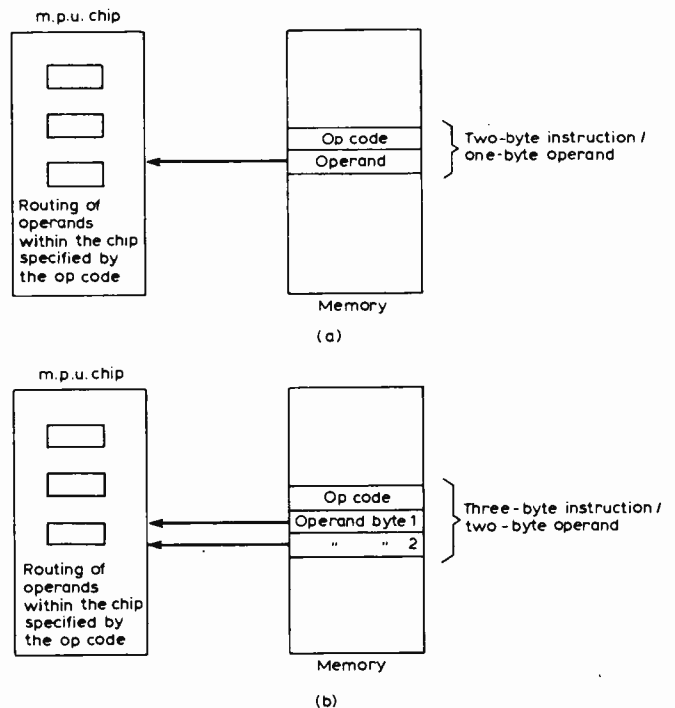


Fig. 7. Inherent addressing.

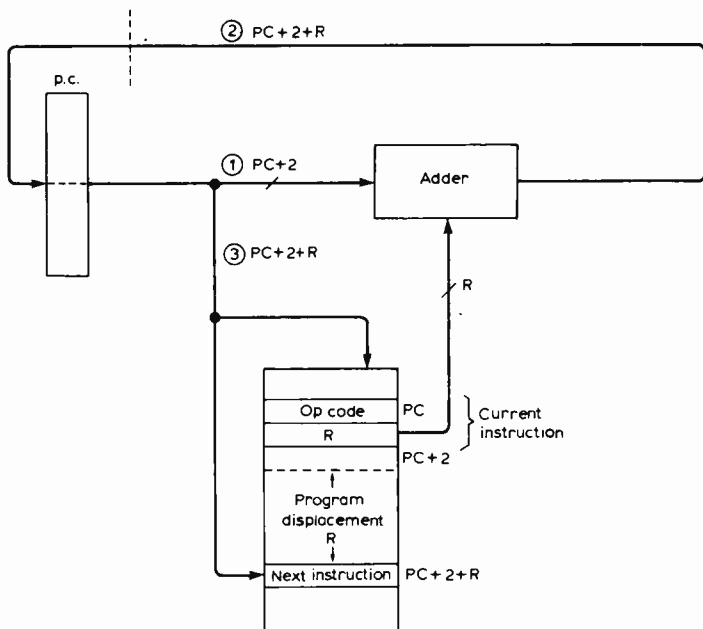


Fig. 5. Relative addressing.

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 equip-

ment 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

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

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.

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.

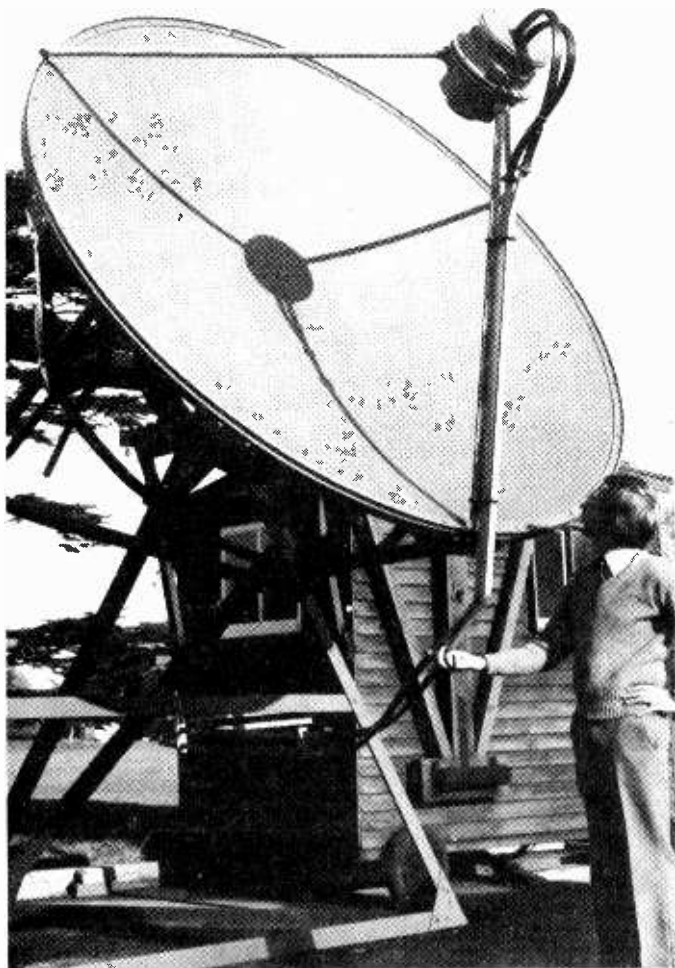
During the descent to 5,000 feet, the Ground Proximity Warning System operated, and the crew immediately commenced an overshoot procedure. With high engine power being applied, the aircraft was put into a steep turn to the right, but it struck the mountainside before it had climbed above 5,500 feet.

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.

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.



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.

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.

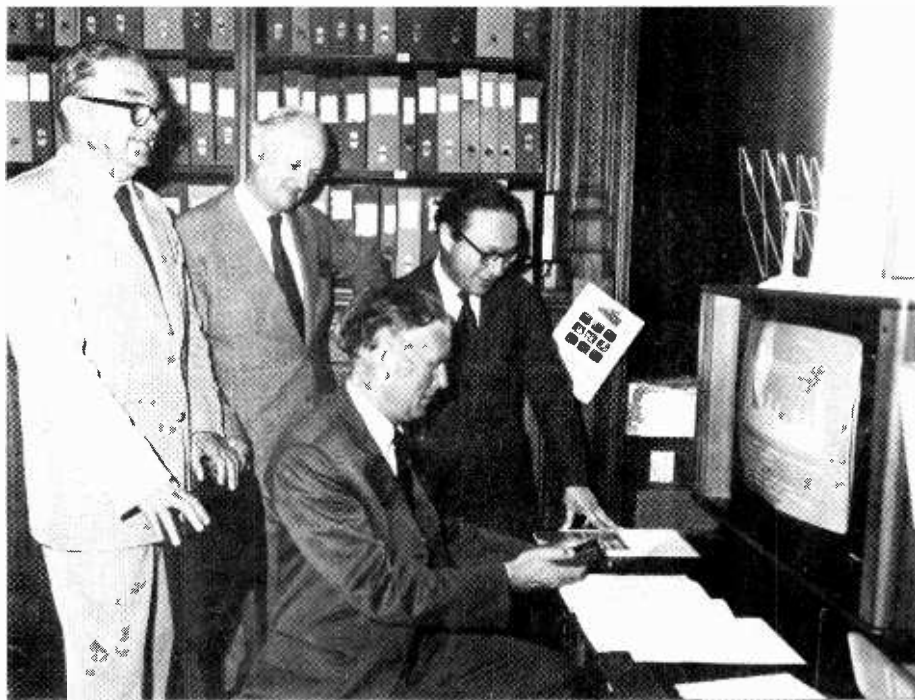
Home Secretary shows more interest in company than person in data privacy exchange

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.

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.



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 Cap-

tains, 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 Grovewood 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.

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.

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.

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 encount-

ered was that of achieving uniform brightness in each of the 40 modules, and circuits are now being developed to overcome 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.

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.

'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.

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 abbreviation 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 \times 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.

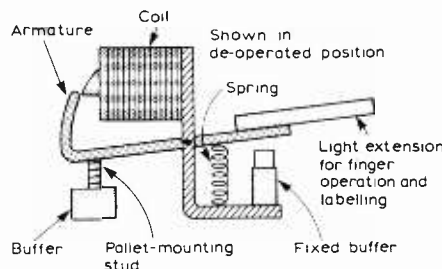


Fig. 1 Pallet-magnet with finger-tab extension. The contacts are not shown.

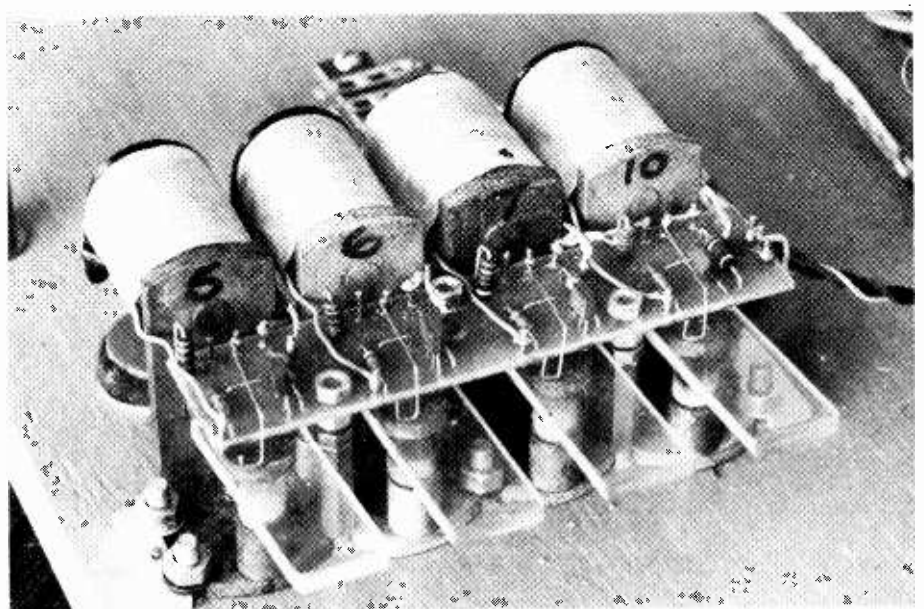


Fig. 2. Prototype assembly of four single-magnet tabs. The p.c.b., type E03, accommodates 8 circuits, but can be cut down as shown.

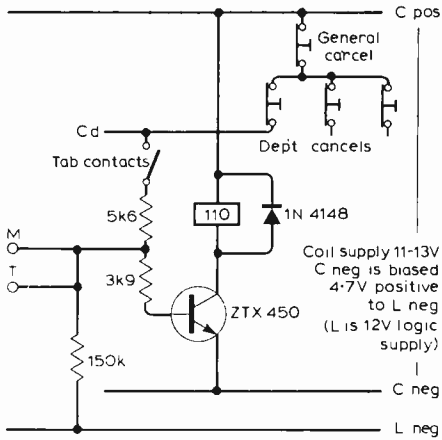


Fig. 3. Drive for single-magnet tab. The memory line M is used to capture the tab position and to supply the drive signal. Cancel line Cd feeds all tabs of one department.

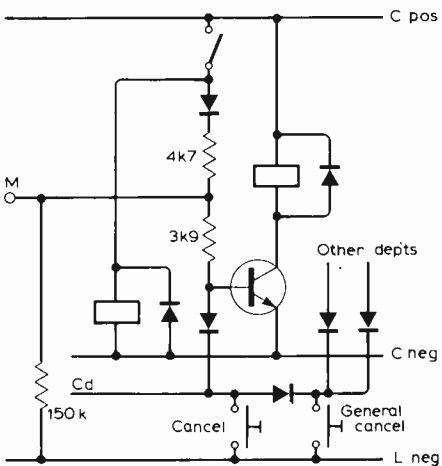


Fig. 4. Single-magnet tab with relay load.

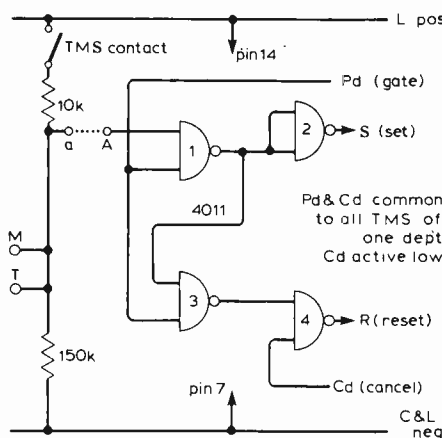


Fig. 5. Gating for one TMS. For signals Pd and Cd, see Fig. 9 and Fig. 15. The L supply can be 7 to 8V.

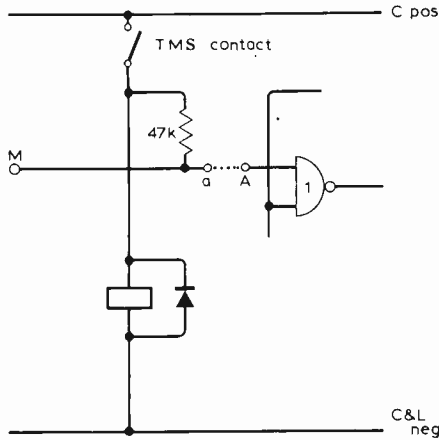


Fig. 6. Use of a relay load.

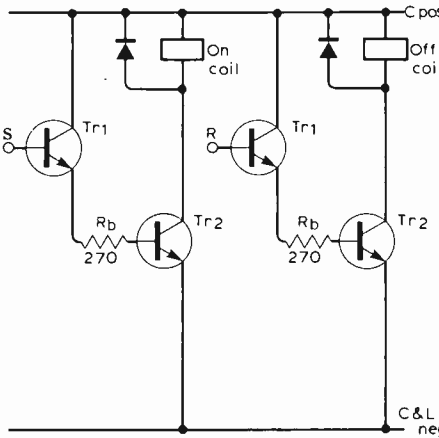


Fig. 7. Coil drivers for one TMS. Resistors R_b are chosen to provide about 20 mA to Tr₂.

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 | 8 |
| (see Fig. 22) | |
| Contact wire | 40 cm approx. |
| EO4 board | |
| 4036 | 4 |
| 4093 | 2 |
| 4539 | 2 |
| 1N4148 | 12 |
| 20-pin connector | 1 |
| 10-pin connector | 1 |
| 1µF 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 1/2A at 15V. A suitable two-stage driver is shown in Fig. 7.

Capture memory

Table 1, Fig. 8 and Fig. 9 relate to the EO4 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 EO4 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.

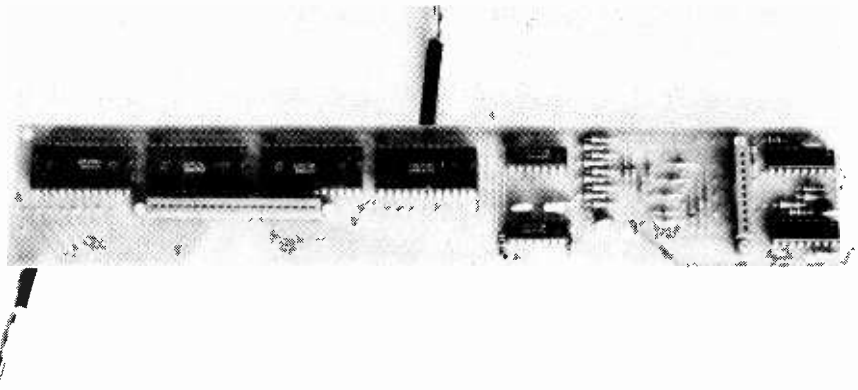


Fig. 9. Component layout and connections for EO4 board.

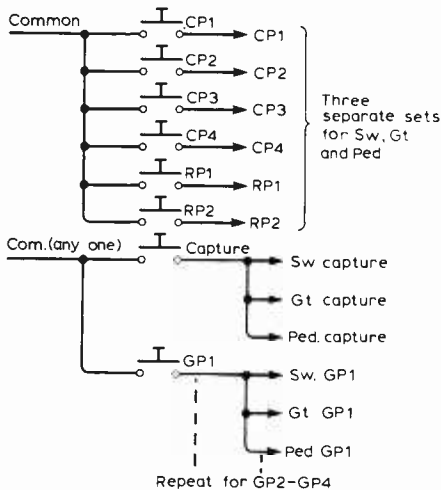
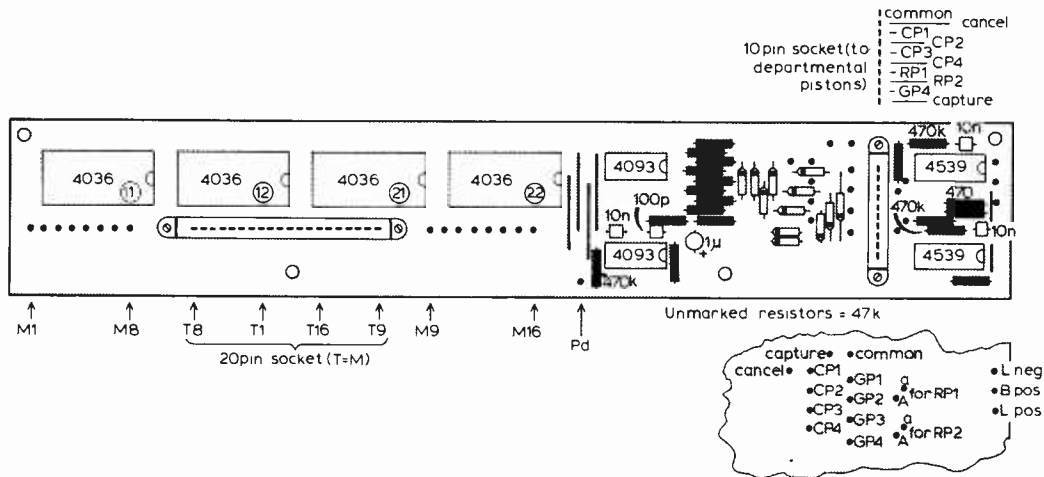


Fig. 10. Example of piston connections for three departments.

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

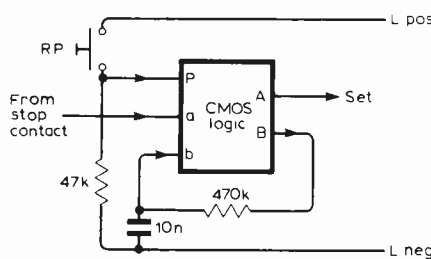
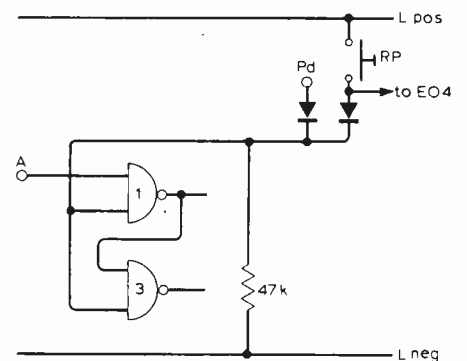


Fig. 12. Gating also from RP signal.



circuit contacts. These are slow-counter cells² 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 parti-

cularly 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 R₁, and current limit by R₂, 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 Tr₁ 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

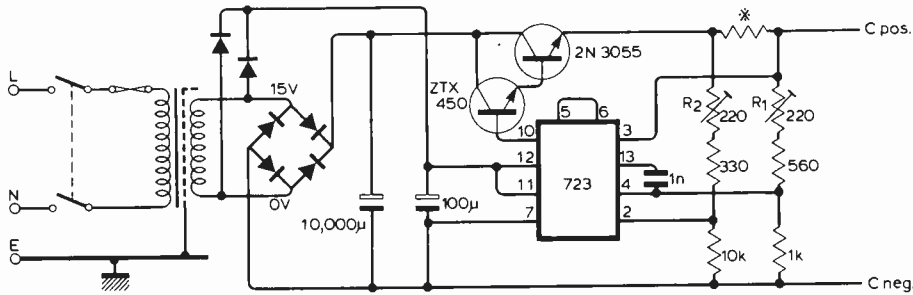


Fig. 13. Coil supply of 11 to 12V for single-magnet tabs. The bridge rectifier and 2N3055 require heatsinks, and the series resistor is selected to drop 1V at maximum current.

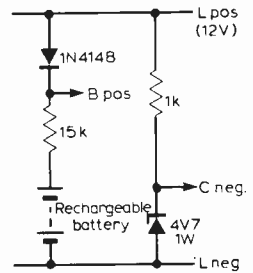


Fig. 14. Biasing for Fig. 13 C supply. The battery can have two or three 90 mA hours cells.

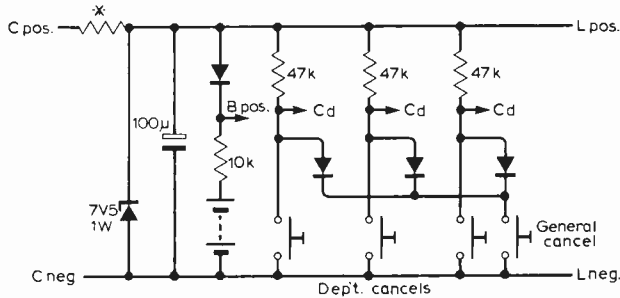


Fig. 15. Nominal L voltage for TMS using Fig. 5, 6 and 7. The series resistor is selected to pass 50mA from a maximum C voltage.

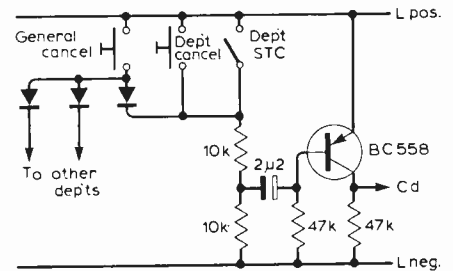


Fig. 16. Pulse timer for use with second-touch cancelling.

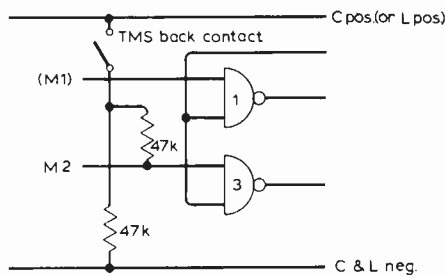


Fig. 17. Use of two M lines. The cross connection from gate 1 to gate 3 is omitted.

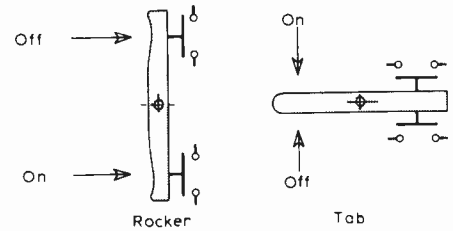


Fig. 18. Two types of spring-centred console switch.

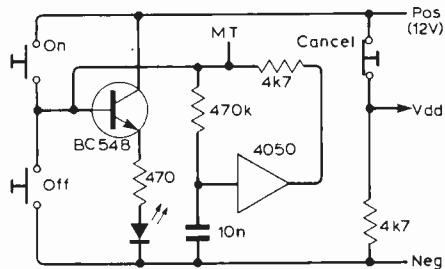


Fig. 19. Latching for spring-centred stop and l.e.d. indicator.

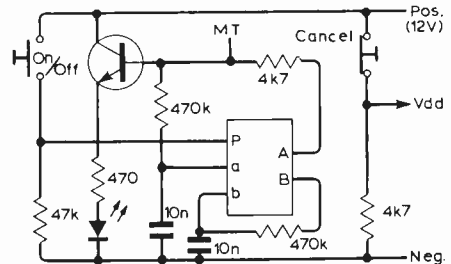


Fig. 20. Single-circuit stop with toggle.

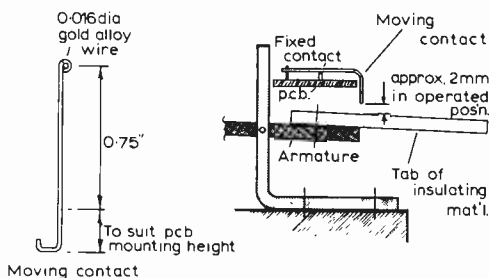


Fig. 21. Contact details for a single-magnet tab. A pin jig should be made for forming the moving contact.

