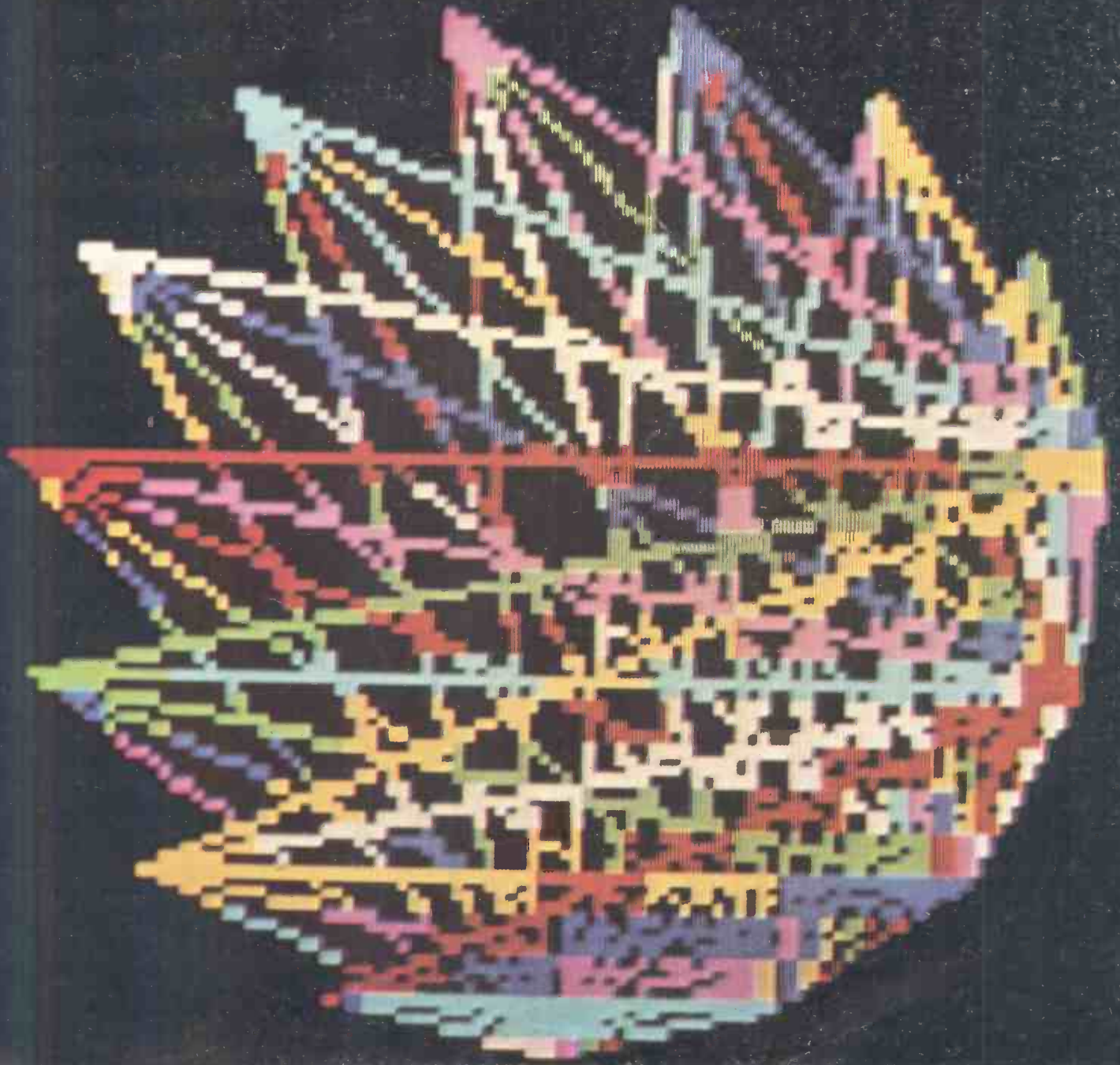


wireless world

SEPTEMBER 1980 50p

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Electronic cryptography

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Front cover shows display taken from the screen of the memory-mapped, colour graphics v.d.u., described by S. J. Marchant in the April 1980 issue. Picture by Bill Banks.