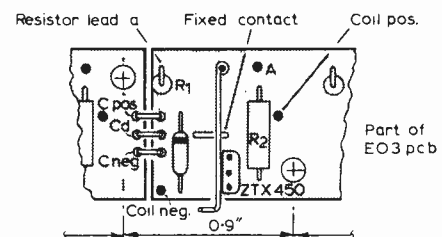


Fig. 22. Component layout and connections for EO3 p.c.b. For a normal tab, R₁ is 5k6, R₂ is 3k9, A = M(T), a is unused. For a tab with RP, R₁ is 27k, R₂ is 5k6, a = M(T) = toggle input, A = toggle output. Cut track Aa below.

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 SportsScene 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 Tr₇₀₁, 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 Tr₇₀₂ (a BF480) whose tuning is varied by a varicap diode.

The final r.f. amplifier Tr₇₀₃ (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.

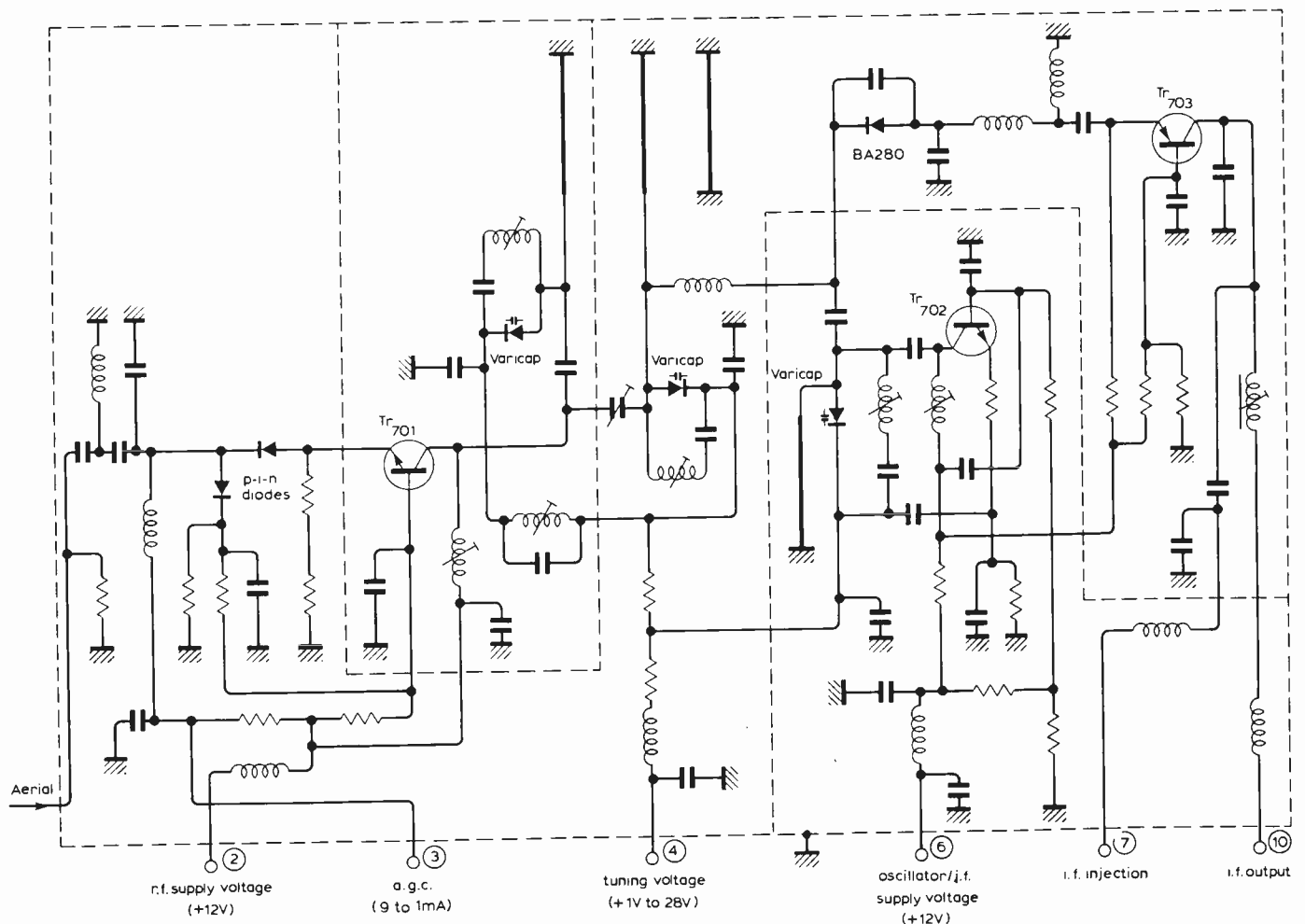
Vision i.f.

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



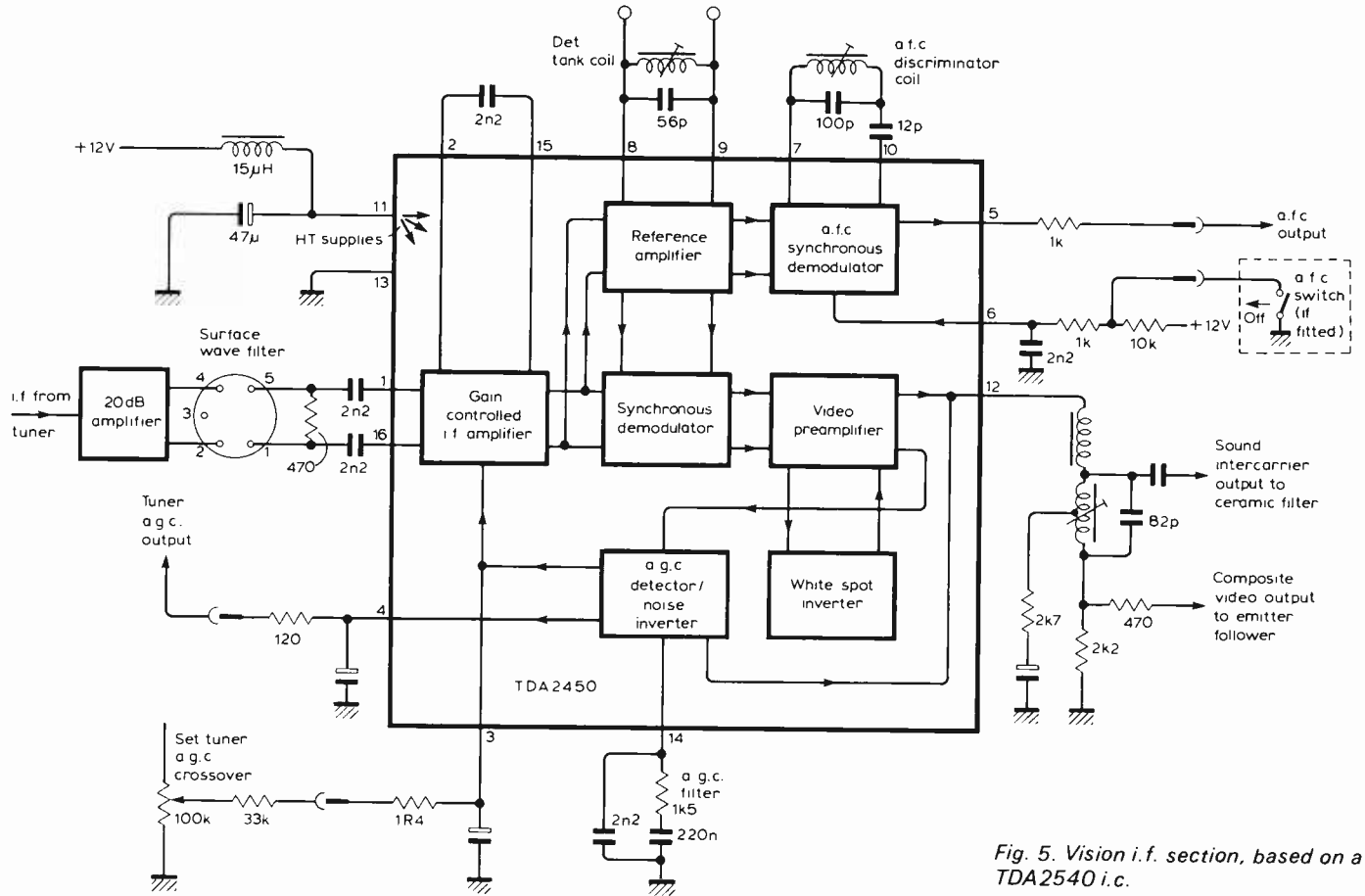


Fig. 5. Vision i.f. section, based on a TDA2450 i.c.

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 TDA2450, 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.

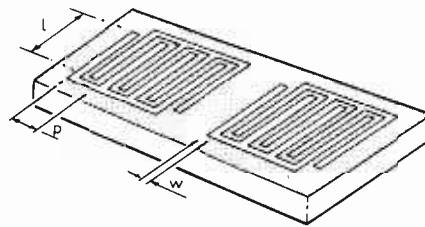


Fig. 6. Simplified diagram of a s.a.w. (surface acoustic wave) filter.

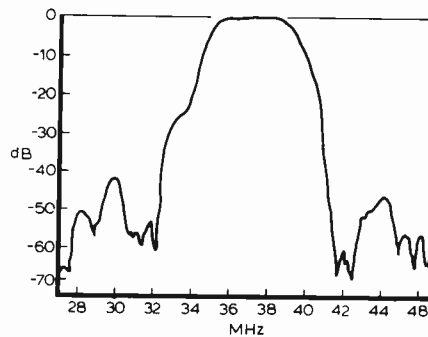


Fig. 7. Frequency response of i.f. given by s.a.w. filter.

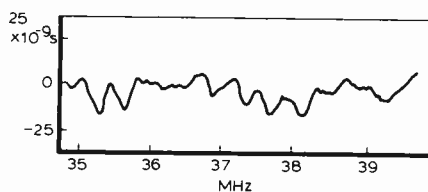


Fig. 8. Group delay characteristic of s.a.w. filter.

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.

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

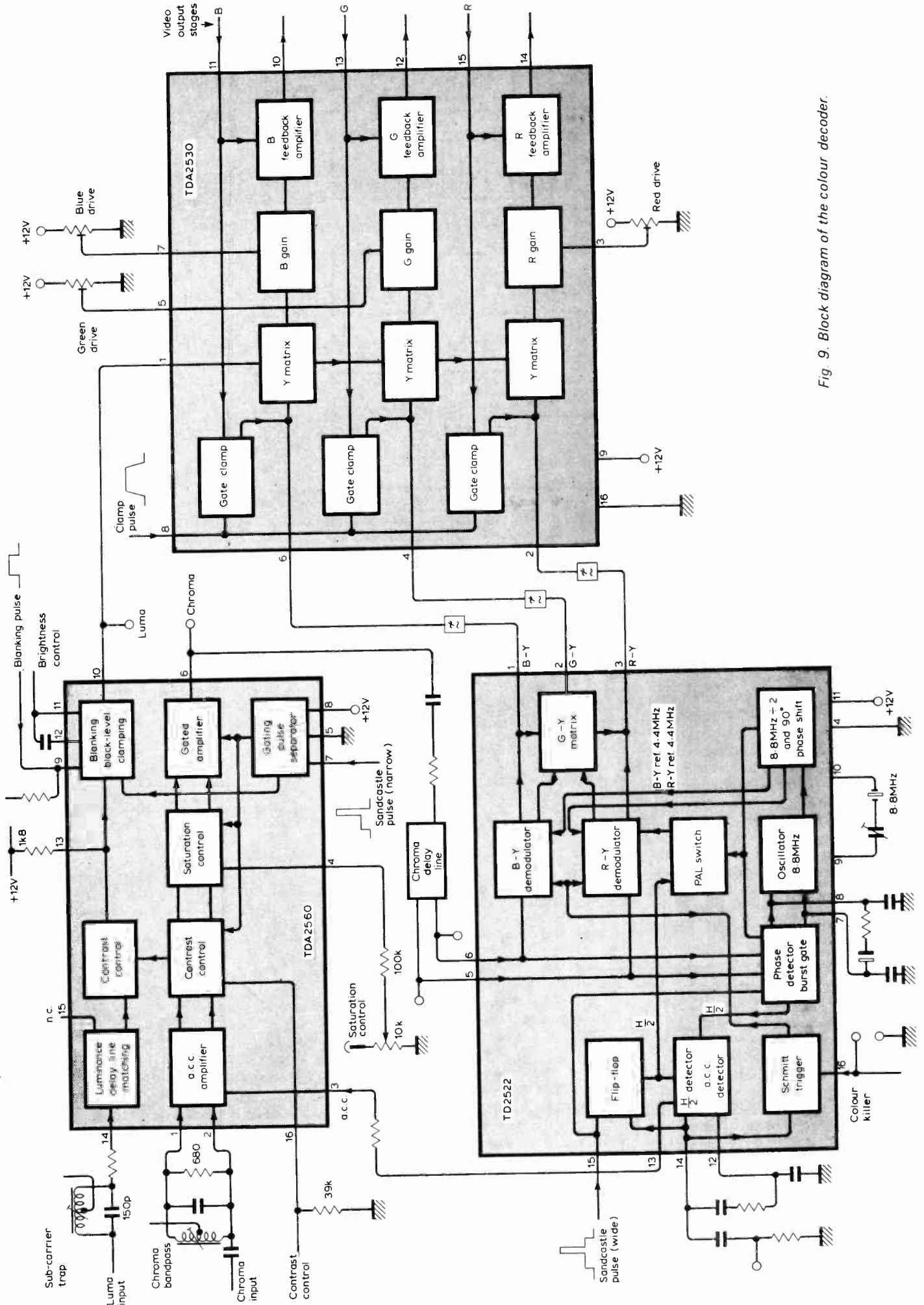


Fig. 9. Block diagram of the colour decoder.

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

IN OUR NEXT ISSUE

Floating-bridge amplifier

The floating bridge is claimed to possess all the advantages of a bridge amplifier — high power, large voltage swing with low-voltage devices, low power dissipation and low voltage power supply — with none of the drawbacks of complexity, limited bandwidth and relatively high distortion. These articles describe the design and construction of a simple, 15W amplifier, which can be powered by a 12V car battery. A 200W version is also described.

Satellite television

Since S. J. Birkill's experiments with the 860MHz ATS-6 television satellite were described in 1976, he has worked successfully in the 4GHz and 11/12GHz regions, receiving good results from Intelsat — 1VA, Molniya, Sirio, OTS and the Russian Rainbow and Horizon satellites of the Intersputnik system. He describes the equipment used and gives a selection of off-screen photographs of pictures received.

Versatile active filters

The majority of multi-channel tone controls use either active filters, which can cause trouble with the noise generated in the filters being fed to the output amplifier, or series LCR types, which suffer from the use of large inductors. The performance of the LCR type of filter tends to exceed that of the RC variety and the author has used it, but has synthesized the inductance by means of an operational amplifier and a CR network.

On sale
23 July

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.c.s. 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.

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 stabilized 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

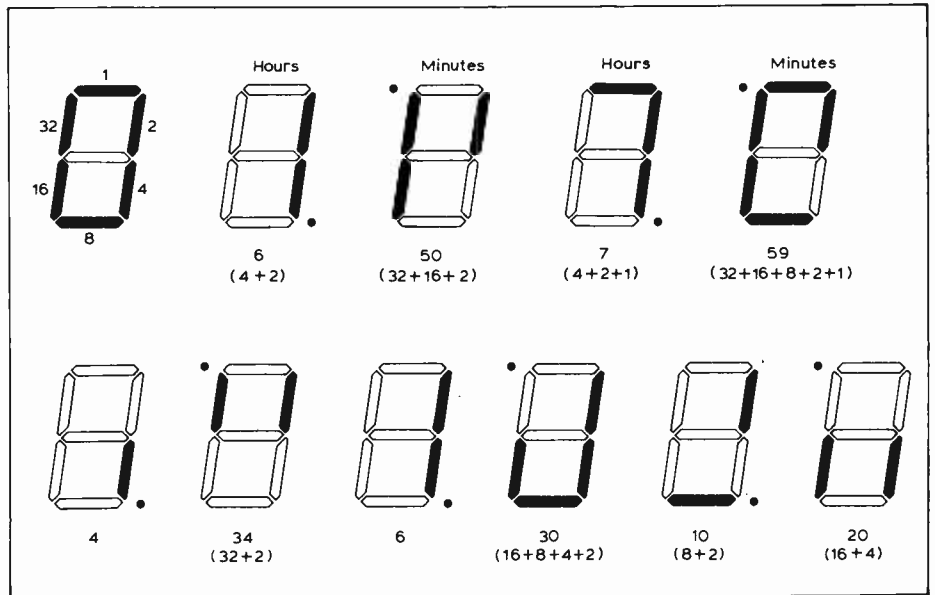
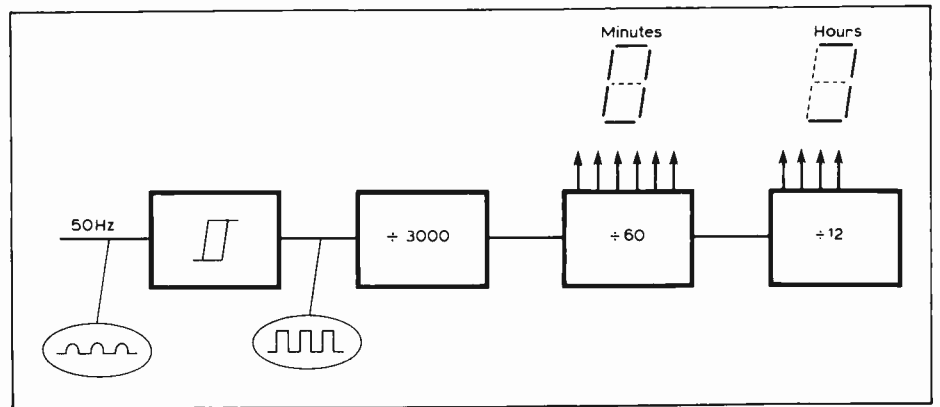


Fig. 1. Binary display based on two seven-segment characters.

Fig. 2. Block diagram of the clock.



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

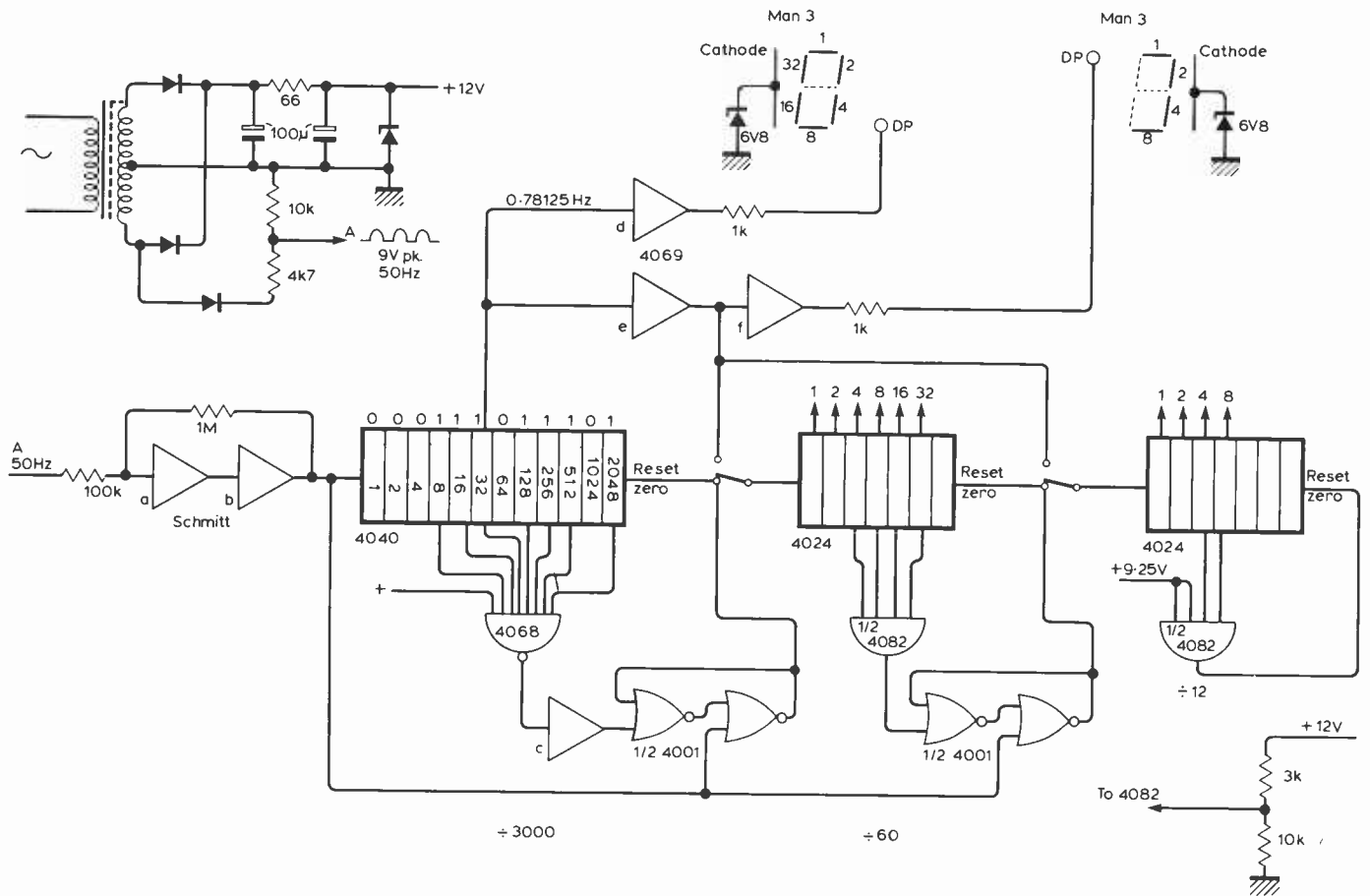
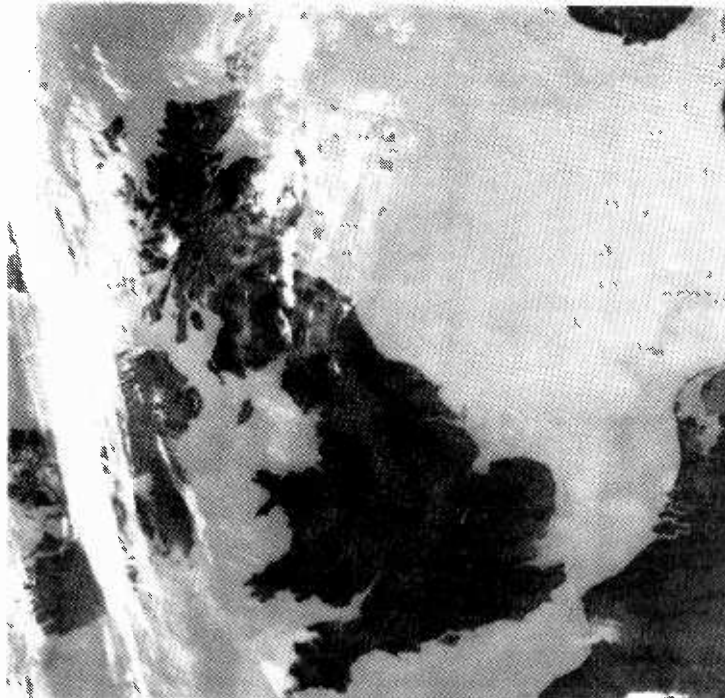


Fig. 3. Complete circuit comprising seven i.cs.

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 IC₈ to be joined together. The two should be separate.

In the component list, C₂ should be C₄, and in Fig. 3, pin 15 on IC_{7(a)} should be pin 5. IC₆ pin 3 is the one to which R₂₁ is connected. R₆ and R₇ are transposed on the layout of Board A (May issue).

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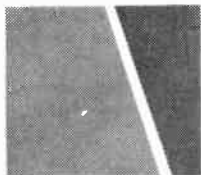
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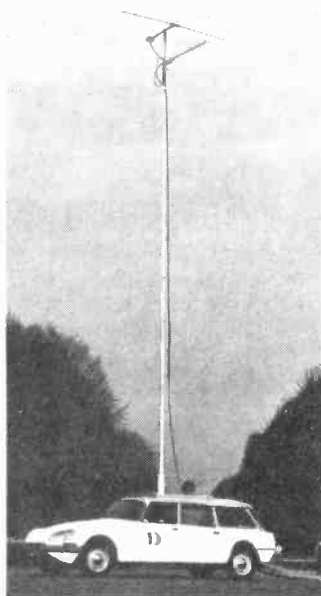


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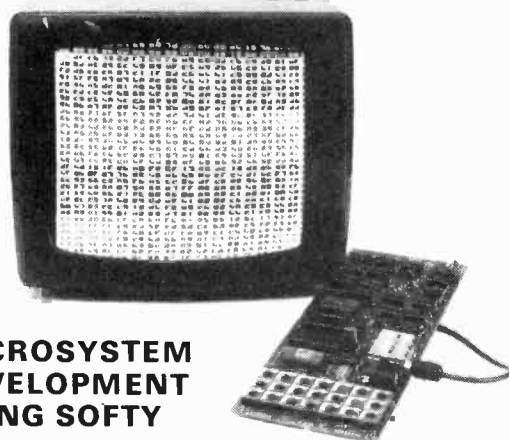
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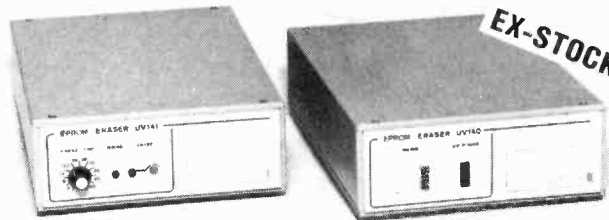
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Transient recorder

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.

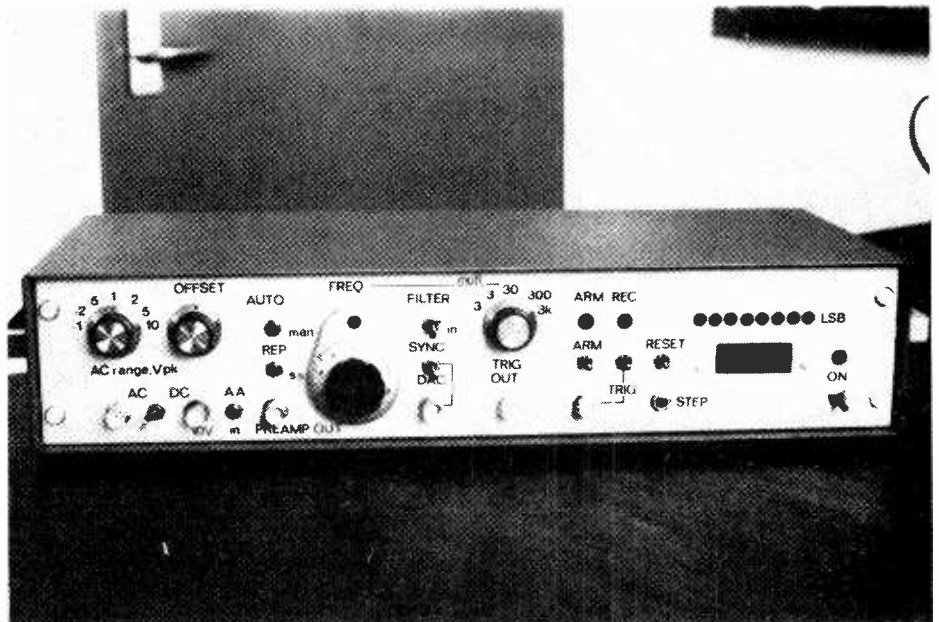
The function of a conventional transient recorder is quite straightforward. On receipt of a trigger pulse from either a manual trigger control or from a test rig, the recorder samples the amplitude of a signal at regular intervals, known as the sampling period ($1/\text{sampling frequency}$). After each 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

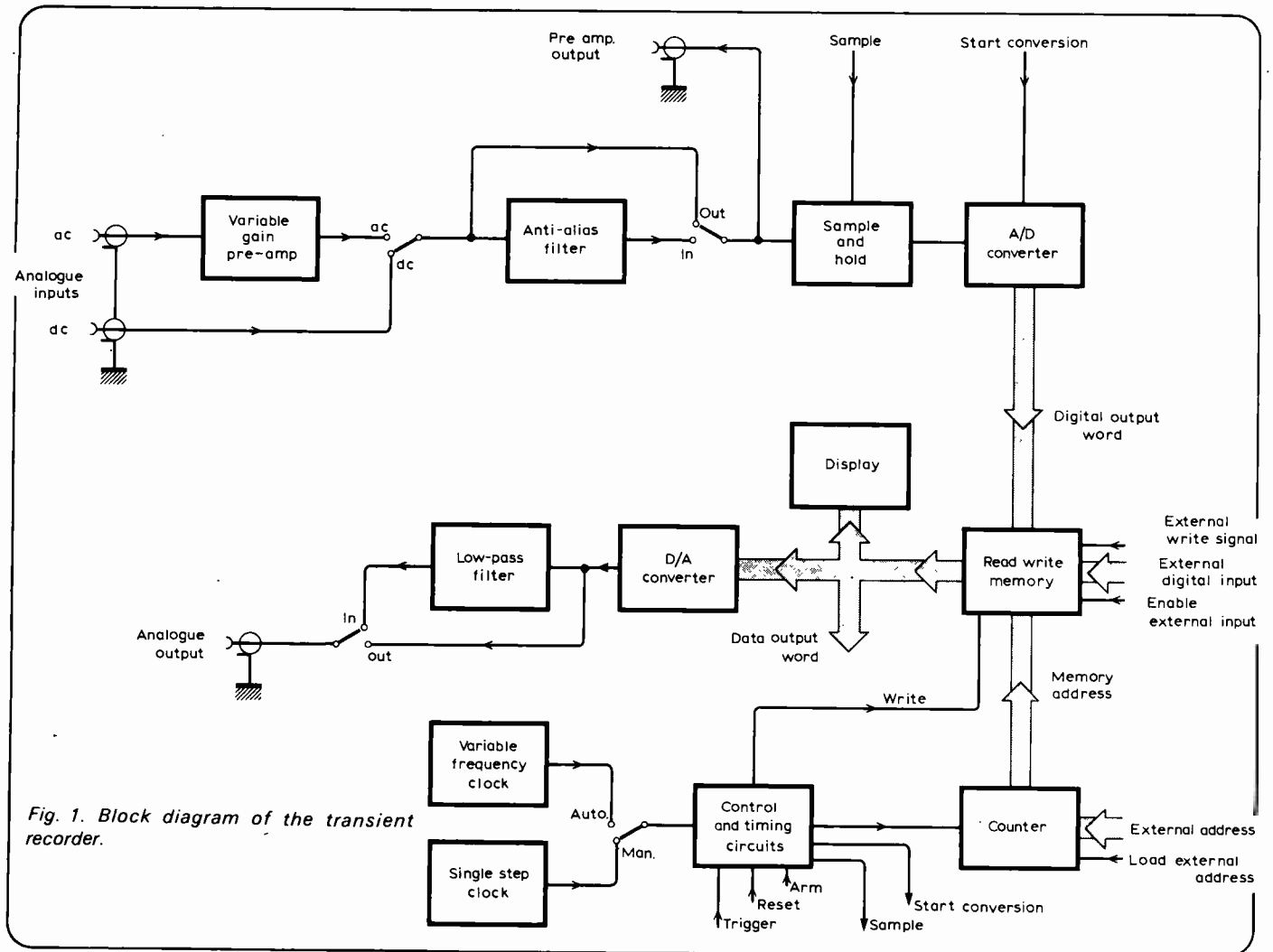
frequency is equivalent to the sampling frequency, and switched ranges are provided from 0.3Hz to 33 kHz. After a recording, the contents of the memory can be read out under control of the same clock/counter circuit or by a manual single step clock control. Memory data can be displayed by a l.e.d. readout 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.

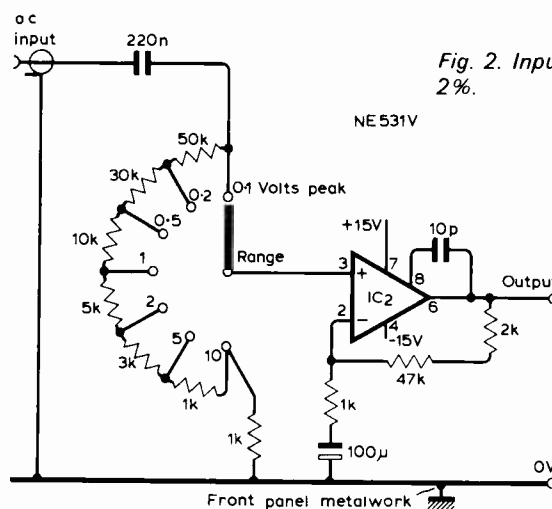
The a.c. input amplifier in Fig.2 is a simple fixed-gain stage with a passive attenuator, which provides a constant input impedance of about 100k Ω .

If the amplified signal contains frequencies higher than half of the



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



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 $4\mu\text{s}$ for 0.1% accuracy. When a sample is required, the t.t.l.-level line is taken low for $6\mu\text{s}$ and then returned to the high state to hold the output voltage. Approximately $4\mu\text{s}$ later, conversion starts which takes a further $20\mu\text{s}$. The total cycle time is therefore about

30 μ s 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 i.e.d.s from the outputs of IC₁₁ and IC₁₂ 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 R₃ 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 R₂ 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 IC₁₀ 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.

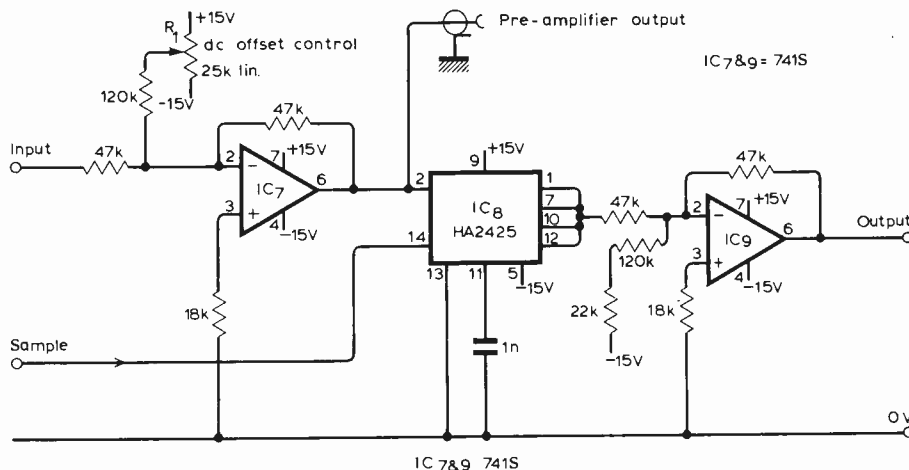


Fig. 4. Sample and hold circuit. The signal can be checked, prior to sampling, to ensure that it is within the +5 to -5V range of the a-to-d converter.

The busy output goes low when a conversion is in process, and can be monitored to check that the conversion time is approximately 20 μ s. 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 x 4-bit r.a.m.s. 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 6 μ s 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 6 μ s pulse allows low-speed memories to be used, the P8101 device has a cycle time of 1.3 μ s. However, if the memory is to be accessed by a computer using memory-mapped input/output, IC₁₄ and IC₁₅ 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 IC₁₆ and IC₁₇. The states of the output lines can be displayed by eight i.e.d.s 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 2 μ s, which can easily cope with the maximum playback rate of 33k words/s. Op-amp IC₂₁ 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 IC₂₁ as these were not found necessary in the prototype. However, IC₂₀ 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

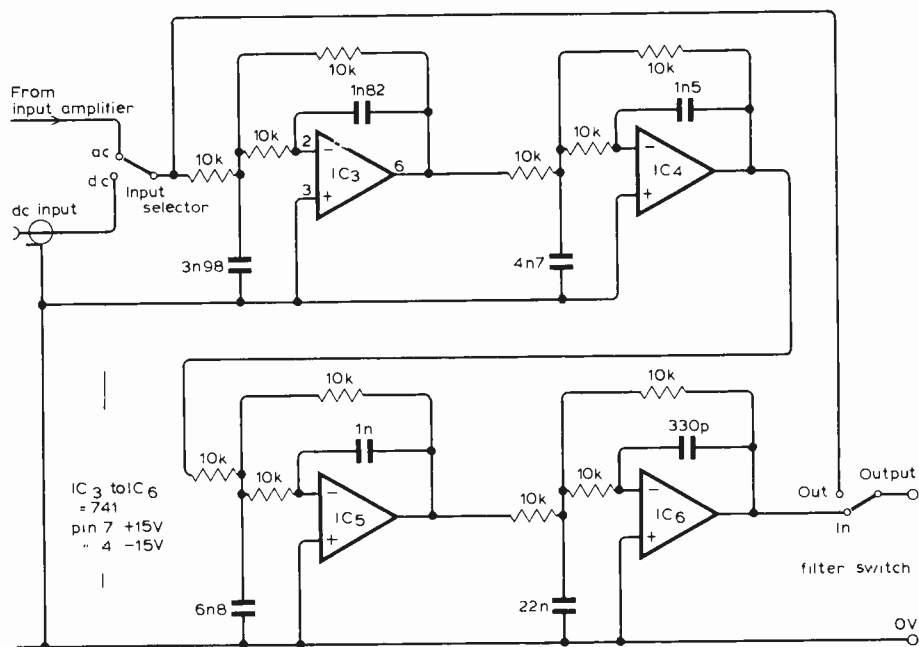


Fig. 3. Anti-alias filter. With the values shown, the cutoff frequency is 6kHz.

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

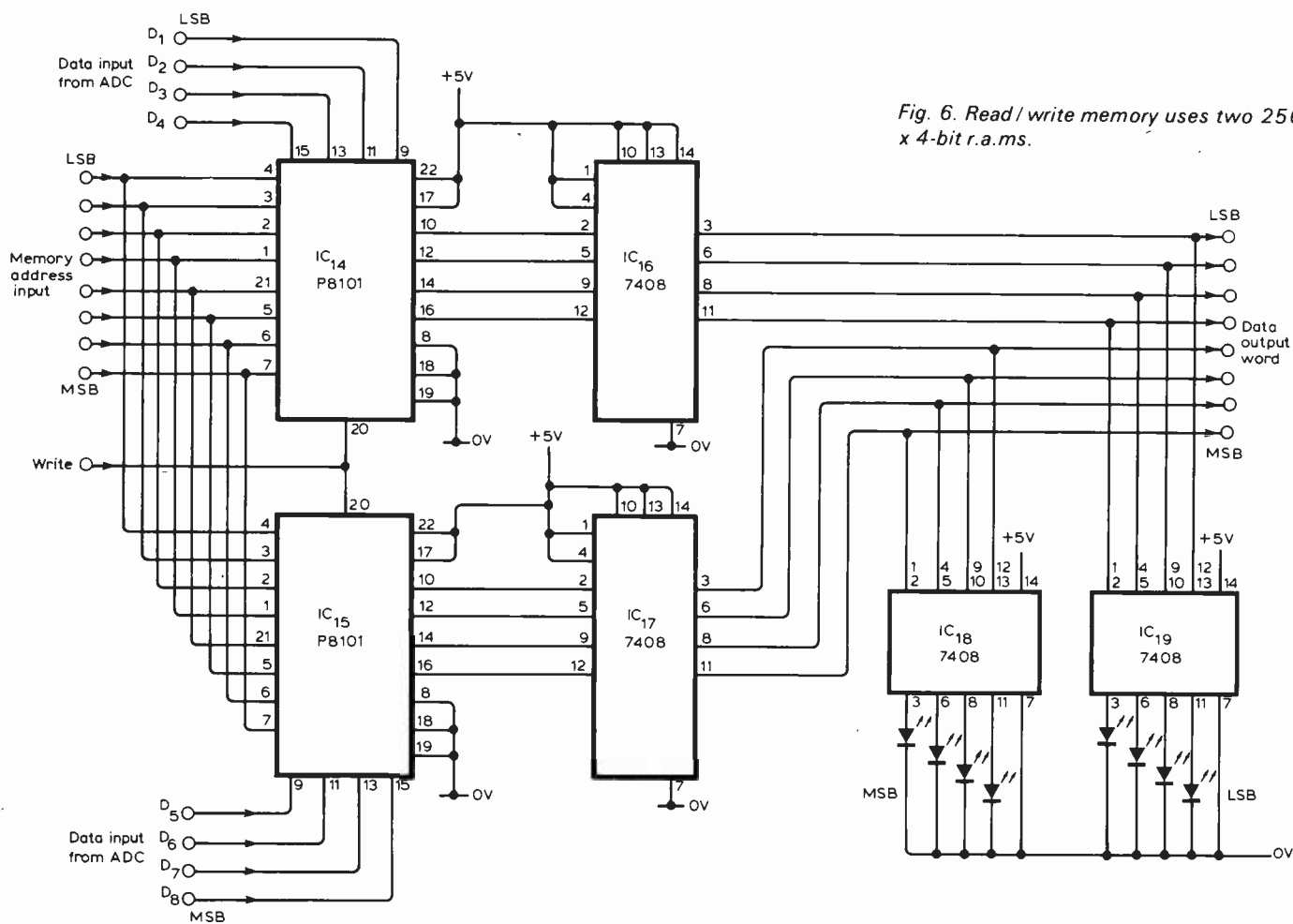
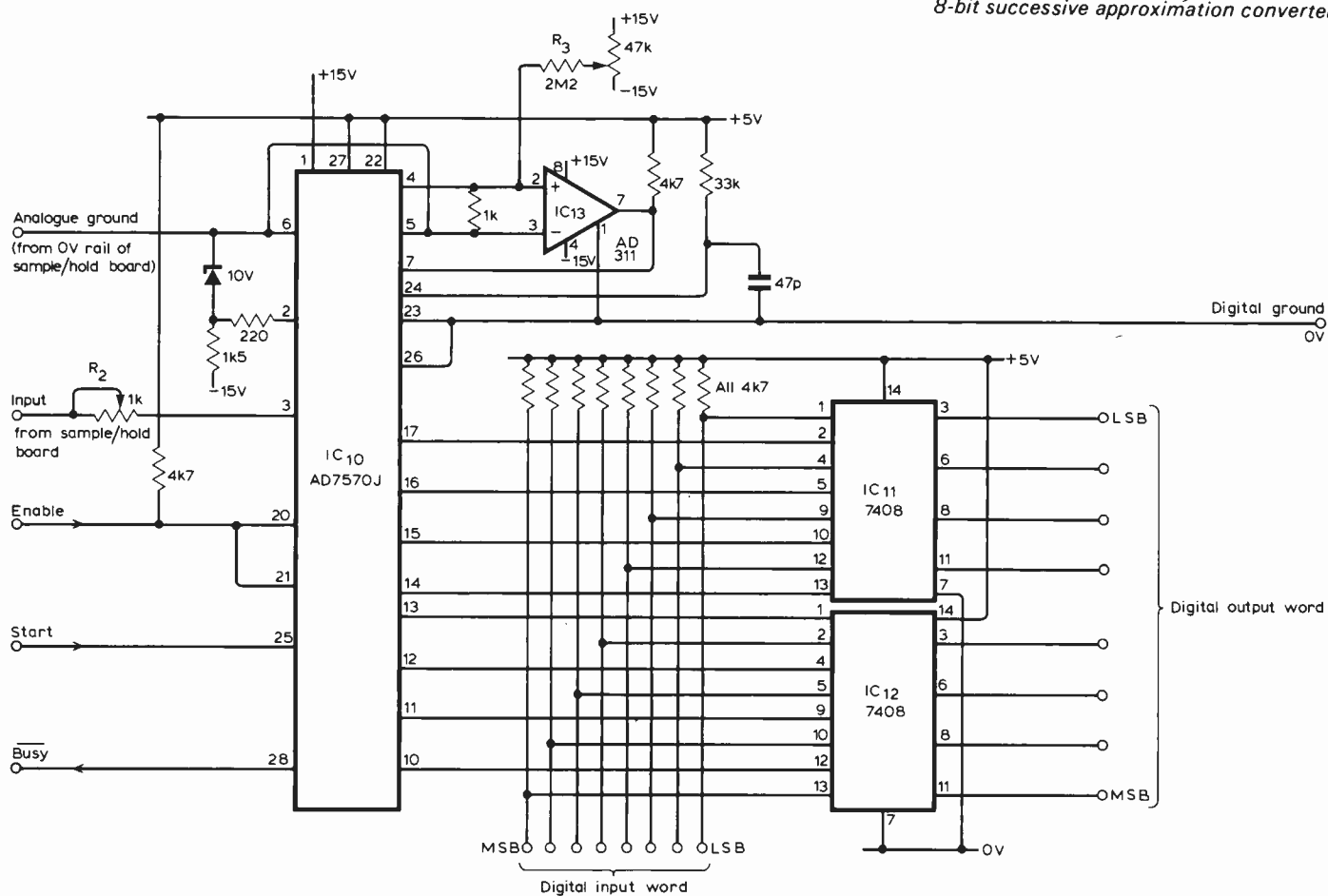
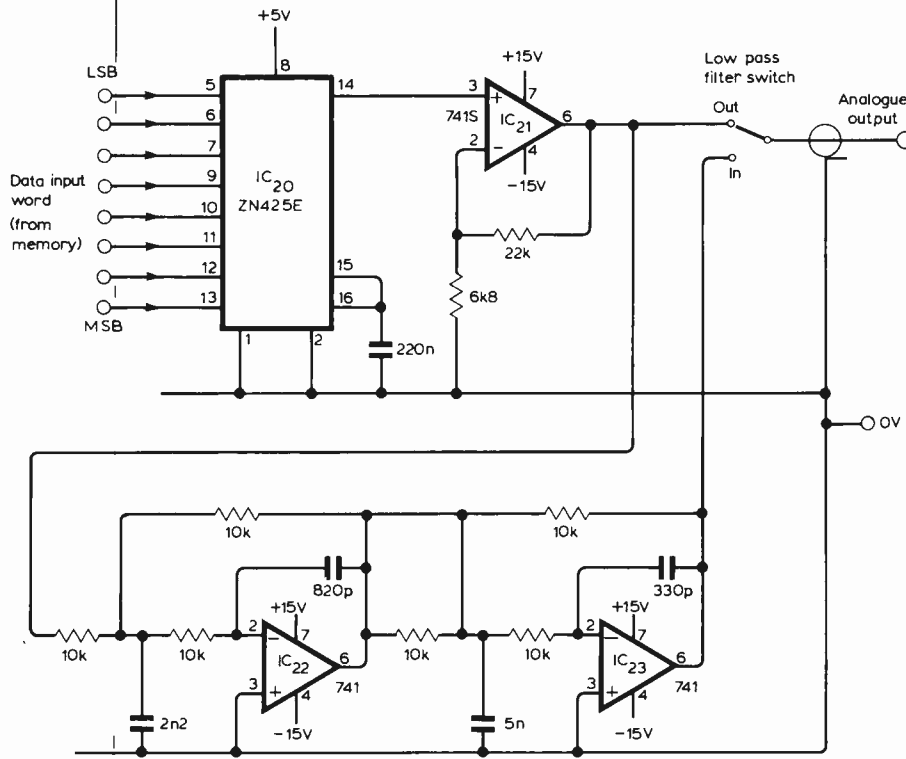


Fig. 6. Read/write memory uses two 256 x 4-bit r.a.ms.