IN OUR NEXT ISSUE

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wireless world

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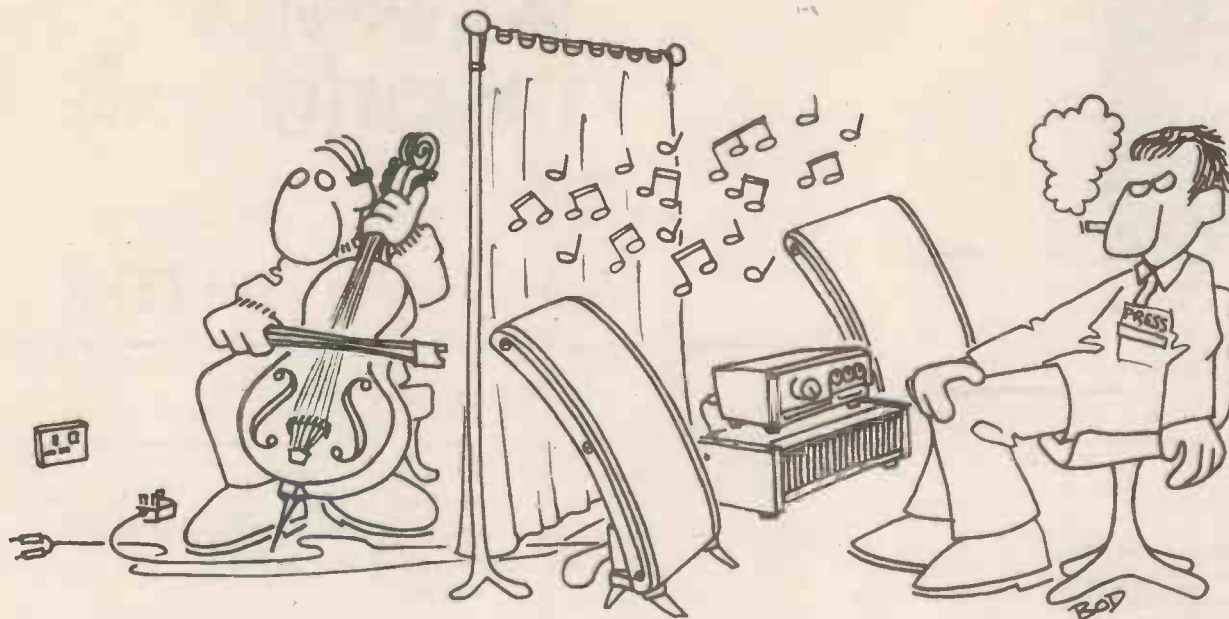
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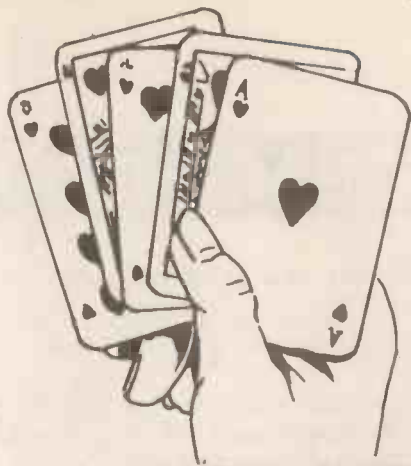
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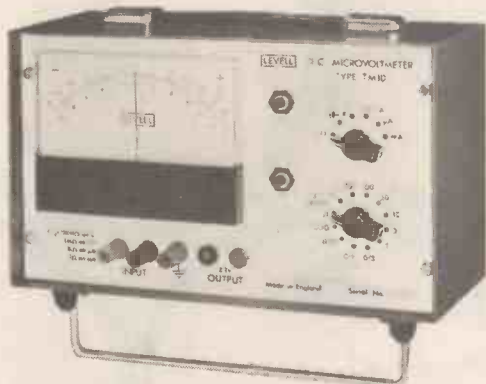
H.F. VOLTAGE & dB RANGES 1mV, 3mV, 10mV ... 3V fsd.
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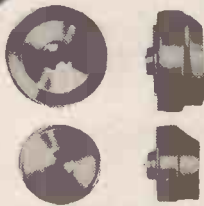
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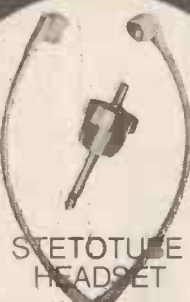
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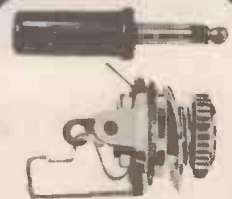
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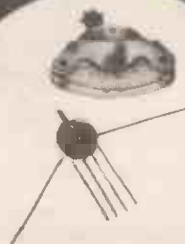
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Some other **PM 2517** plus points:

- LED or LCD display
- True RMS readings of AC voltage and current
- Autoranging with manual override
- Optional accessories include temperature and data hold probes

Reader inquiry number 220

The **PM 3207** - Super Scope - is a tough, general purpose oscilloscope which offers at a low price the quality and technology you expect from Philips Test and Measuring Instruments.

- 15 MHz dual trace
- Auto triggering from either channel with adjustable level between peaks and TV triggering
- 5 mV sensitivity, Y and X (via A input)
- B invert facility

Reader inquiry number 221

Both these instruments are available off the shelf from the **Philips Electronic Instruments Department** (see address below) or from the following distributors. **British Tungram**, West Road, Tottenham, London N17 0RN. Tel: 01-808-4884. **Philips Service Centres** (25 throughout the country). Tel: 01-686-0505 for the address of your nearest branch. **Wessex Electronics Ltd**, 114-116 North Street, Downend, Bristol BS16 5SE. Tel: (0272) 571404.

PATTERN FOR THE FUTURE

The **PM 5519** colour TV pattern generator is already a widely used instrument. As a major manufacturer of Video cassette recorders, and colour television receivers - and the company which has developed the world's most advanced video disc system - Philips have carefully selected the best patterns for aligning and testing these products. With over 20 colour and b/w test patterns to choose from it is the most versatile pattern generator on the market.