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

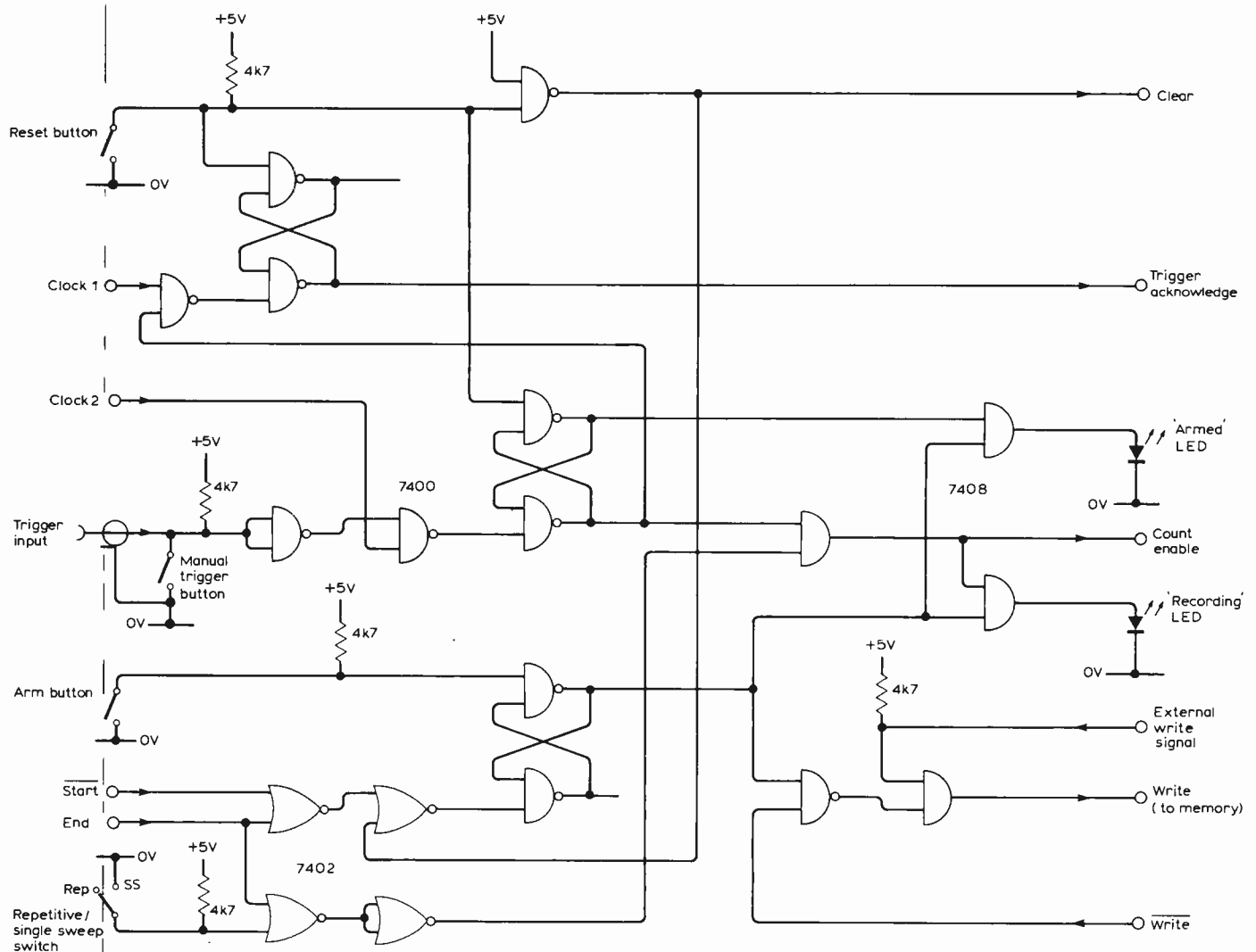


Fig. 8. Control logic triggers a sweep of the recorded data.

NEW PRODUCTS

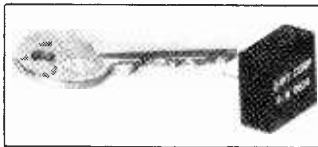
Lightweight magnetron

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.

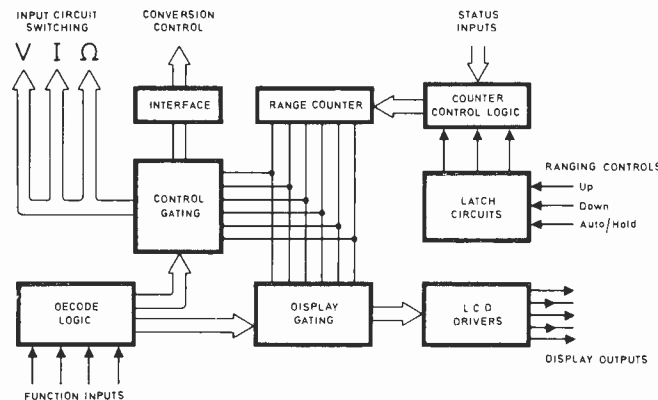
WW302

Auto-ranging Avometer

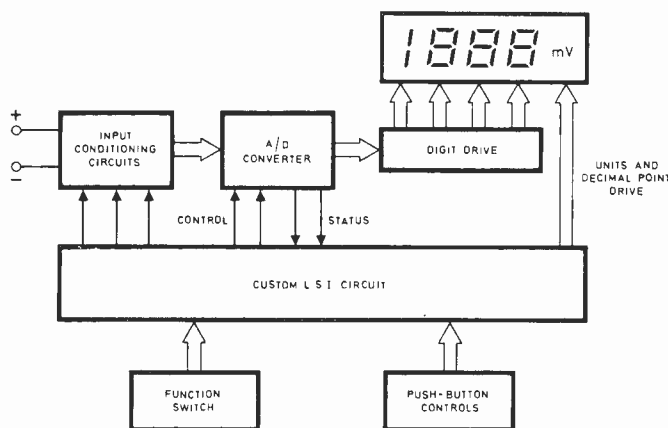
Full autoranging facilities are claimed for the model DA117 Avometer by the makers, Avo Ltd. This meter is an l.s.i.-based version of the Avo digital model DA116, which has been in production for some time. According to the company responsible for the development of the l.s.i. chip used in the DA117, 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

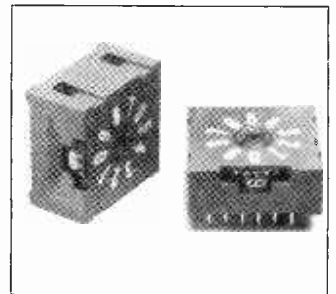
High friction mats

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



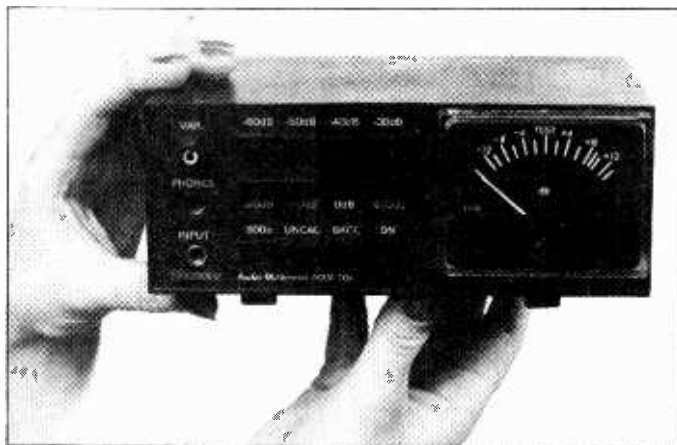
heat-sealed sub-assembly encloses the electrical contacts and an O-ring gasket seals the rotating surfaces. Maximum non-switching load of all forms is 1A at 28V d.c., max. switching load is 100mA at 28V d.c., contact resistance is 100milliohms (first contact) and the operating temperature is -10°C to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

WW305

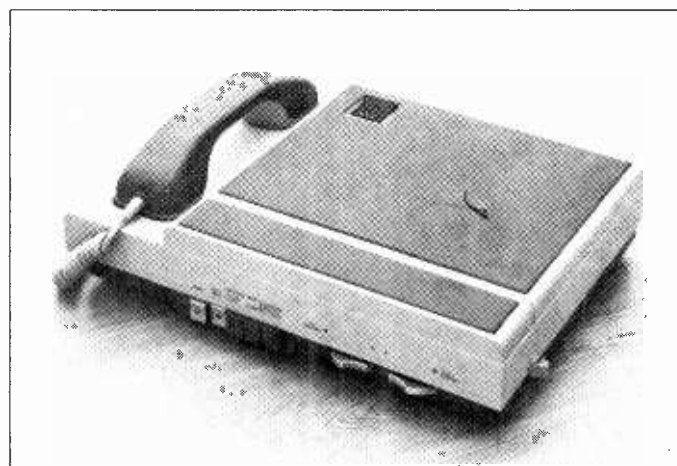
Audio level meter

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 100k Ω balanced but switchable to 600 Ω and maximum input is 400V pk continuous. The amplifier output, available through a headphone jack socket, has an impedance of 50 Ω 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 Multi-meter", the level meter costs £198.28 plus v.a.t. Bulgin Electronics Soundex Ltd, Park Lane, Broxbourne, Herts, EN10 7NQ.

WW306



WW306



WW307

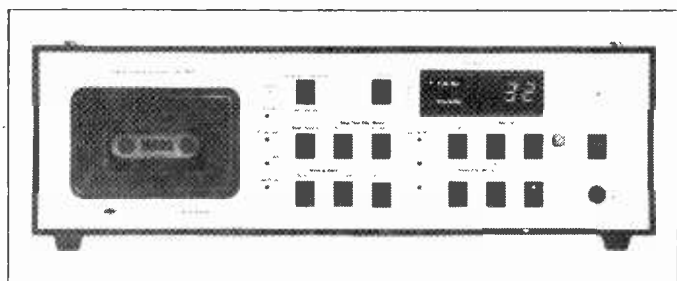
Telephone answering machine

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

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



WW308

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 1,200 Ω . The case, which measures approximately 8x6mm, 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 fishermen's 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 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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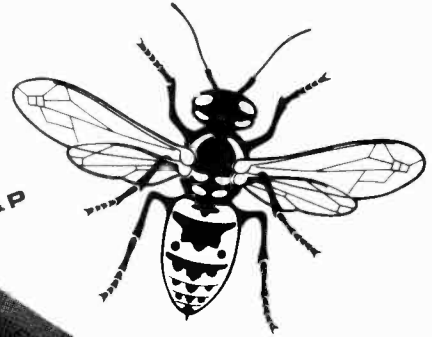
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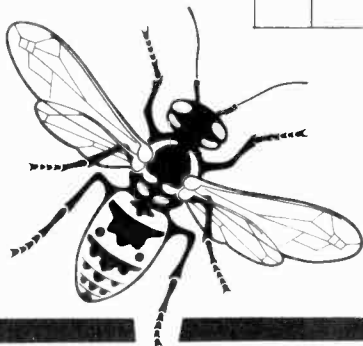
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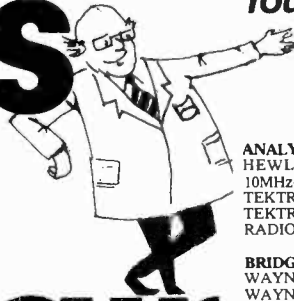
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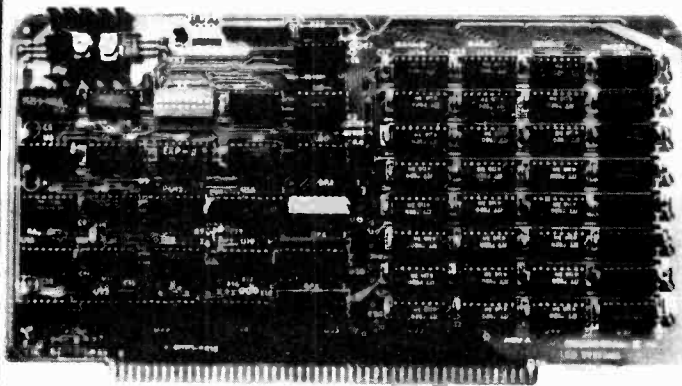
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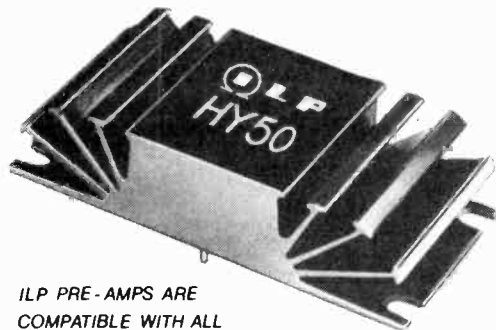
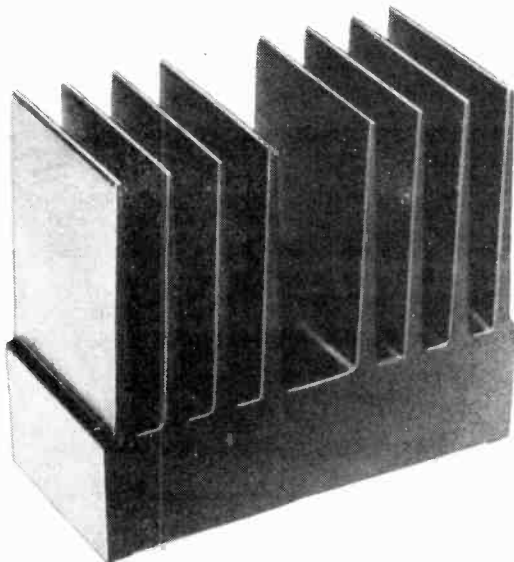
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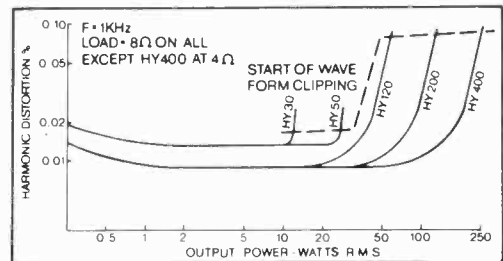
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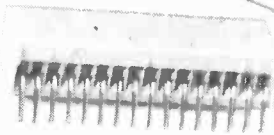
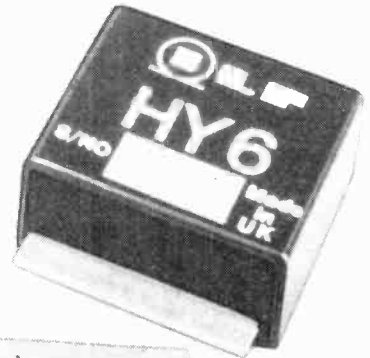
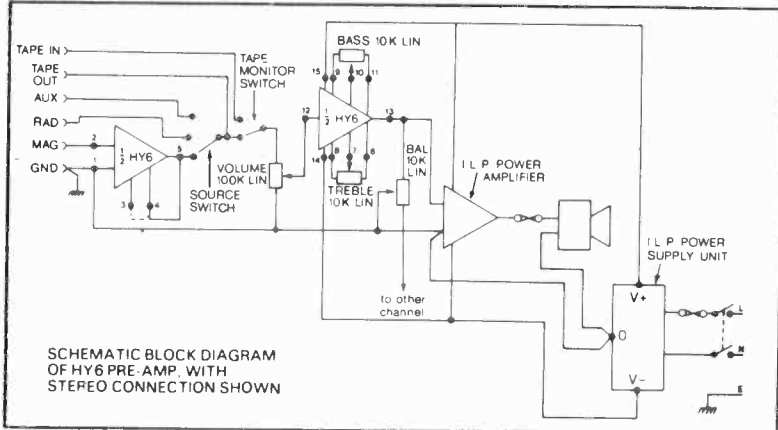
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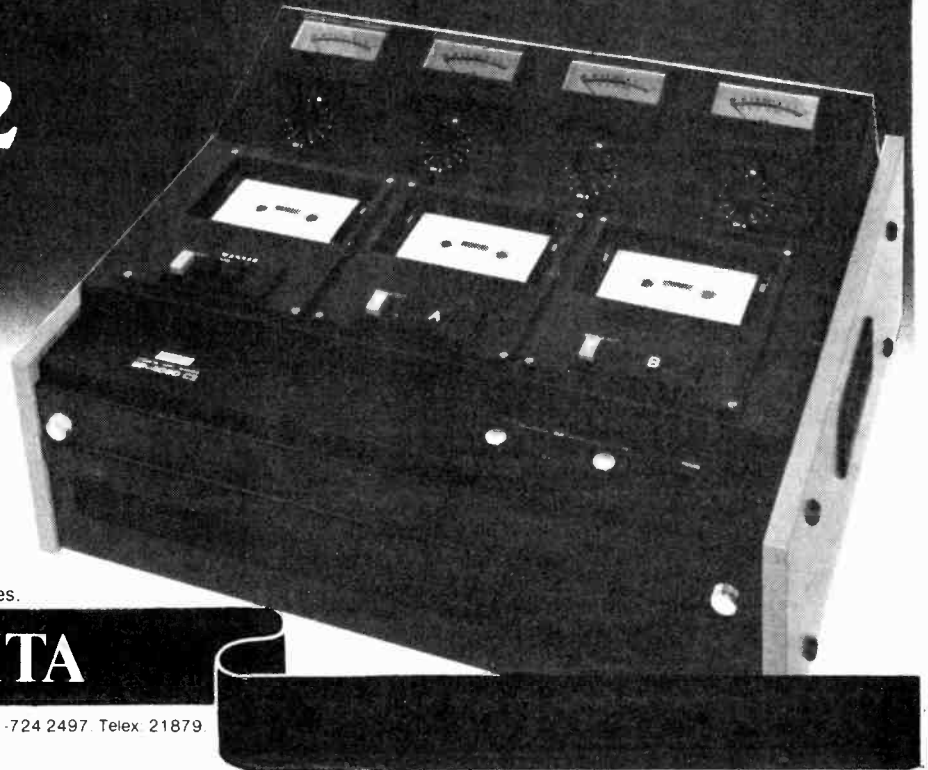
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Brief Spec. Amplifier Low field Toroidal transformer, Mag. input, Tape In / Out facility (for noise reduction unit, etc.) THD less than 0.1% at 20W into 8 ohms. **High Slew Rate.** Low noise op. amps used throughout. Power on / off FET transient protection. All sockets, fuses, etc., are PC mounted for ease of assembly. Tuner section uses 3302 FET module requiring no RF alignment, ceramic IF, INTERSTATION MUTE, and phase-locked IC stereo decoder. LED tuning and stereo indicators. Tuning range 88-104MHz, 30dB mono S/N @ 1.2µV, THD 0.3%. Pre-coder 'birdy' filter.

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A very high performance tuner with dual gate MOSFET RF and Mixer ready built front end, triple gang varicap tuning, linear phase I.F. and 3 state MPX decoder.

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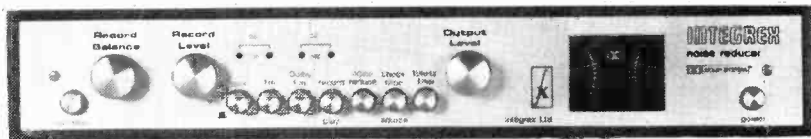
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Wireless World Dolby noise reducer

Trademark of Dolby Laboratories Inc.



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Harmonic distortion 0.1% at Dolby level typically 0.05% over most of band, rising to a maximum of 0.12%

Signal-to-noise ratio: 75dB (20Hz to 20kHz, signal at Dolby level) at Monitor output

Dynamic range >90dB

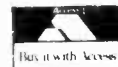
30mV sensitivity

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|----------------|------|--------|------|--------|----------------|-------|------|-------|------|----------------|------|--------|------|--------|----------------|---------|------|--------|------|--------|------|--------|------|--------|------|--------|------|--------|------|
| AA119 | 0.12 | AA130 | 0.31 | AA131 | 0.48 | BD131 | 0.40 | BD132 | 0.44 | BD133 | 0.40 | BF257 | 0.20 | BF258 | 0.20 | CR53/80 | 1.04 | GA2201 | 1.15 | OC203 | 2.52 | ZTX502 | 0.18 | 2N1309 | 0.63 | 2N1311 | 2.02 | 2N3771 | 2.02 |
| AA132 | 0.21 | AA133 | 0.20 | AA134 | 0.12 | BD134 | 0.39 | BD135 | 0.39 | BD136 | 0.39 | BF259 | 0.37 | BF260 | 0.37 | GEX66 | 1.73 | GA2202 | 1.15 | OC204 | 2.88 | ZTX503 | 0.20 | 2N1613 | 0.29 | 2N1614 | 2.30 | 2N3772 | 2.30 |
| AA135 | 0.48 | AA136 | 0.48 | AA137 | 0.48 | BD137 | 0.17 | BD138 | 0.17 | BD139 | 0.17 | BF336 | 0.35 | BF337 | 0.35 | GEX541 | 4.60 | GA2207 | 1.15 | OC205 | 2.88 | ZTX504 | 0.23 | 2N1671 | 1.73 | 2N1672 | 3.45 | 2N3773 | 3.45 |
| AA138 | 0.21 | AA139 | 0.21 | AA140 | 0.21 | BD140 | 0.51 | BD141 | 0.40 | BD142 | 0.40 | BF338 | 0.25 | BF339 | 0.25 | GJ3M | 0.86 | OC16 | 2.30 | OC206 | 2.88 | ZTX505 | 0.23 | 2N1893 | 0.79 | 2N1894 | 0.79 | 2N3819 | 0.41 |
| AA2123 | 0.39 | AA2124 | 0.39 | AA2125 | 0.39 | BD143 | 0.49 | BD144 | 0.39 | BD145 | 0.39 | BFS21 | 4.55 | BFS22 | 4.55 | GM0378A | 0.02 | OC20 | 2.88 | OC207 | 2.02 | ZTX506 | 0.18 | 2N2147 | 2.02 | 2N2148 | 2.02 | 2N3820 | 0.52 |
| AA217 | 0.31 | AA218 | 0.31 | AA219 | 0.31 | BD146 | 0.51 | BD147 | 0.39 | BD148 | 0.39 | BFS23 | 2.36 | BFS24 | 2.36 | MJE340 | 0.92 | OC23 | 3.16 | OC208 | 2.02 | ZTX507 | 0.18 | 2N2218 | 0.29 | 2N2219 | 0.29 | 2N3866 | 0.83 |
| AC107 | 0.69 | AC108 | 0.69 | AC109 | 0.69 | BD149 | 0.39 | BD150 | 0.39 | BD151 | 0.39 | MJE371 | 1.35 | MJE372 | 1.35 | OC24 | 3.45 | R2008B | 2.82 | R2009 | 2.82 | ZTX508 | 0.18 | 2N2220 | 0.21 | 2N2221 | 0.21 | 2N3904 | 0.15 |
| AC125 | 0.23 | AC126 | 0.23 | AC127 | 0.23 | BD152 | 1.26 | BD153 | 1.26 | BD154 | 1.26 | MJE521 | 0.60 | MJE522 | 0.60 | OC26 | 1.04 | R2010B | 2.02 | R2011 | 2.02 | ZTX509 | 0.18 | 2N2222 | 0.21 | 2N2223 | 0.21 | 2N3906 | 0.15 |
| AC128 | 0.23 | AC129 | 0.23 | AC130 | 0.23 | BD155 | 1.38 | BD156 | 1.38 | BD157 | 1.38 | MJE295 | 1.44 | MJE296 | 1.44 | OC28 | 2.30 | TIC244 | 0.35 | TIC245 | 0.35 | ZTX510 | 0.18 | 2N2224 | 0.21 | 2N2225 | 0.21 | 2N4058 | 0.16 |
| AC141 | 0.29 | AC142 | 0.29 | AC143 | 0.29 | BD158 | 0.46 | BD159 | 0.46 | BD160 | 0.46 | MPF104 | 0.25 | MPF105 | 0.25 | OC29 | 2.30 | TIP209 | 0.37 | TIP210 | 0.37 | ZTX511 | 0.18 | 2N2226 | 0.21 | 2N2227 | 0.21 | 2N4060 | 0.14 |
| AC141K | 0.40 | AC142K | 0.40 | AC143K | 0.40 | BD161 | 1.05 | BD162 | 1.05 | BD163 | 1.05 | MPF106 | 0.35 | MPF107 | 0.35 | OC31 | 0.92 | TIP211 | 0.37 | TIP212 | 0.37 | ZTX512 | 0.18 | 2N2228 | 0.21 | 2N2229 | 0.21 | 2N4061 | 0.14 |
| AC142 | 0.23 | AC143 | 0.23 | AC144 | 0.23 | BD164 | 0.39 | BD165 | 0.39 | BD166 | 0.39 | MPF108 | 0.45 | MPF109 | 0.45 | OC32 | 0.86 | TIP213 | 0.37 | TIP214 | 0.37 | ZTX513 | 0.18 | 2N2230 | 0.21 | 2N2231 | 0.21 | 2N4062 | 0.15 |
| AC142K | 0.35 | AC143K | 0.35 | AC144K | 0.35 | BD167 | 1.44 | BD168 | 1.44 | BD169 | 1.44 | MPF110 | 0.55 | MPF111 | 0.55 | OC34 | 0.59 | TIP215 | 0.37 | TIP216 | 0.37 | ZTX514 | 0.18 | 2N2232 | 0.21 | 2N2233 | 0.21 | 2N4063 | 0.17 |
| AC176 | 0.23 | AC177 | 0.23 | AC178 | 0.23 | BD170 | 1.72 | BD171 | 1.72 | BD172 | 1.72 | MPF112 | 0.38 | MPF113 | 0.38 | OC44 | 2.89 | TIP217 | 0.37 | TIP218 | 0.37 | ZTX515 | 0.18 | 2N2234 | 0.21 | 2N2235 | 0.21 | 2N4064 | 0.15 |
| AC179 | 0.23 | AC180 | 0.23 | AC181 | 0.23 | BD173 | 0.63 | BD174 | 0.63 | BD175 | 0.63 | MPF114 | 0.25 | MPF115 | 0.25 | OC45 | 0.63 | TIP219 | 0.37 | TIP220 | 0.37 | ZTX516 | 0.18 | 2N2236 | 0.21 | 2N2237 | 0.21 | 2N4065 | 0.17 |
| AC188 | 0.23 | AC189 | 0.23 | AC190 | 0.23 | BD176 | 0.28 | BD177 | 0.28 | BD178 | 0.28 | MPF116 | 0.41 | MPF117 | 0.41 | OC46 | 0.83 | TIP221 | 0.37 | TIP222 | 0.37 | ZTX517 | 0.18 | 2N2238 | 0.20 | 2N2239 | 0.20 | 2N4066 | 0.14 |
| ACV17 | 0.98 | ACV18 | 0.98 | ACV19 | 0.98 | BD179 | 0.28 | BD180 | 0.28 | BD181 | 0.28 | MPF118 | 0.53 | MPF119 | 0.53 | OC47 | 0.83 | TIP223 | 0.37 | TIP224 | 0.37 | ZTX518 | 0.18 | 2N2240 | 0.24 | 2N2241 | 0.24 | 2N4067 | 0.28 |
| ACV18 | 0.92 | ACV19 | 0.92 | ACV20 | 0.92 | BD182 | 0.21 | BD183 | 0.21 | BD184 | 0.21 | MPF120 | 0.38 | MPF121 | 0.38 | OC48 | 0.83 | TIP225 | 0.37 | TIP226 | 0.37 | ZTX519 | 0.18 | 2N2242 | 0.24 | 2N2243 | 0.24 | 2N4068 | 0.40 |
| ACV19 | 0.86 | ACV20 | 0.86 | ACV21 | 0.86 | BD185 | 0.21 | BD186 | 0.21 | BD187 | 0.21 | MPF122 | 0.50 | MPF123 | 0.50 | OC49 | 0.83 | TIP227 | 0.37 | TIP228 | 0.37 | ZTX520 | 0.18 | 2N2244 | 0.24 | 2N2245 | 0.24 | 2N4069 | 0.28 |
| ACV20 | 0.80 | ACV21 | 0.80 | ACV22 | 0.80 | BD188 | 0.21 | BD189 | 0.21 | BD190 | 0.21 | MPF124 | 0.38 | MPF125 | 0.38 | OC51 | 0.83 | TIP229 | 0.37 | TIP230 | 0.37 | ZTX521 | 0.18 | 2N2246 | 0.24 | 2N2247 | 0.24 | 2N4070 | 0.28 |
| ACV21 | 0.86 | ACV22 | 0.86 | ACV23 | 0.86 | BD191 | 0.28 | BD192 | 0.28 | BD193 | 0.28 | MPF126 | 0.50 | MPF127 | 0.50 | OC52 | 0.83 | TIP231 | 0.37 | TIP232 | 0.37 | ZTX522 | 0.18 | 2N2248 | 0.24 | 2N2249 | 0.24 | 2N4071 | 0.28 |
| ACV22 | 0.86 | ACV23 | 0.86 | ACV24 | 0.86 | BD194 | 0.28 | BD195 | 0.28 | BD196 | 0.28 | MPF128 | 0.50 | MPF129 | 0.50 | OC53 | 0.83 | TIP233 | 0.37 | TIP234 | 0.37 | ZTX523 | 0.18 | 2N2250 | 0.24 | 2N2251 | 0.24 | 2N4072 | 0.40 |
| ACV23 | 0.86 | ACV24 | 0.86 | ACV25 | 0.86 | BD197 | 0.28 | BD198 | 0.28 | BD199 | 0.28 | MPF130 | 0.50 | MPF131 | 0.50 | OC54 | 0.83 | TIP235 | 0.37 | TIP236 | 0.37 | ZTX524 | 0.18 | 2N2252 | 0.24 | 2N2253 | 0.24 | 2N4073 | 0.40 |
| AD161 | 0.52 | AD162 | 0.52 | AD163 | 0.52 | BD200 | 0.28 | BD201 | 0.28 | BD202 | 0.28 | MPF132 | 0.50 | MPF133 | 0.50 | OC55 | 0.83 | TIP237 | 0.37 | TIP238 | 0.37 | ZTX525 | 0.18 | 2N2254 | 0.24 | 2N2255 | 0.24 | 2N4074 | 0.40 |
| AD162 | 0.52 | AD163 | 0.52 | AD164 | 0.52 | BD203 | 0.28 | BD204 | 0.28 | BD205 | 0.28 | MPF134 | 0.50 | MPF135 | 0.50 | OC56 | 0.83 | TIP239 | 0.37 | TIP240 | 0.37 | ZTX526 | 0.18 | 2N2256 | 0.24 | 2N2257 | 0.24 | 2N4075 | 0.40 |
| AD165 | 0.52 | AD166 | 0.52 | AD167 | 0.52 | BD206 | 0.28 | BD207 | 0.28 | BD208 | 0.28 | MPF136 | 0.50 | MPF137 | 0.50 | OC57 | 0.83 | TIP241 | 0.37 | TIP242 | 0.37 | ZTX527 | 0.18 | 2N2258 | 0.24 | 2N2259 | 0.24 | 2N4076 | 0.40 |
| AD168 | 0.52 | AD169 | 0.52 | AD170 | 0.52 | BD209 | 0.28 | BD210 | 0.28 | BD211 | 0.28 | MPF138 | 0.50 | MPF139 | 0.50 | OC58 | 0.83 | TIP243 | 0.37 | TIP244 | 0.37 | ZTX528 | 0.18 | 2N2260 | 0.24 | 2N2261 | 0.24 | 2N4077 | 0.40 |
| AF114 | 0.86 | AF115 | 0.86 | AF116 | 0.86 | BD212 | 1.50 | BD213 | 1.50 | BD214 | 1.50 | MPF140 | 0.50 | MPF141 | 0.50 | OC59 | 0.83 | TIP245 | 0.37 | TIP246 | 0.37 | ZTX529 | 0.18 | 2N2262 | 0.24 | 2N2263 | 0.24 | 2N4078 | 0.40 |
| AF115 | 0.86 | AF116 | 0.86 | AF117 | 0.86 | BD215 | 1.50 | BD216 | 1.50 | BD217 | 1.50 | MPF142 | 0.50 | MPF143 | 0.50 | OC60 | 0.83 | TIP247 | 0.37 | TIP248 | 0.37 | ZTX530 | 0.18 | 2N2264 | 0.24 | 2N2265 | 0.24 | 2N4079 | 0.40 |
| AF117 | 0.86 | AF118 | 0.86 | AF119 | 0.86 | BD218 | 1.50 | BD219 | 1.50 | BD220 | 1.50 | MPF144 | 0.50 | MPF145 | 0.50 | OC61 | 0.83 | TIP249 | 0.37 | TIP250 | 0.37 | ZTX531 | 0.18 | 2N2266 | 0.24 | 2N2267 | 0.24 | 2N4080 | 0.40 |
| AF139 | 0.46 | AF140 | 0.46 | AF141 | 0.46 | BD221 | 1.50 | BD222 | 1.50 | BD223 | 1.50 | MPF146 | 0.50 | MPF147 | 0.50 | OC62 | 0.83 | TIP251 | 0.37 | TIP252 | 0.37 | ZTX532 | 0.18 | 2N2268 | 0.24 | 2N2269 | 0.24 | 2N4081 | 0.40 |
| AF139 | 0.46 | AF140 | 0.46 | AF141 | 0.46 | BD224 | 1.50 | BD225 | 1.50 | BD226 | 1.50 | MPF148 | 0.50 | MPF149 | 0.50 | OC63 | 0.83 | TIP253 | 0.37 | TIP254 | 0.37 | ZTX533 | 0.18 | 2N2270 | 0.24 | 2N2271 | 0.24 | 2N4082 | 0.40 |
| AF139 | 0.46 | AF140 | 0.46 | AF141 | 0.46 | BD227 | 1.50 | BD228 | 1.50 | BD229 | 1.50 | MPF150 | 0.50 | MPF151 | 0.50 | OC64 | 0.83 | TIP255 | 0.37 | TIP256 | 0.37 | ZTX534 | 0.18 | 2N2272 | 0.24 | 2N2273 | 0.24 | 2N4083 | 0.40 |
| AF139 | 0.46 | AF140 | 0.46 | AF141 | 0.46 | BD230 | 1.50 | BD231 | 1.50 | BD232 | 1.50 | MPF152 | 0.50 | MPF153 | 0.50 | OC65 | 0.83 | TIP257 | 0.37 | TIP258 | 0.37 | ZTX535 | 0.18 | 2N2274 | 0.24 | 2N2275 | 0.24 | 2N4084 | 0.40 |
| AF139 | 0.46 | AF140 | 0.46 | AF141 | 0.46 | BD233 | 1.50 | BD234 | 1.50 | BD235 | 1.50 | MPF154 | 0.50 | MPF155 | 0.50 | OC66 | 0.83 | TIP259 | 0.37 | TIP260 | 0.37 | ZTX536 | 0.18 | 2N2276 | 0.24 | 2N2277 | 0.24 | 2N4085 | 0.40 |
| AF139 | 0.46 | AF140 | 0.46 | AF141 | 0.46 | BD236 | 1.50 | BD237 | 1.50 | BD238 | 1.50 | MPF156 | 0.50 | MPF157 | 0.50 | OC67 | 0.83 | TIP261 | 0.37 | TIP262 | 0.37 | ZTX537 | 0.18 | 2N2278 | 0.24 | 2N2279 | 0.24 | 2N4086 | 0.40 |
| AF139 | 0.46 | AF140 | 0.46 | AF141 | 0.46 | BD239 | 1.50 | BD240 | 1.50 | BD241 | 1.50 | MPF158 | 0.50 | MPF159 | 0.50 | OC68 | 0.83 | TIP263 | 0.37 | TIP264 | 0.37 | ZTX538 | 0.18 | 2N2280 | 0.24 | 2N2281 | 0.24 | 2N4087 | 0.40 |
| AF139 | 0.46 | AF140 | 0.46 | AF141 | 0.46 | BD242 | 1.50 | BD243 | 1.50 | BD244 | 1.50 | MPF160 | 0.50 | MPF161 | 0.50 | OC69 | 0.83 | TIP265 | 0.37 | TIP266 | 0.37 | ZTX539 | 0.18 | 2N2282 | 0.24 | 2N2283 | 0.24 | 2N4088 | 0.40 |
| AF139 | 0.46 | AF140 | 0.46 | AF141 | 0.46 | BD245 | 1.50 | BD246 | 1.50 | BD247 | 1.50 | MPF162 | 0.50 | MPF163 | 0.50 | OC70 | 0.83 | TIP267 | 0.37 | TIP268 | 0.37 | ZTX540 | 0.18 | 2N2284 | 0.24 | 2N2285 | 0.24 | 2N4089 | 0.40 |
| AF139 | 0.46 | AF140 | 0.46 | AF141 | 0.46 | BD248 | 1.50 | BD249 | 1.50 | BD250 | 1.50 | MPF164 | 0.50 | MPF165 | 0.50 | OC71 | 0.83 | TIP269 | 0.37 | TIP270 | 0.37 | ZTX541 | 0.18 | 2N2286 | 0.24 | 2N2287 | 0.24 | 2N4090 | 0.40 |
| AF139 | 0.46 | AF140 | 0.46 | AF141 | 0.46 | BD251 | 1.50 | BD252 | 1.50 | BD253 | 1.50 | MPF166 | 0.50 | MPF167 | 0.50 | OC72 | 0.83 | TIP271 | 0.37 | TIP272 | 0.37 | ZTX542 | 0.18 | 2N2288 | 0.24 | 2N2289 | 0.24 | 2N4091 | 0.40 |
| AF139 | 0.46 | AF140 | 0.46 | AF141 | 0.46 | BD254 | 1.50 | BD255 | 1.50 | BD256 | 1.50 | MPF168 | 0.50 | MPF169 | 0.50 | OC73 | 1.15 | TIP273 | 0.37 | TIP274 | | | | | | | | | |



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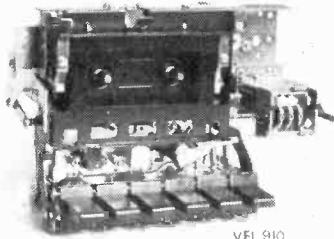
LINSLEY HOOD CASSETTE RECORDER 2



LINSLEY HOOD CASSETTE RECORDER 1



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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

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| H524 Standard Ferrite Erase Head | 1.50 |
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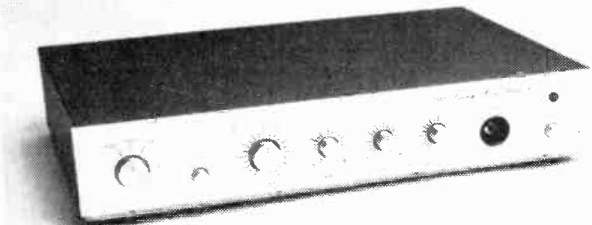
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LINSLEY-HOOD 30 WATT AMPLIFIER



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.

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(For reel-to-reel decks)

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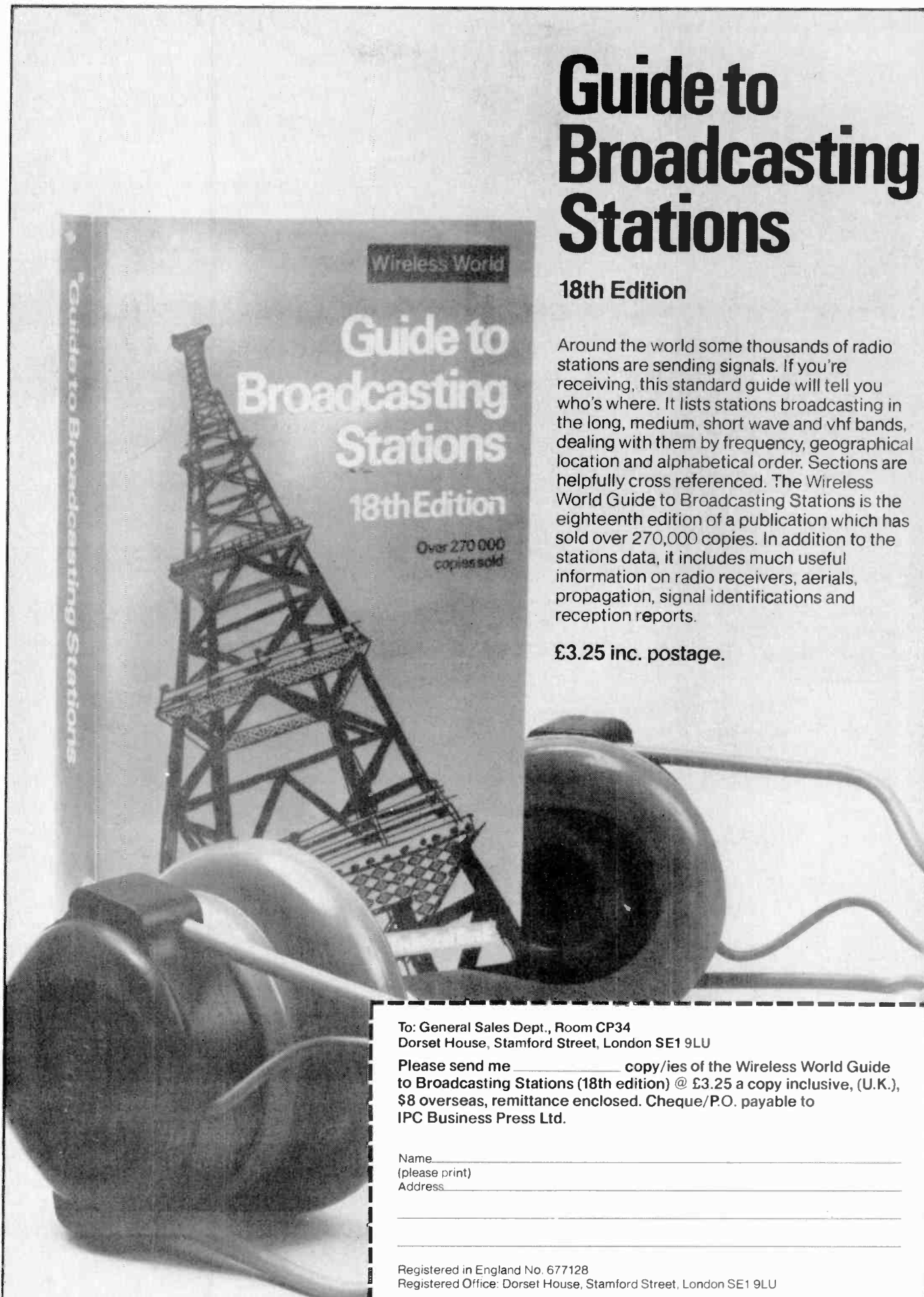
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Manual or automatic play Two speeds Precision ultra slim arm.

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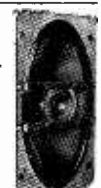
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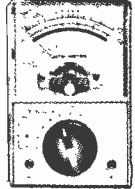
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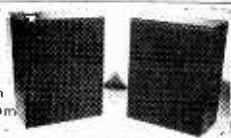
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Values = 5, 7, 10, 20, 50, 100, 200, 250, 470, 2000 ohms

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Table with columns: VALVE TYPE, PRICE. Includes models like 6AM6, 6K8G, 6X8, etc.

RADIO COMPONENT SPECIALISTS

Radio Books and Components Lists 20p. (Minimum post/packing charge 50p.) Access or Barclaycard Visa. Please Tel: 01-684 1665 for same day despatch. Cash prices include VAT.

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8K ON BOARD MEMORY!

5K RAM, 3K ROM or 4K RAM, 4K ROM (link selectable). Kit supplied with 3K RAM, 3K ROM. System expandable for up to 32K memory.

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56 Key alphanumeric keyboard for entering high level language plus 16 key Hex pad for easy entry of machine code.

GRAPHICS!

64 character graphics option — includes transistor symbols! Only £18.20 extra!

MEMORY MAPPED

High resolution VDU circuitry using discrete TTL for extra flexibility. Has its own 2K memory to give 32 lines for 64 characters.

KANSAS CITY

Low error rate tape interface.

2 MICROPROCESSORS

Z80 the powerful CPU with 158 instruction including all 78 of the 8080, controls the MM57109 number cruncher. Functions include +, -, *, /, squares, roots, logs exponentials, log functions, inverses, etc. Range 10⁻⁹⁹ to 9 × 19⁻⁹⁹ ro 8 figures plus 2 exponent digits.

EFFICIENT OPERATION

Why waste valuable memory on sub routines for numeric processing? The number cruncher handles everything internally!

RESIDENT BASIC

With extended mathematical capability. Only 2K memory used but more powerful than most 8K Basics!

1K MONITOR

Resident in EPROM.

SINGLE BOARD DESIGN

Even keyboards and power supply circuitry on the superb quality double-sided plated through-hole PCB.



PSI COMP 80

Z80 Based powerful scientific computer.

Design as published in

WIRELESS WORLD

COMPLETE KIT

NOW ONLY

£225 + VAT!

Cabinet size 19.0" x 15.7" x 3.3"

Television not included in price

The kit for this outstandingly practical design by John Adams published in a series of articles in Wireless World really is complete!

Included in the PSI COMP 80 scientific computer kit is a professionally finished cabinet, fibre-glass double sided, plated-through-hole printed circuit board, 2 keyboards PCB mounted for ease of construction, IC sockets, high reliability metal oxide resistors, power supply using custom designed toroidal transformer, 2K Basic and 1K monitor in EPROMS and, of course, wire, nuts, bolts, etc.

KIT ALSO AVAILABLE AS SEPARATE PACKS

For those customers who wish to spread their purchase or build a personalised system the kit is available as separate packs e.g. PCB (16" x 12.5") £43.20. Pair of keyboards £34.80. Firmware in EPROMS £30.00. Toroidal transformer and power supply components £17.60. Cabinet (very rugged, made from steel, really beautifully finished) £26.50. P.S. Will greatly enhance any other single board computer including OHIO SUPERBOARD for which it can be readily modified. Other packs listed in our FREE CATALOGUE.

PSI COMP 80 Memory Expansion System

Expansion up to 32K all inside the computer's own cabinet!

By carefully thought-out engineering a mother board with buffers and its own power supply (powered by the computer's transformer) enables up to 3 8K RAM or 8K ROM boards to be fitted neatly inside the computer cabinet. Connections to the mother board from the main board expansion socket is made via a ribbon cable.

| | | |
|----------------------------|---|--|
| Mother Board: | Fibre glass double sided plated through hole PCB 8 7/8" x 3 0/8" set of all components including all brackets, fixing parts and ribbon cable with socket to connect to expansion plug | £39.90 |
| 8K Static RAM board | Fibre glass double sided plated through hole PCB 5 6/8" x 4 8/8" Set of components including IC sockets, plug and socket but excluding RAMs | £12.50 £11.20 £4.50 |
| | 2 114L RAM (16 required) | |
| | Complete set of board, components, 16 RAMs | £89.50 |
| 8K ROM board | Fibre glass double sided plated through hole PCB 5 6/8" x 4 8/8" Set of components including IC sockets, plug and socket but excluding ROMs | £12.40 £10.70 £8.00 |
| | 2 708 ROM (8 required) | |
| | Complete set of board, components, 8 ROMs | £78.50 |

OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!

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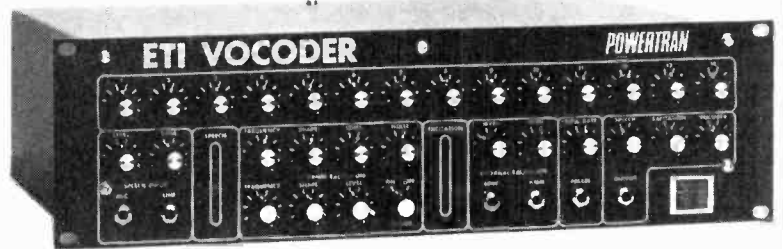
NEW!

ETI VOCODER

COMPLETE KIT

ONLY £195 + VAT

Being published in Electronics Today International



Panel size 19.0" x 5.25". Depth 12.2"

14 CHANNELS!
NOISE GENERATOR!
SLEW RATE CONTROL!

2 OSCILLATORS!
voiced / unvoiced detector!
LED PPM METERS!

Kit includes FREE foot control and test oscillator!

Like all our kits, the ETI VOCODER really is complete — fully finished metalwork, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc. — even a 13A plug!

**MANY MORE KITS
ON PAGES 103, 105**

POWERTRAN

Value Added Tax not included in prices

PRICE STABILITY: Order with confidence! Irrespective of any price changes we will honour all prices in this advertisement until October 31st, 1980, if this month's advertisement is mentioned with your order. Errors and VAT rate change excluded.

EXPORT ORDERS: No VAT. Postage charged at actual cost plus £1 handling and documentation.

U.K. ORDERS: Subject to 15% surcharge for VAT. NO charge is made for carriage. Or current rate if changed.

SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.

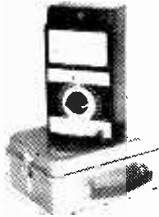
SALES COUNTER: If you prefer to collect your computer from the factory, Call at Sales Counter. Open 9 a.m.-12 noon 1-4.30 p.m. Monday-Thursdays.

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SPECIAL OFFER OF BRAND NEW USSR MADE MULTIMETERS



| TYPE | U4313 | U4315 |
|------------------|------------------------|----------------------|
| Sensitivity D.C. | 20,000 o.p.v | 20,000 o.p.v. |
| Sensitivity A.C. | 2,000 o.p.v. | 2,000 o.p.v. |
| D.C. Current | 60µA-1.5A | 50µA-2.5A |
| A.C. Current | 0.6mA-1.5A | 0.5mA-2.5A |
| D.C. Volts | 75mV-600V | 75mV-1000V |
| A.C. Volts | 15V-600V | 1V-1000V |
| Resistance | 1K-1M | 300Ω-500kΩ |
| Capacity | 0.5µF | 0.5µF |
| Accuracy | 1.5% D.C. 2.5% A.C. | 2.5% D.C. 4% A.C. |

Price complete with pressed steel carrying case and test leads
Packing and postage (U.K.)

£10.50 £1.50
£10.50 £1.50



TYPE U4324

| | |
|--------------|----------------------------------|
| D.C. Current | 0.06-0.6-60-600mA-3A |
| A.C. Current | 0.3-3-30-300mA-3A |
| D.C. Voltage | 0.6-1.2-3-12-30-60-120-600-1200V |
| A.C. Voltage | 3-6-15-60-150-300-600-900V |
| Resistance | 500Ω-5-50-500kΩ |
| Accuracy | D.C. 2.5% A.C. 4% (of F.S.D.) |

PRICE complete with test leads and fibreboard storage case £9.50
Packing and postage (U.K.) £1.20

TYPE U4323 COMBINED WITH SPOT FREQUENCY OSCILLATOR



| | |
|-------------------|---|
| Sensitivity | 20,000Ω/V |
| Voltage ranges | 2.5-1000V A.C./D.C. |
| Current ranges | 0.05-500mA D.C. only |
| Resistance | 5Ω-1MΩ |
| Accuracy | 5% F.S.D. |
| Oscillator output | 1kHz 50/50 squarewave 465KHz sinewave modulated by 1KHz squarewave |

PRICE, in carrying case, complete with leads and manual £8.00
Packing and postage (U.K.) £1.00



TYPE U4341 COMBINED MULTIMETER AND TRANSISTOR TESTER

| | |
|-------------|--|
| Sensitivity | 16,700Ω/V D.C., 3,300Ω/V A.C. |
| Current | 0.06-0.6-6-60-600mA D.C., 0.3-3-30-300mA A.C. |
| Voltage | 0.3-1.5-6-30-60-150-300-900V D.C. 1.5-7.5-30-150-300-750V A.C. |
| Resistance | 2-20-200kΩ-2MΩ |
| Transistors | Collector cut-off current 60µA max D.C. current gain 10.350 in two ranges |

PRICE, complete with steel carrying case, test lead, battery and instruction manual £9.50
Packing and Postage (U.K.) £1.50

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OUR 1980 CATALOGUE/PRICE LIST OF VALVES, SEMICONDUCTORS AND PASSIVE COMPONENTS IS AVAILABLE. PLEASE SEND P.O. for £0.60 FOR YOUR COPY

WW — 039 FOR FURTHER DETAILS

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The Advertising Standards Authority. ✓
If an advertisement is wrong, we're here to put it right.

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MEMOREX mini discs soft sectored — with FREE library case £19.95 per ten.

SALE

We're moving shortly to new premises and don't want to carry much.

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All prices include VAT
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TRANSCENDENT DPX

DIGITALLY CONTROLLED, TOUCH SENSITIVE, POLYPHONIC, MULTI-VOICE SYNTHESIZER

Another superb design by synthesizer expert Tim Orr — published in *Electronics Today International*

The Transcendent DPX is a really versatile new 5 octave keyboard instrument. There are two audio outputs which can be used simultaneously. On the first there is a beautiful harpsichord or reed sound — fully polyphonic, i.e. you can play chords with as many notes as you like. On the second output there is a wide range of different voices, still fully polyphonic. It can be a straightforward piano or a honky tonk piano or even a mixture of the two! Alternatively you can play strings over the whole range of the keyboard or brass over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass at the lower end (the keyboard is electronically split after the first two octaves) or vice versa or even a combination of strings and brass sounds simultaneously. And on all voices you can switch in circuitry to make the keyboard touch sensitive! The harder you press down a key the louder it sounds — just like an acoustic piano. The digitally controlled multiplexed system makes practical touch sensitivity with the complex dynamics law necessary for a high degree of realism. There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrato comes in only after waiting a short time after the note is struck for even more realistic strong sounds.



Cabinet size 36.3" x 15.0" x 5.0" (rear) 3.3" (front)

COMPLETE KIT ONLY £299 +VAT

To add interest to the sounds and make them more natural there is a chorus / ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects. As the system is based on digital circuitry digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer composing, etc., etc.)

Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet. The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc., even a 13A plug!

POWERTRAN

MANY MORE KITS ON PAGE 105. MORE KITS AND ORDERING INFORMATION ON PAGE 101

TRANSCENDENT 2000

SINGLE BOARD SYNTHESIZER

LIVE PERFORMANCE SYNTHESIZER DESIGNED BY CONSULTANT TIM ORR (FORMERLY SYNTHESIZER DESIGNER FOR EMS LIMITED) AND FEATURED AS A CONSTRUCTIONAL ARTICLE IN ELECTRONICS TODAY INTERNATIONAL.

The TRANSCENDENT 2000 is a 3 octave instrument transposable 2 octaves up or down giving an effective 7 octave range. There is portamento, pitch bending, a VCO with shape and pitch modulation, a VCF with both low and high pass outputs and a separate dynamic sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features.

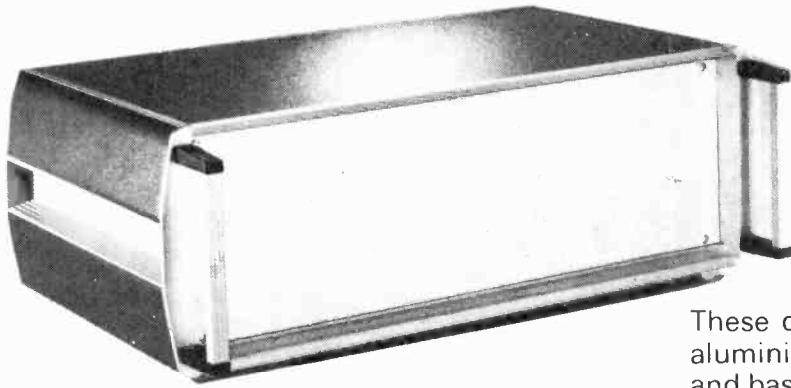
The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or 1/2% metal film) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibreglass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready-built units selling for many times the price.

**COMPLETE KIT
ONLY
£168.50 + VAT!**

Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesizer with nothing more elaborate than a multi-meter and a pair of ears!



Cabinet size 24.6" x 15.7" x 4.8" (rear) 3.4" (front)



NEW

HANDLE PROFILE MAKES LIFTING AND CARRYING EFFORTLESS

The Mod-1 type U series, an addition to the AKA Mod-1 range, is a free-standing instrument case with one very important feature. In each side of the case there is a unique handle profile, making it easy to grip, lift and carry, however heavy the contents.

These distinctive cases are made of anodised aluminium extrusions with attractive blue top and base plates, and side panels. Type U cases are manufactured in three widths, two depths, and heights of 3, 4 and 6U. Front handles, folding feet and a rear panel are provided; the front panels, card guides, edge connectors and other accessories are ordered separately. Send for free catalogue and price list.

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WW — 048 FOR FURTHER DETAILS

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PLUG-IN for TEKTRONIC OSCILLOSCOPE: Type 3B3 Time Base £95. Type 3A6 Dual Trace £95. Carriage extra.

AUTO TRANSFORMER: 230/115v 50 c/s 1000 watts. Mounted in strong steel case 5" x 6 1/2" x 7". Bitumen impregnated. £17.25 + carriage.

TRANSISTORISED 3cm RADAR AMPLIFIER SWITCH: with 24v waveguide switch, 9 x 4cm ins. with crystal CV.2355 and spark gap VX.1046. £17.25 + £1 post.

INSULATION TEST SET 0 to 10KV, negative earth, with Ionisation Amplifier, 100/230 Volts AC. £48.87 + carr.

BC-221 FREQUENCY METER: 125-20,000kc/s complete with original calibration charts £24.15 + carr.

ROTARY INVERTER TYPE PE-218E: Input 24-28v. DC 80 amps, 4,800rpm. Output 11v. AC 13 amp 400c/s. 1Ph. P.F.9. £23 + carr.

RECTIFIER UNIT: 200-250v AC input. 24v. DC at 26 amps output continuous rating. £40.25 + carr.

MARCONI PLUG-IN TIME BASE UNIT TM6967 E54.

RESONATOR PERFORMANCE CTC 424 8.5 to 9.0 kmc/s 3 cm £80.50 + post £2.

INVERTER 24v. DC input 400 cycles 1pH 6600 r.p.m. 200v. peak. £8.05 + £2 post.

OXYGEN BOTTLE 1800lb w.p. £11.50 + carr.

NOISE SOURCE UNIT with CV.1881 noise source mount. Produces thermal noise 15.5dB 200/250v. AC £80.50.

HS33 HEADSET. Low imp. £5.35 + 75p post.

MUIRHEAD DECADE OSCILLATOR TYPE 890D: £92 + carr. £5.

SIEMENS POWER METER REL3U/84/A1b: 0-12kmHz 1mw 500mw 6 ranges. 0.17dB 50 ohms. £92 + carr.

CV.1596 CATHODE RAY TUBE: (09D.09G). 4" screen, green electrostatic base B12B. HT1200 volts, heater 4 volts £11.50.

RADAR RECEIVING ANTENNA TYPE X443 Mk.D: Suitable for detecting signals on X, K, J and Q bands. 9g Hz-60g Hz. Complete with waveguide horns, associated crystals. Transistorised amplifier and geared motor, etc. £143.75.

VACUUM & PRESSURE DEAL TEST EQUIPMENT: complete with 2 x 4" gauges indicating 0.20lbs p.s.i. 0-30lbs vacuum. With stand, hand pump, etc. £34.50 + carr.

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Large stocks of unused U.S.A.F. surplus maps, weather charts, etc. including:

ONC-E1 — U.K. in full and part N.W. Europe. Scale 1:1,000,000.
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SIZE 58" x 42". colour. Many others. Please send S.A.E. for list.
Price each 75p (inc. P&P)
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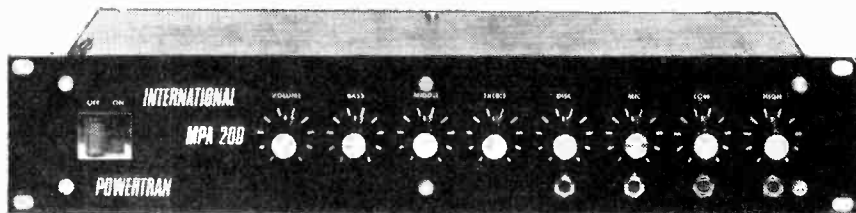
Cables: Radio Shack, London, NW6. Telex: 23718

WW — 029 FOR FURTHER DETAILS

MPA 200 100 WATT (rms into 8Ω) MIXER / AMPLIFIER

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.



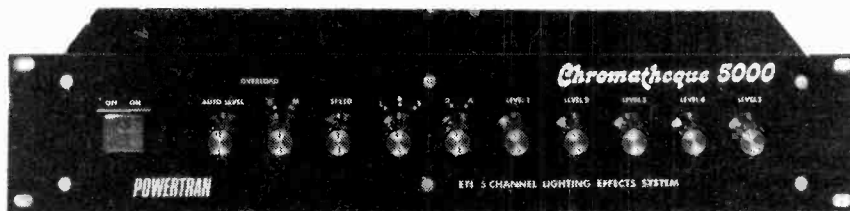
Panel size 19.0" x 3.5". Depth 7.3"

COMPLETE KIT ONLY
£49.90 + VAT!
MATCHES THE CHROMATHEQUE 5000 PERFECTLY!

CHROMATHEQUE 5000 5 CHANNEL LIGHTING EFFECTS SYSTEM

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward.

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



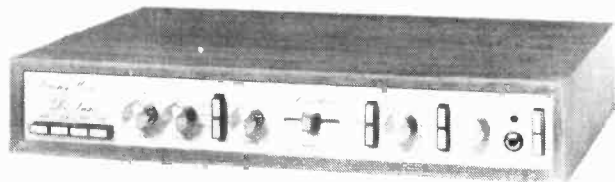
Panel size 19.0" x 3.5". Depth 7.3"

COMPLETE KIT ONLY
£49.50 + VAT!

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

This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in Hi-Fi News and Record Review and features include rumble filter, variable scratch filter, versatile tone controls and tape monitoring while distortion is less than 0.01%.



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!

Above 2 kits are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet, cable, nuts, bolts, etc. and full instructions — in fact everything!

BLACK HOLE

MUSIC EFFECTS DEVICE — AS FEATURED IN ELECTRONICS TODAY INTERNATIONAL!

The BLACK HOLE designed by Tim Orr, is a powerful new musical effects device for processing both natural and electronic instruments, offering genuine VIBRATO (pitch modulation) and a CHORUS mode which gives a "spacey" feel to the sound achieved by delaying the input signal and mixing it back with the original. Notches (HOLES) introduced in the frequency response, move up and down as the time delay is modulated by the chorus sweep generator. An optional double chorus mode allows exciting antiphase effects to be added. The device is floor standing with foot switch controls, LED effect selection indicators, has variable sensitivity, has high signal / noise ratio obtained by an audio compander and is mains powered — no batteries to change! Like all our kits everything is provided including a highly superior, rugged steel, beautifully finished enclosure

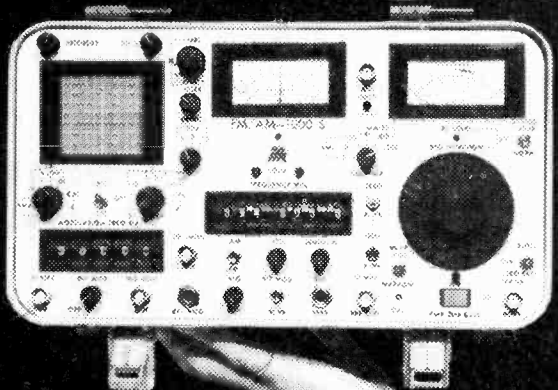
COMPLETE KIT ONLY £49.80 + VAT (single delay line system)

De Luxe version (dual delay line system) also available for **£59.80 + VAT**

Cabinet size 10.0" x 8.5" x 2.5" (rear) 1.8" (front)



Testing... Testing... Testing...



The New SUPER-S has RF power output, to 0 dBm, 2-tone generator, a phase locked BFO and is now reduced in price.

anywhere!

The New FM/AM 1000s with Spectrum Analyser—we call it the **SUPER-S**

A portable communications service monitor from IFR, light enough to carry anywhere and good enough for most two-way radio system tests. The FM/AM 1000s can do the work of a spectrum analyser, oscilloscope, tone generator, deviation meter, modulation meter, signal generator, wattmeter, voltmeter, frequency error meter—and up to five service engineers who could be doing something else!

For further information contact Mike Taylor



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FLDTEC G

IFR precision simulators

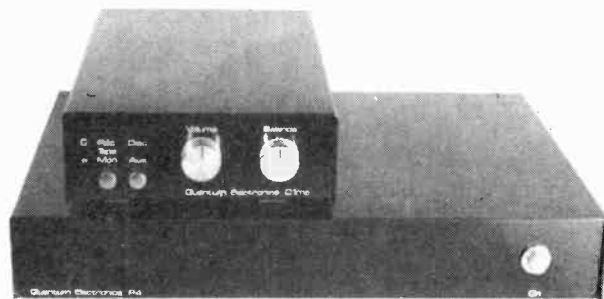
WW—027 FOR FURTHER DETAILS

Quantum Electronics

NEW PRODUCTS — NEW PRODUCTS

Our product range for the 80s is outlined but it is impossible to cover everything in such a small space. For detailed information and a price list send a large SAE or a dollar bill.

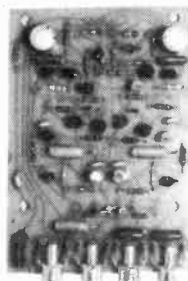
PRE-AMP & POWER AMP KITS



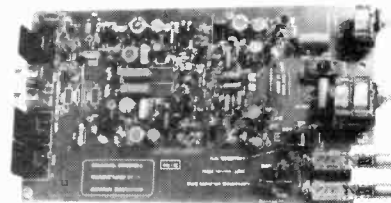
The pre-amp is now available in kit form in versions to suit any cartridge and consists of the Module C2 (below) and the hardware kit HK1. No soldering is involved and assembly takes about 20 mins. There are six power amp kits, four mono and two stereo, from 45 to 260W to satisfy virtually every requirement. They use ready-built and tested p.c. boards to achieve an ease of construction similar to module based kits at lower cost. There are also mains supply kits to enable independent use of the pre-amp, which is normally powered via our power amp. Similar equipment is also available ready-built from us or via our dealers.

C2 + HK1 £70.95 P2 (stereo 45W per channel) kit £87.28
P4 (stereo 110W per channel) kit £109.42

MOVING-COIL & PRE-AMP MODULES



MC1

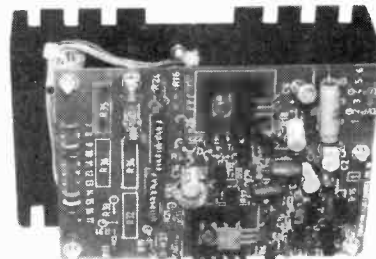


C2 (C2mc)

Previously restricted to trade and export, the C2 pre-amp module is now available separately in 3 versions to match any cartridge. It has unbeatable specifications, caters for disc, auxiliary and 2 or 3 head tape machines and requires only a rough supply of ± 18 to 35V d.c. The new moving coil pre-pre-amp achieves low thd, high overload, good r.f. rejection and good noise performance without resorting to the expensive multiple transistor design. Only tantalum capacitors and metal oxide resistors are used in the signal path and it can be powered either via the C2 or by a battery. Hardware kits are available to build both types and they are also available ready-built.

MC1 Module: £22.25

C2mc £51.75



POWER AMP MODULES AND SUPPLIES

The power amp modules are now also available to retail customers in a variety of powers and formats up to 260W r.m.s. They use the same high performance circuitry as the kits above, giving t.h.d. below 0.1% at 1kHz, but are capable of sustained high level use with excellent reliability. There are power supplies for use with any one or two of these modules, all of which use toroidal transformers, also available separately. The module illustrated is a medium duty 150W r.m.s. type, the M1508, which requires the MS3 supply.

M1508: £35.79

MS3 £26.28

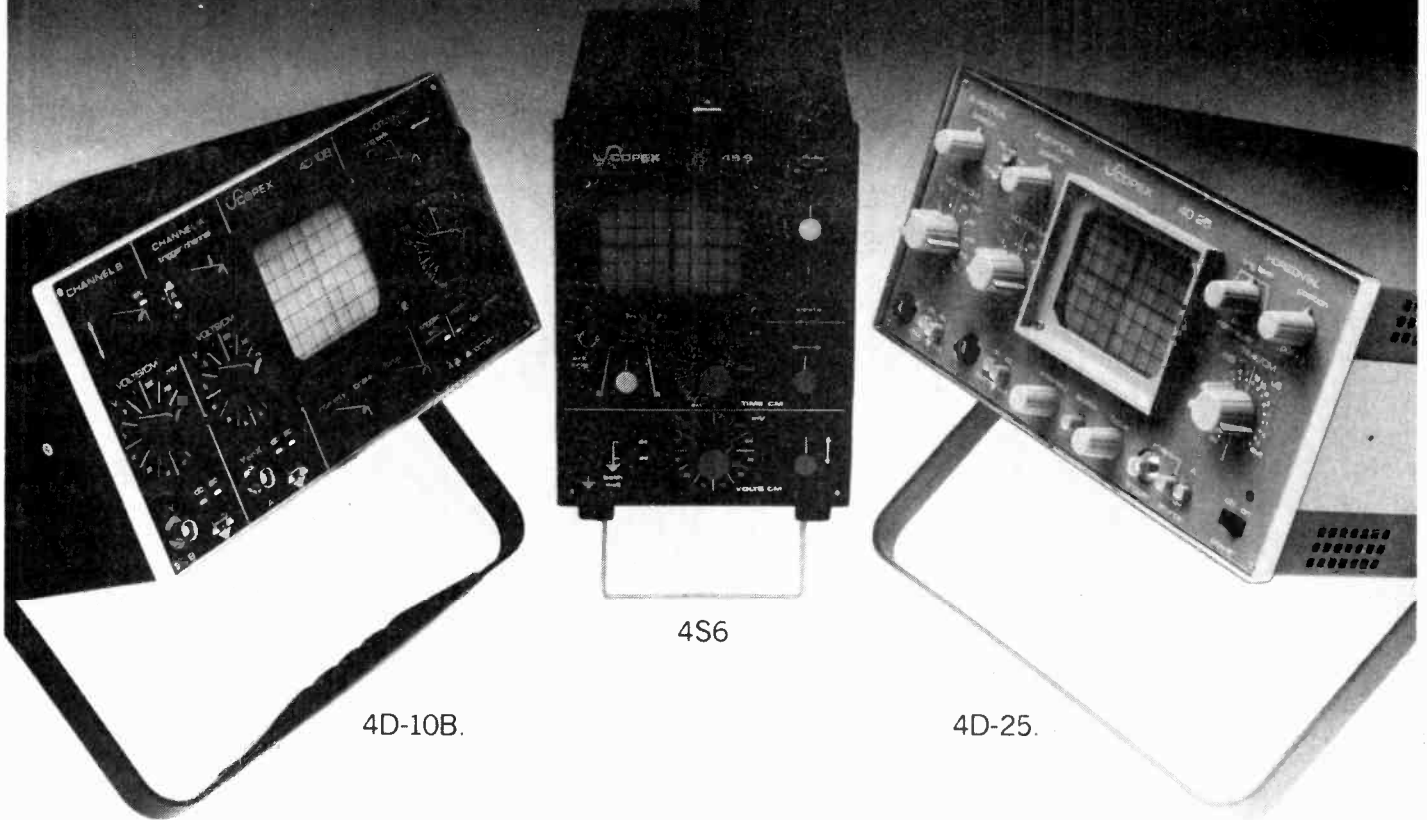
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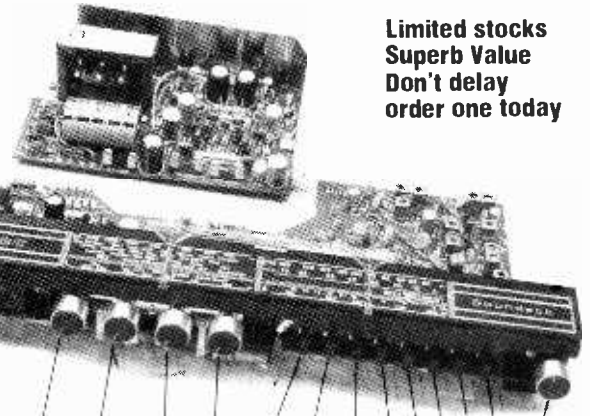
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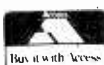
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| EF1200 | 1.85 | SC1/600 | 4.50 | 6C6 | 0.55 | 19H5 | 39.55 |
| EH90 | 0.85 | SP61 | 1.80 | 6CL6 | 1.70 | 20D1 | 0.80 |
| EL32 | 1.10 | TT2 | 15.50 | 6CY5 | 1.15 | 20F2 | 0.85 |
| EL34 | 1.80 | U25 | 1.15 | 6D6 | 0.70 | 20E1 | 1.30 |
| | 2.90* | U26 | 1.15 | 6EA8 | 3.20 | 20P1 | 0.85 |
| EL37 | 4.40 | U27 | 1.15 | 6F7 | 2.80 | 20P3 | 0.75 |
| EL38 | 4.60 | U191 | 0.85 | 6F6 | 1.60 | 20P4 | 1.25 |
| EL41 | 1.40 | U281 | 0.70 | 6F6G | 1.10 | 20P5 | 1.35 |
| EL81 | 0.95 | U301 | 0.65 | 6F6G | 1.10 | 25L6GT | 0.95 |
| EL82 | 0.70 | U600 | 11.50 | 6F8G | 0.85 | 25Z4G | 0.75 |
| EL84 | 0.80 | U801 | 0.90 | 6F12 | 1.50 | 30C15 | 0.50 |
| EL86 | 0.95 | UBC41 | 1.20 | 6F14 | 1.15 | 30C17 | 0.50 |
| EL90 | 1.00 | UABC80 | 0.75 | 6F15 | 1.30 | 30C18 | 2.45 |
| EL91 | 4.20 | UAF42 | 1.20 | 6F23 | 1.75 | 30F5 | 1.15 |
| EL95 | 0.80 | UBF80 | 0.70 | 6F24 | 1.75 | 30FL2 | 1.40 |
| EL504 | 1.70 | UBF89 | 0.70 | 6F33 | 10.50 | 30FL12 | 1.25 |
| EL509 | 2.70 | UBL1 | 1.25 | 6GA9 | 0.90 | 30FL14 | 2.15 |
| EL802 | 1.70 | UBL21 | 1.75 | 6G8A | 0.95 | | |
| EL821 | 8.20 | UCB84 | 0.85 | | | | |
| EL822 | 9.50 | UCB85 | 0.70 | | | | |
| EM31 | 1.80 | UCF80 | 1.30 | | | | |
| EM80 | 0.85 | UCH81 | 0.75 | | | | |
| EM81 | 0.85 | UCL82 | 0.95 | | | | |
| EM84 | 0.85 | UF41 | 1.25 | | | | |
| EM87 | 1.15 | UF80 | 0.95 | | | | |
| EY81 | 0.95 | UF85 | 0.95 | | | | |
| EY86/87 | 0.65 | UL41 | 1.50 | | | | |
| EY88 | 0.85 | UL84 | 0.95 | | | | |
| EZ80 | 0.70 | UM80 | 0.90 | | | | |
| EZ81 | 0.70 | UM84 | 0.70 | | | | |
| GY501 | 1.30 | UY85 | 0.85 | | | | |
| GZ32 | 1.05 | VR105/30 | | | | | |
| GZ33 | 4.20 | | 1.25 | | | | |

VALVES AND TRANSISTORS

Prices may vary

TELEUMETER MRA3 DISTANCE MEASURERS
LOW RESISTANCE HEADPHONES TYPE CLB £1.50.
40p postage. VAT 15%.

HIGH VACUUM VARIABLE CAPACITORS - ceramic envelopes - UC 1000A/20/150 - VMMHC 1000 60-1000pF, 20kv-150A RF max = 27MHz
TEST SET FZ2 for testing Transceivers A40 A41 A42 and CPRC26

UNIVERSAL WIRELESS TRAINING SET No 1 Mk 2 YA 8318 to train 32 operators simultaneously on key and phone. Complete installation consists of 3 kits packed in 3 special transit cases

HARNESS "A" & "B" CONTROL UNITS "A" "R" "J1" "J2," Microphones No 5 6 7 connectors frames carrier sets etc
DRUM CABLE continuous connection YC 00433

INTEGRATED CIRCUITS

| | | | | | |
|----------|------|-----------|------|------------|------|
| SN7401N | 0.32 | SN74173N | 0.38 | SN76033N | 1.95 |
| SN5402N | 0.28 | SN7474N | 0.30 | MC6800P | 8.20 |
| SN5410F | 0.32 | SN7485N | 0.95 | MC6800P | 9.50 |
| SN5470F | 0.48 | SN74L85N | 1.10 | MC14511BA1 | 2.95 |
| SN7407N | 0.29 | SN74123N | 0.42 | MM6300-1J | 3.80 |
| SN7408N | 0.18 | DM74123N | 0.38 | MCM6810AP | 3.40 |
| SN7445P | 0.85 | SN15836N | 0.26 | 6340-1J | 3.60 |
| SN74453P | 1.10 | SN760013N | 1.80 | MIC345-5D | 0.28 |
| SN7453N | 0.18 | SN76003N | 1.60 | MIC936-5D | 0.22 |

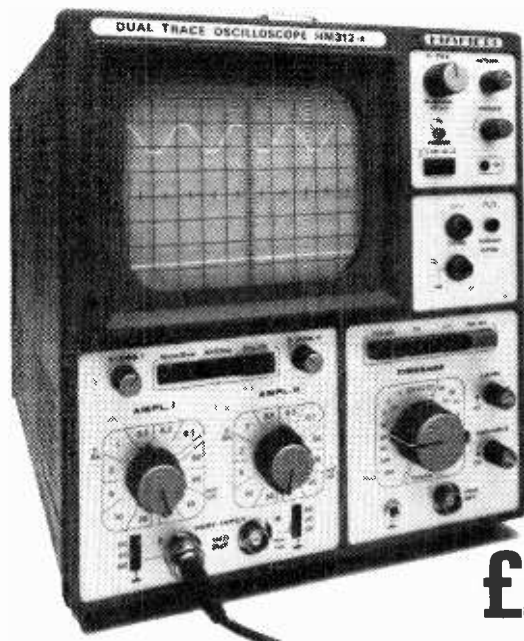
36" AERIAL MASTS consisting of 6 sections 6 x 2 1/4 dia. Complete with all accessories to erect and install

Mullard C11. High power installation, 1000W. Technical details and prices available on request. For export only.

SPARES FOR AR88-D. Ask for list
POSTAGE: £1-£3 30p; £3-£5 40p; £5-£10 45p; £10-£15 60p; over £15 free

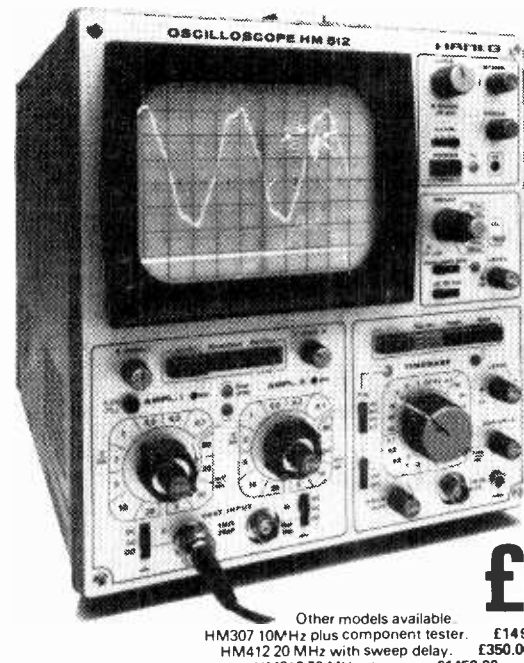
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HM312 Dual Trace Oscilloscope.
DC-20MHz.
Sensitivity 5mV-20V/cm
Time base range 0.5uS-0.2S/cm with x5 horiz mag to 100nS/cm.
CRT screen 8x10cm. Full XY using chll as X input.
Bandwidth 2.3 MHz.
TV trigger.

£250



HM512 Dual Trace Oscilloscope with delayed sweep.
DC-50MHz.
Sensitivity 5mV-20V/cm Time base range 0.1uS-2.0S/cm with x5 horiz mag to 20nS/cm.
Delay ranges 7 decade steps 100ns-1S with fine control CRT screen 8 x 10cm.
Full XY using ch II as x input, bandwidth 4 MHz. Z input. Delay line allows viewing of leading edge.
Vertical overscan indicated by 2 LED's.

£580

Other models available:
HM307 10MHz plus component tester. £149.00
HM412 20 MHz with sweep delay. £350.00
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WW — 075 FOR FURTHER DETAILS

A MATTER OF LIFE OR DEATH

When an accident occurs involving severe electric shock, people on the spot may be suffering from a kind of shock themselves. The realisation that one has literally only seconds to save a life can itself be momentarily paralysing. That's why Electrical Review has completely re-styled its Electrical Shock Chart. The new chart, prepared in consultation with St. John's Ambulance Brigade, highlights the main points

in red, and explains and illustrates the actions to be taken so clearly that they can be grasped instantaneously even in a crisis. It also includes vital instruction on what to do if the casualty does not respond to artificial respiration—with a section on external heart compression.

Action this second could save a life. Post this coupon NOW.

VIVID RED AND BLACK. PLASTIC, CARD OR PAPER.
 SIZE 19 in × 13½ in (474mm × 346mm)

ELECTRIC SHOCK

ACT AT ONCE – DELAY IS FATAL

make sure it is safe to approach

If the casualty is not clear of the source of the shock break the contact by switching off the current, removing the plug, or

wrenching the cable free. If this is not possible, stand on dry insulating material (rubber, wood, brick, thickly folded news-

paper, books) and try to push or pull the casualty clear of the contact using similar insulating material (such as a broomstick) as a lever. Do not touch him with bare hands.

if the casualty is breathing

Place the casualty in the recovery position and call for medical aid.

recovery position →



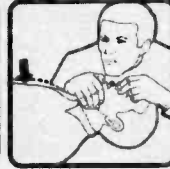
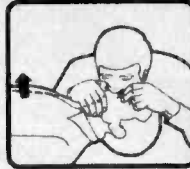
if the casualty is NOT breathing

Call for medical aid while you

perform artificial respiration—speed is essential



3. Take a deep breath. Pinch casualty's nostrils together with your fingers. Seal your lips around his mouth and blow air steadily into his lungs. Watch his chest rise.

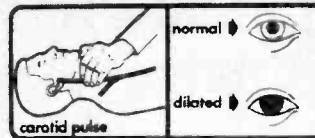


4. Remove mouth and watch chest fall. 5. Repeat and continue inflations at your natural rate of breathing. When casualty starts breathing place him immediately in the recovery position.

if the casualty does not respond to artificial respiration

Take care! Too small a thump will be ineffective but too large a thump could injure the casualty. Assess the casualty—a thin person will require less force than a fat person.

Check again for the carotid pulse. If the pulse is present continue inflations. When the casualty breathes on his own, place him immediately in the recovery position. If the pulse is still absent start external heart compression.



Check the pulse again. If it is present continue with inflations until casualty breathes on his own, then place him immediately in the recovery position. If the pulse is absent repeat the 15 inflations and two inflations until there is a response from the casualty.

doctor:-

phone:-

ambulance:-

phone:-

hospital:-

phone:-

nearest first aid:-

phone:-

on recovery continue to watch casualty carefully as breathing may stop. If it does, turn casualty on his back and start artificial respiration again. Cover casualty with one blanket only.

Prepared in co-operation with St. John Ambulance.

electrical review
 Dorset House, Stamford St., London, SE1 9LU
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Electrical Review Shock First Aid Chart

To General Sales Dept., Room CP34, Dorset House, Stamford Street, London SE1 9LU.
 Please send me the copies of the Electrical Review First Aid Chart indicated below:

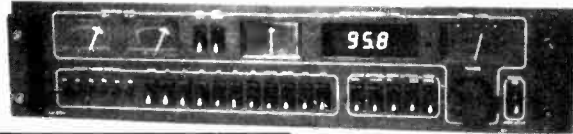
..... paper charts at 60p each
 plastic charts at £1.80 each
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I enclose cheque money order for

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All prices include postage and packing. Cheques should be made payable to IPC Business Press Ltd.

Complete Audio/Tuner Kits



Mk III FM Tuner series

Carriage for Mk III tuner £3 inc

The Mark III series FM tuner has been updated, and now includes a centre zero tuning meter as standard. The instruction manual has been meticulously revised, enabling easy assembly by constructors of various levels of experience - a preview copy may be purchased for £1.00.

- Mark III A series 'Reference series' tuner modules£171.35 inc.
- Mark III B series 'Hyperfi' modules, with switched IF BW, pilot cancel decoder£198.95 inc.

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.

Power Amplifier

Style and performance - with a real 'belt and braces' PSU design.

After a couple of preview comments, it seems that many of you are waiting to hear about the matching HMOSFET power amplifier for the Mk III tuner. Well, it's out at last - complete with twin toroidal PSUs for comfortable 80W RMS per channel, over 100W peak, but limited by thermal shutdown of the HMOS. 10W-100W log LED output peak indicator, DC offset protection and switch-on pause relay. AC or DC input coupling, direct or relay protected output terminals. The works. Only one version of this item: Complete kit £178.25 inc. Carr. £5.

Preamplifier

More features and facilities, thanks to DC switching and control design

Previewing the most comprehensive audio preamplifier yet.... DC switching of 7 inputs, plus two tape in/out. 2 low pass, 2 high pass active filters, genuine volume related loudness, 1dB channel matching, with DC volume, balance, bass and treble controls. Suitable for bus/BM control, tape dubbing, switched monitor etc. 80dB S/N, THD .75dB or better. Pluggable PU equalization boards, tone control override. Price for complete unit about £149 ex VAT.

Semiconductors

Radio/Communications ICs

FOR COMPLETE LISTINGS - SEE OUR NEW PRICELIST

| | | | | | |
|---------|------|---------|------|---------|------|
| CA3089E | 2.11 | HA1197 | 1.61 | SD6000 | 4.31 |
| CA3189E | 2.53 | CA3123E | 1.61 | TDA4420 | 2.59 |
| HA1137W | 1.95 | TDA1072 | 3.09 | MC1330P | 1.38 |
| HA11225 | 2.47 | TBA651 | 2.53 | MC1350P | 1.38 |
| HA12412 | 2.81 | TDA1090 | 3.51 | KB4412 | 2.24 |
| KB4420 | 1.95 | TDA1220 | 1.61 | KB4413 | 2.24 |
| TBA120S | 1.15 | TDA1083 | 2.24 | KB4417 | 2.53 |
| KB4406 | 0.80 | TDA1082 | 2.24 | MC3357P | 3.16 |
| SL1610 | 1.84 | SL1626 | 2.80 | | |
| SL1611 | 1.84 | SL1630 | 1.86 | | |
| SL1612 | 1.84 | SL1640 | 2.17 | | |
| SL1613 | 2.17 | SL1641 | 2.17 | | |
| SL1620 | 2.50 | SL6600 | 4.37 | | |
| SL1623 | 2.80 | SL6640 | 3.16 | | |
| SL1624 | 3.77 | SL6690 | 3.68 | | |
| SL1625 | 2.50 | MC1496 | 1.44 | | |

VARICAP DIODES.....
 A section from our PL:
 BA102 0.35 16:1 ratio AM tuning
 BB204 0.41 KV1215 9v triple 2.93
 BB105 0.41 KV1211 9v dual 2.01
 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 has 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 capabilities. (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 (amplifiable) -£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:

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

Listings in the new pricelist.

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.

CATALOGUES 60p ea., all three for £1.60
 PRICES SHOWN HERE INCLUDE VAT
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Please send an SAE with all enquiries. Phone orders by ACCESS - but minimum £5. Callers welcome



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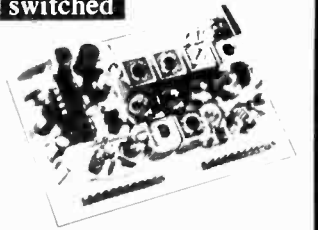
TELEPHONE (STD 0277) 230909 TELEX 995194 AMBIT G POSTCODE CM14 4SG

WWW-072 FOR FURTHER DETAILS

Radio/Audio/Communications Modules

LW-MW-SW-SW DC tuned and switched

- 91072- All switching of bands by a single pin to gnd. Varicap tuned, with LO output for synth. MW/LW version or MW/LW plus 1 or 2 SW bands MW/LW: £15.58 +1SW £16.73



VHF Tunerheads

Europe's largest stock range for broadcast and communications. Probably also the world's - details in the catalogues and PL. Specials are also supplied in the region 30 220MHz.

Pilot Cancel PLL Stereo decoders

Again, Europe's widest range of stereo decoders including pilot cancel PLL types. The pic shows the 944378 - pilot cancel including post decoder 26/38kHz filtering and muting preamp output



944378 2
£26.45

Switched bandwidth FM IF strips

Broadcast FM IF strips for all occasions, including the new 911225 - with diode switched narrow filter option, ultra linear phase ceramic filters, 84dB S/N, and 0.04% THD (40kHz deviation). Plus usual things like AGC, AFC, dev. mute, level meter drive. £23.95 (supplied in screen can with 0.1 edge connection system) Also the 7230 hyperfi series - as the 911225, but with slope controlled AFC that operates in conjunction with signal level - and an extra IF amp stage for DXing.

Various digital frequency displays

The World's largest range of receiver DFM's is now joined by the DFM7 (shown) - and L shaped version of the DFM3 with remote display mount connector possibility - 1kHz SW resolution with 455kHz or 10.7MHz offsets, 100Hz res up to 3.9999MHz, and VHF to 299.99 MHz in 10kHz steps : £41.75



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
- 34.5MHz 1.3dB loss, 80dB stopband HF first filter in synth, RX £36.80
- RC XTALS FM pairs (no spits) £3.74
- AM pairs £3.57
- USB/LSB Xtals for 10.7SSB filter £2.88 ea



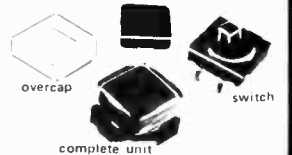
Piezo Sounders

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) The data sheets shows various drive circuits, and give full specifications with regard to broadband responses and power consumption etc. 1 off 44p inc. 100 off 28.75p (25p ex vat)

Keyboard switches and caps

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 K T5 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, K T5 : 16p - or 29p/pair



LCD CLOCKS

Clocks use 1.5v at 15uA only. DVM 9v/1mA

LCD DVM

- CM161: 7mm LCD 12/24hr, alarms etc £11.44 each
- CM172: 13mm, 12hr, alarms, timer etc £14.32 each
- CM174: 13mm, 12hr, min/sec stopwatch £14.32 ea
- DVM 176: ICM7106 based LCD 3½digit £22.36 each



WHAT'S NEW at AMBIT

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Bigger print than our recent one page list - and vastly extended

If you still need convincing to invest £1.60 in the cats, be mean and get this first

POWER MOSFET APPLICATIONS HANDBOOK by HITACHI :

£1.50 each - or free with pairs of HMOS and the PA101B.

Everything you should know about HMOSFET devices theory and applications.

OWO PLEASE. Commercial MA terms on application. Goods are offered subject to availability, prices subject to change - so please phone and check it in doubt.

Parts 1-3 AMBIT catalogues 60p ea, or £1.60 the lot.



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| 8255A | Programmable Peripheral Interface | £9.95 |
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| 8755A | 2Kx8 Eprom 16 1/0 Lines | £34.50 |
| 2716 | 5volt Single Rail 2Kx8 Eprom | £10.25 |
| 2652 | MPC Comm. Controller | £24.00 |
| 4116 | 16K Dynamic 250ns Rams 8 for | £28.50 |
| 2102 1K | Static 650ns Rams 8 for | £5.25 |
| 1702 | 256x8 Eprom | £3.75 |

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COMPUTER BARGAINS

NORTH STAR HORIZON, 56K Ram, dual double sided, double density floppys, 4 I/O ports, software etc, as new **£1850.00**
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SHUGART SA800
8" Floppy Disk Drives
as new **£225.00 + VAT**

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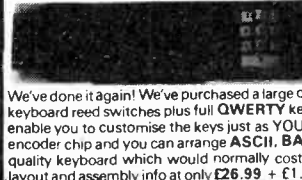


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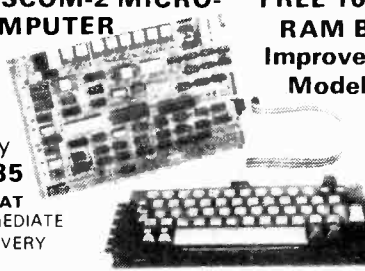
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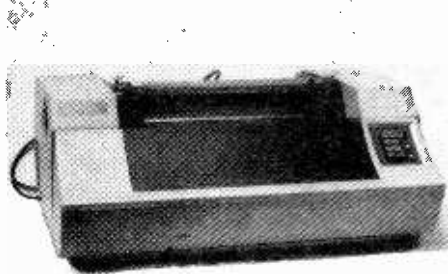
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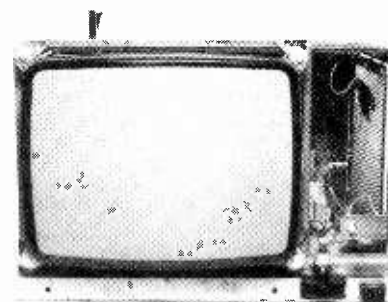
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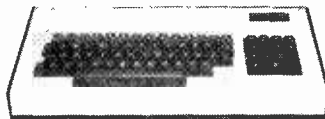
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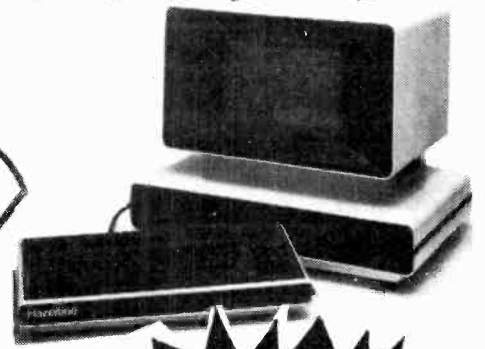
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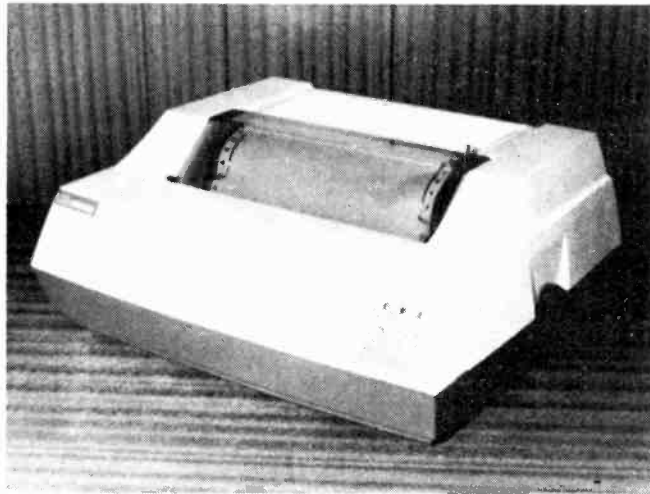
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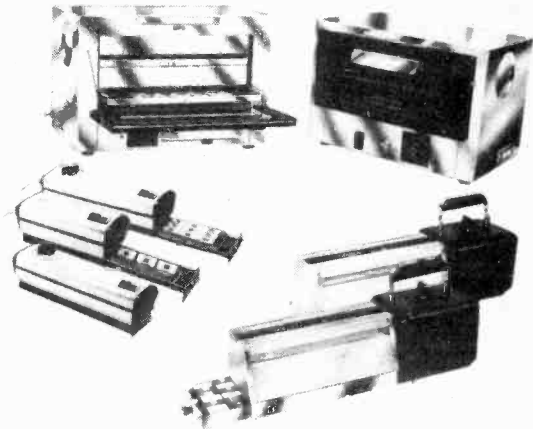
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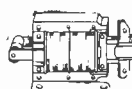
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VARIABLE 0-260V

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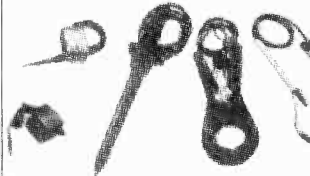
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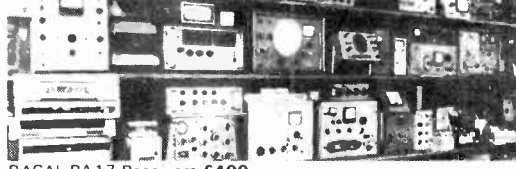
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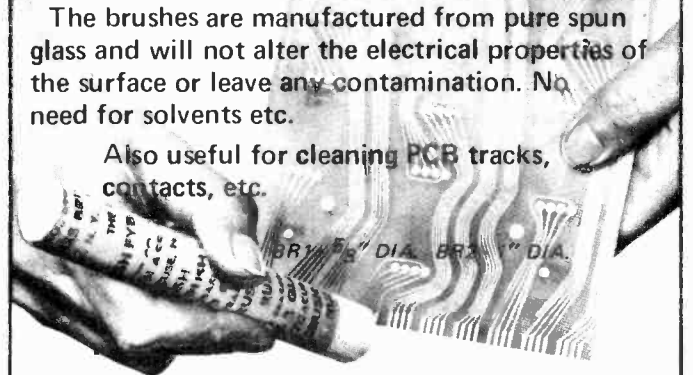
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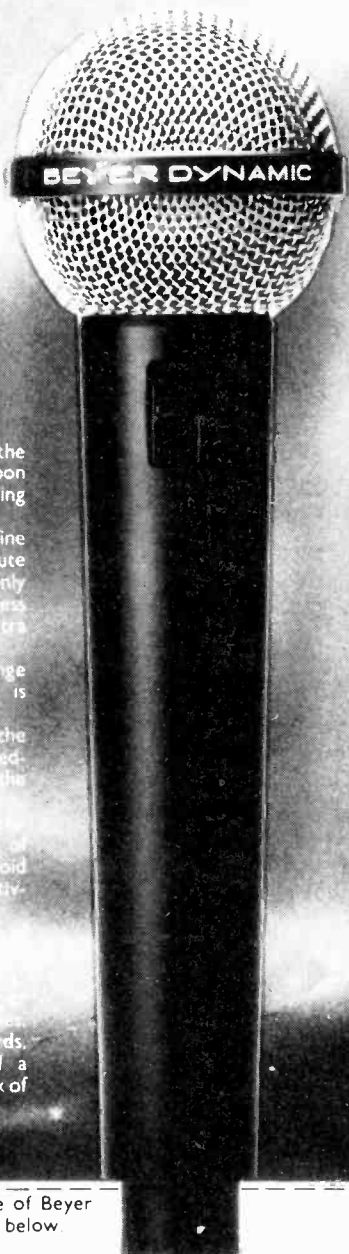
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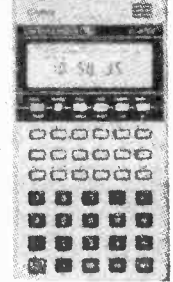
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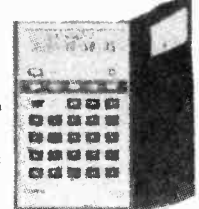
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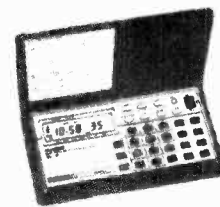


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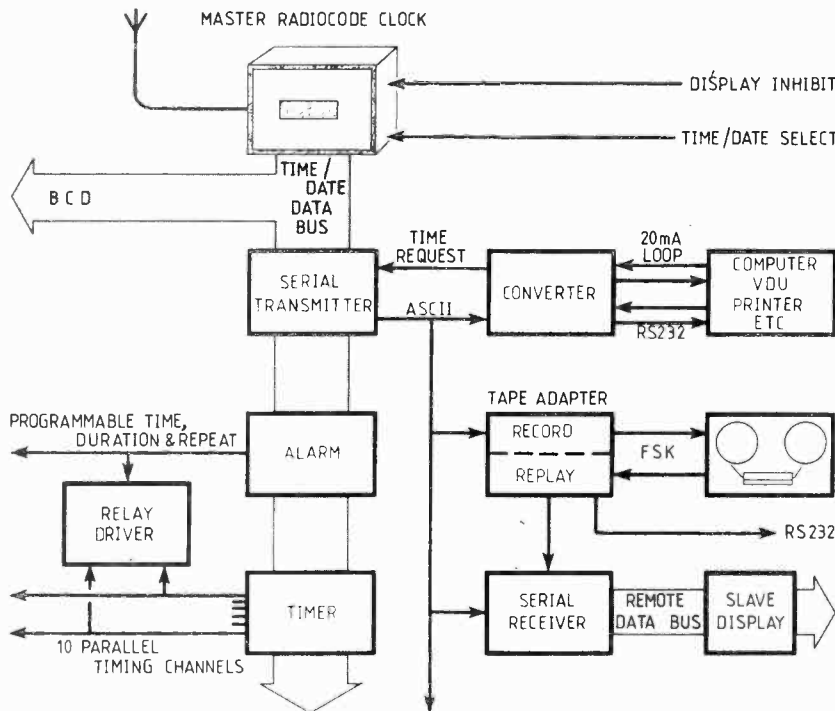
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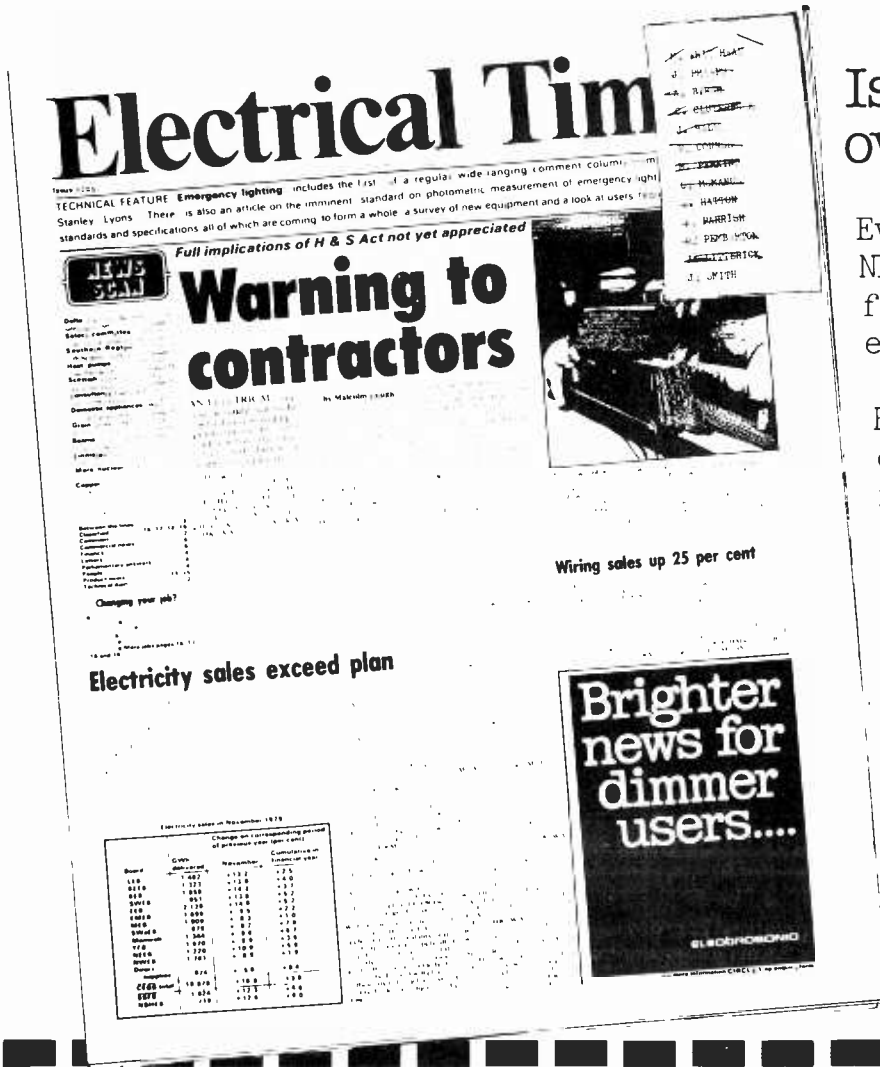
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The company are located in a large 19th century country-house with several acres of grounds which are open at the week-ends for individual and family activities. The area is in pleasant Berkshire countryside but with easy access to the M4. Public transport is also available. An excellent relocation package is offered where necessary, and house prices are reasonable.

Ring Jack Cowdy on 01-603 7335



Information Processing People
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AUDIO VISUAL AIDS TECHNICIANS

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)

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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
Laboratory and specialist equipment

Salary dependent on qualifications and previous experience.

Scales: Technicians Grade II — £5547-£6918
Technicians Grade III — £4605-£5952

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.

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APPOINTMENTS IN ELECTRONICS £5 — £10,000

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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.

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A challenging and full career in
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Minimum qualification — HNC.
Starting salary up to £6,737.

Please apply for an application form to the
Recruitment Officer (Dept. WW 1),
H.M. Government Communications
Centre, Hanslope Park, Milton Keynes
MK19 7BH.

186



Norwich Airport

SENIOR TECHNICAL OFFICER

£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)

ELECTRONIC ENGINEER

A unique opportunity occurs to work for a British Company in the U.S.A.

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.
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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 EFF/ENG Unit recording onto a 1" VPR20.

Included in our plans for expansion is the installation of a 1" editing suite.
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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.



Recruitment Office

Government Communications Headquarters

Oakley, Priors Road, Cheltenham GL52 5AJ

(9483)



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(291)

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£7,000 +

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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:

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(518)

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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.



Electronic Communications Ltd

Ultra Electronic Communications Ltd.,
419 Bridport Road,
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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

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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 £6 1/2 - £8 1/2 K

Computer Equipment manufacturer - leading Micro Boom - is expanding its design team for new Products/Markets/Applications. Using 'State of the Art' techniques

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(514)

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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 of 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 O.N.C. 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 

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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)

 **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 nav aids 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 salaries 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 +**

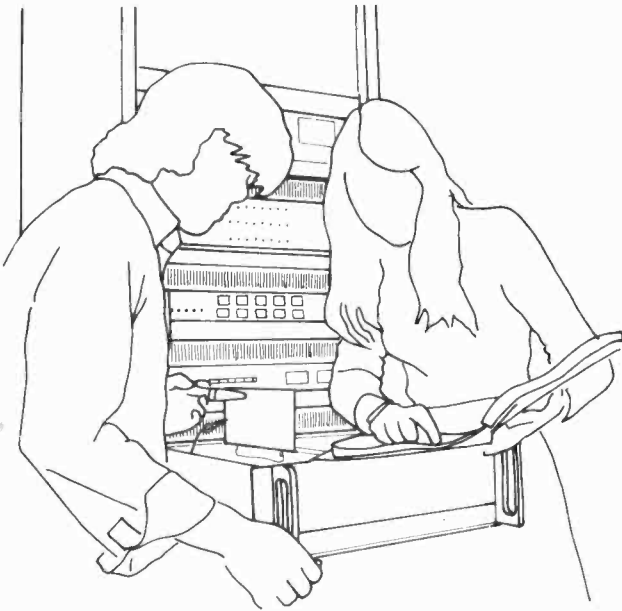
Electronics Engineer with good knowledge of digital electronics wanted for fault finding and repair work on microcomputer systems.

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



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| Present salary | £3,500-£4,500 £4,500-£5,500 over £5,500-£6,500 |
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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 EQUIPMENT LTD
Rose Industrial Estate,
Cores End Road,
Bourne End, Bucks. SL8 5AT
Tel: Bourne End (06285) 29131

(525)

B.Sc. (Hons) in Physics and Physical Electronics

This course is designed to give a broad-based understanding of modern physics and the physical basis of electronics and computing. It is available in full-time (3 year) and sandwich (4 year) options.

Further details from: **The Secretary (Ref. WW5), Physics Department, Polytechnic of North London, Holloway Road, London, N7 8DB. (Tel: 01-607 2789, Ext. 2181).**

The Polytechnic
of North London

(527)

ROYAL FREE HOSPITAL
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DEPT. OF MEDICAL
PHYSICS

MEDICAL PHYSICS TECHNICIANS

for well equipped Electronics Laboratory for maintenance of Radiotherapy machines, Physics equipment, CT scanners, and Ultrasound apparatus. Equipment includes Linear accelerator, two Cobalt units, 300 kV superficial machines. Also development work on computerised Cobalt treatment unit, film badge reader etc.

Post 1 — MPT 1V

Qualifications — ONC, HND or equivalent specialising in electronics.
Salary £4280-£5504 p.a. (1V).

Post 2 — 11 or 111 as above plus 3 yrs. experience. (£5003-£7316).

For details and application form—Personnel Dept. Tel: 01-794 0500, ext. 4286. Quote ref. 1487.

(526)

Unique opportunities for

Technician Engineers

Havant, Hants up to £7,300

We are currently looking for experienced personnel to fill key roles as Technician Engineers within our expanding laboratories and to undertake design, development, test and field trials on avionics and communications equipment from our wide range of electronic products.

The work will be extremely varied, involving the development, evaluation, debugging, design proving and field trials of advanced RF analogue and digital equipment using the most up-to-date techniques, including microprocessors.

Ideally, applicants will be qualified to C&G, HNC or equivalent level, have had several years' experience of radio communications or electronic equipment and be familiar with both analogue and digital circuitry. However, we can currently offer opportunities at all levels and we welcome applicants with alternative experience, who wish to broaden their knowledge.

Salaries offered will be highly attractive and there are excellent prospects for career progression, both within the technician engineer grades and the Company, with potential being recognised and rewarded accordingly.

Generous relocation expenses are available together with a comprehensive range of company benefits. Situated in a semi-rural environment near Portsmouth, Chichester and the South Downs we are also well-placed for housing, educational and recreational amenities.

If you feel you can meet our requirements please write or phone for an application form to Tony Czapp, Technical Resourcing Officer, The Plessey Company Limited, Martin Road, West Leigh, Havant, Hampshire. Tel: (0705) 486391 ext. 433.



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electronic systems

(504)

SENIOR VIDEO ENGINEER (DEVT. & MAINT.)

£6,636-£7,722 plus 1980 award

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Application form and more details from: **Personnel Officer, Brighton Polytechnic, Moulsecoomb, Brighton BN2 4GJ. Tel: Brighton (0273) 693655 Ext. 2536.**

(519)

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Experienced Telecommunications Technician, with ONC or City and Guilds in Telecomms., for the maintenance of an international telecommunications network. Equipment includes electronic teleprinters, VDUs and facsimile equipment. Knowledge of Post Office line plant practice an advantage. NGA pay scale.

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(516)

A RARE OPPORTUNITY IN ELECTRONICS

We are offering the opportunity for someone with a sound background in analogue electronics and some experience in digital techniques to join a very small company with a very good order book.

The right person will be capable of taking a wide technical responsibility in the first instance, but should also have the ambition to become fully involved with the company as a whole, to the extent of eventually managing it.

This is, in fact, one of those comparatively rare chances to get in on the ground floor of something. However, it will undoubtedly need a lot of talent, ambition and sheer hard work to build a success on the foundations that have already been laid.

If you are interested, please telephone or write to **Mrs. Jean Tottem, Personnel, Thor Research Instruments, Henley Road, Berinsfield, Oxford. Telephone Oxford 340601, in the first instance.**

(534)

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to work in the Project Department. The job includes Project discussion with customers, the detail design of systems, test supervision, and the compilation of system handbooks. Experience in the Broadcast Audio industry and a suitable qualification would be an advantage.

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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

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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)

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(554)

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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)

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 0AL for an application form. (508)

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(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)

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TJB ELECTROTECHNICAL PERSONNEL SERVICES,

12 Mount Ephraim, Tunbridge Wells, Kent. TN4 8AS.

Tel: 0892 39388



Please send me a TJB Appointments Registration form:

Name

Address

(9238)

ALCAN LABORATORIES LIMITED ATLANTIC REGION RESEARCH CENTRE



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)

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.

Appointment is for five years from 1 August 1980. Salary range £4884 to £5832 under review. Applications with full personal and professional details as soon as possible, to The Administrator, Department of Geology and Mineralogy, Parks Road, Oxford OX1 3PR. (373)

ELECTRONIC TECHNICIANS Grades 3 and 4 required to assist in the construction, modification and maintenance of electronic equipment for use in teaching and research carried out in the Psychology Dept of UCL, the work is varied and interesting and covers a wide range of analogue and digital techniques. ONC, C & G, or equivalent required. The Grade 3 technician could have an electrical/mechanical background. Salary in range Grade 4 £4,728-£5,325; Grade 3 £4,374-£4,872 inclusive of London Weighting. Application form from Personnel Officer (Technical Staff CK4), University College London, Gower St., London WC1E 6BT. (370)

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£6636-£7722

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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 TV 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)

BROADCAST ENGINEERS / TECHNICIANS M/F. We have a number of vacancies for experienced personnel to maintain these National Broadcasting Stations. These are permanent positions, accommodation and conditions are first class, with excellent salaries (tax free) and regular U.K. leave. Apply SPS Executives, (Ref. 1740), Recruitment Consultants, Delme Court, West Street, Fareham, Hampshire, or better still telephone (0329) 235611/236857. (457)

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Salary parameters are 5k and 10k.

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Applications Engineers experience in IC applications, radar IF's, use of ECL or high speed A-D conversion.

Development Engineers MOS IC design or digital design including CMOS and TTL logic design experience.

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Apply to Shirley Cave, Resourcing Officer, Plessey Semiconductors Limited, Cheney Manor, Swindon SN2 2QW. Swindon (0793) 36251.



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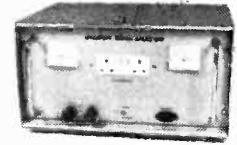
PCB ARTWORK DESIGN SERVICE with component notation masters and assembly drawings. PADS Electrical Ltd. 01-850 6516. 45 Southwood Road. New Eltham SE9. (7905)

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Salary £5003-£6350 inclusive.

For job description and application form please contact Sector Administration, King's College Hospital, Denmark Hill, London SE5 9RS. Tel: 01-274 6222 ext. 2408. Please quote reference no. SA/190.

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(528)

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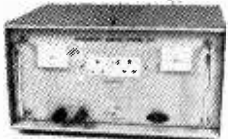


(560)

ESSEX COUNTY COUNCIL, Chelmer Institute of Higher Education. SENIOR TECHNICIAN A (with degree allowance) is required immediately to assist with telecommunications research work. Salary: T3/4 £4,581-£5,784 per annum. The person appointed would ideally have at least an ONC, but an HNC or equivalent experience in Electronics would be an advantage. Interpretation and construction of prototype units using current technology will be a major part of the work. This post offers a real opportunity for career development in the research activities of today's electronic technology and should suit applicants with ambition. Application forms and further details available from the Institute Secretary, Chelmer Institute of Higher Education, Victoria Road South, Chelmsford CM1 1LL, to whom application forms should be returned within 14 days of the date of this advertisement. (Telephone Chelmsford 354491). (548)

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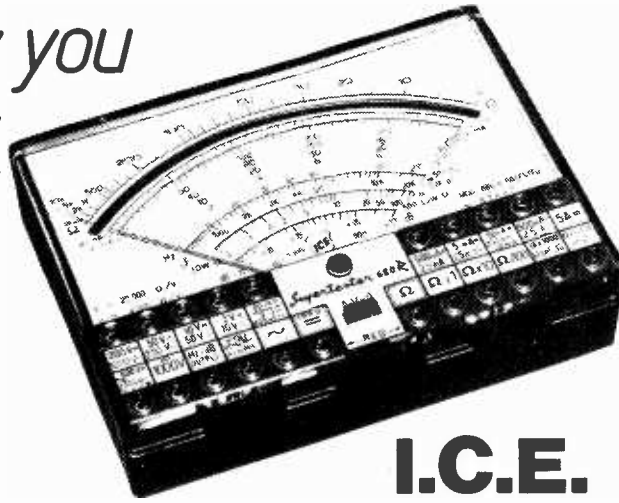
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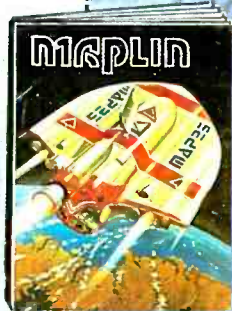
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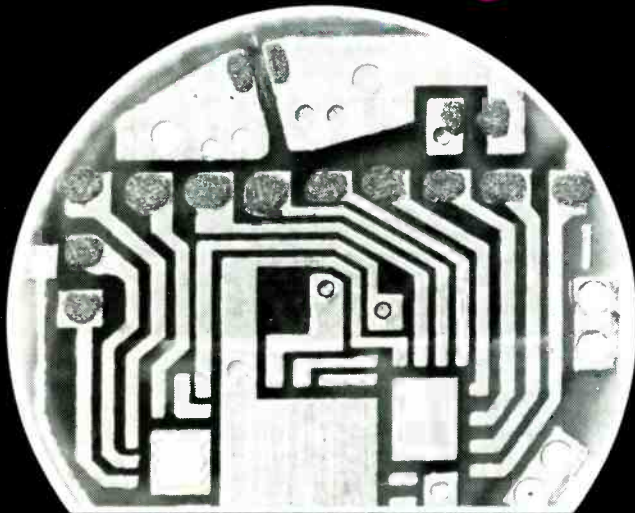
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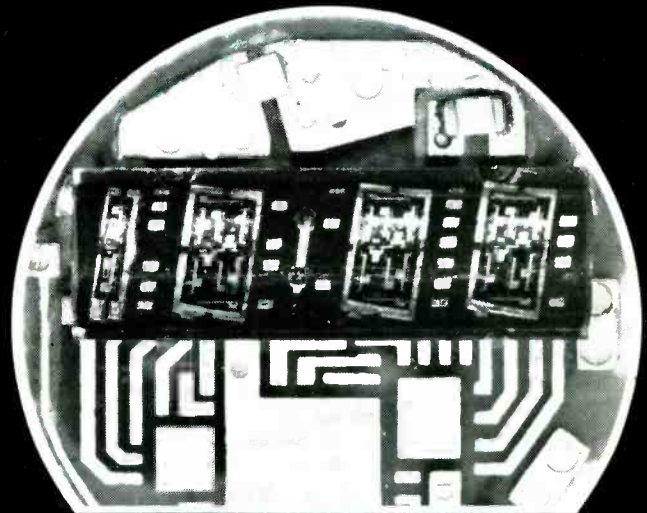
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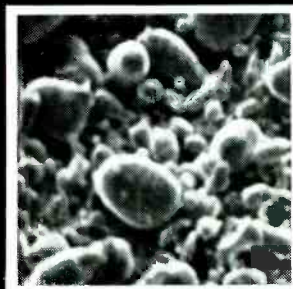
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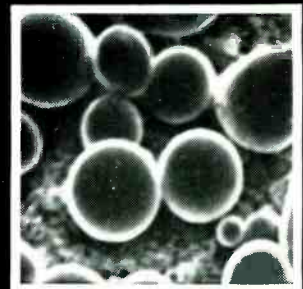
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