- **PM 5519 I** for British system - versions available for other TV systems
- RF signals available in bands I, III, IV and V
- Variable Video Output (with 1 volt fixed position)
- External video and sound modulation facility
- Composite sync output for triggering - includes the line frame and blanking pulses to the local TV standard

Reader inquiry number 222

Some other Philips audio and video service instruments:
PM 5326 RF SIGNAL GENERATOR

- 100 kHz-125 MHz in 9 overlapping ranges

- Built-in 5 digit counter
- 50mV RF output at 75Ω can be attenuated to over 100dB
- Electronically stabilised output level
- Wobbulator facility

Reader inquiry number 223

PM 6307 WOW AND FLUTTER METER

- X-tal controlled oscillator
- High accuracy and frequency stability
 - 3150 Hz or 3000 Hz switchable
 - Separate 'Drift' and 'Flutter' indication

Reader inquiry number 224



TV GENERATORS

All Philips audio and video service instruments are also available from Philips Service Centres (for details see end of PM 3207 section).

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	Inquiry no.
PM 2517 multimeter	220
PM 3207 oscilloscope	221
PM 5519 colour TV pattern generator	222
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PM 6307 wow and flutter meter	224



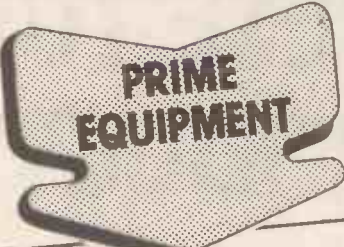
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5303B DC-520 MHz. (Plug-in) 125mV sens. 50Ω	75
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5267A Time Interval Plug-in 10ns	100
5345 DC-500 MHz Time Int. Ave. Burst Total Ratio	120
RACAL 835. DC-15 MHz 6 digits Time interval/Period/Ratio 9024 10 Hz-600 MHz 7 + 1 digits 9835 6 Digit DC-20 MHz 10mV 9837 DC-80 MHz 6 digits	100 250 100 130
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TF2512 DC-500 MHz 0.5-30w 50Ω	130	Power Supplies		ADVANCE	
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415B 0±3100V 30mA 0.005% reg. Protected	350	ITT		Power Lab	90
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132AL. 50V/50Ω 5 Hz-3 MHz RT 12ns	175	HEWLETT PACKARD		214A 100V/50Ω. Double pulse O/P. W50ns-10ms. 10 Hz-1 MHz. 15ns RT	350
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ZR0004 25 dB Potentiometer	52	ZR0005 50 dB Potentiometer	59	ZR0006 75 dB Potentiometer	69
BRYANS SOUTHERN		29000 X-Y Recorder A4 0.25mV-10V/cm	525	BS314 4 channel 1mV-10V 16 speeds	1650
BS316 6 channel 1mV-10V 16 speeds	2350	29300 X-Y Single pen A4 0.25mV-10V/cm 0.1s-50s/cm	545	HEWLETT PACKARD	
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1525 100 kHz-184 MHz Int/Ext AM/FM Batt/Mains	525	GOULD ADVANCE		SG70 5 Hz-125 kHz 600Ω 4w	85
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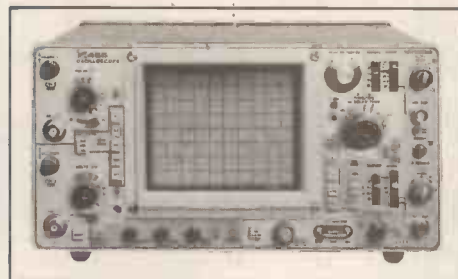
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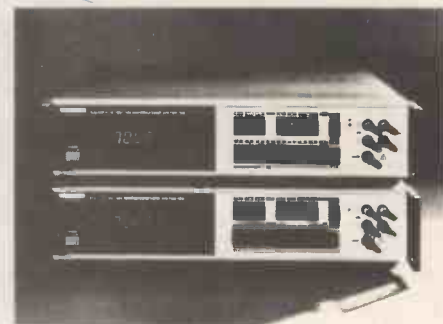
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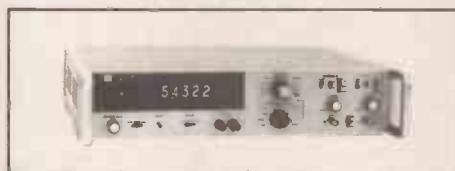


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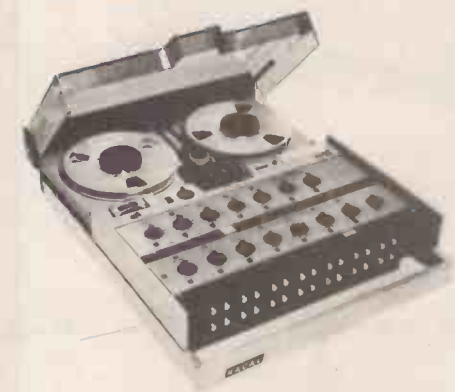
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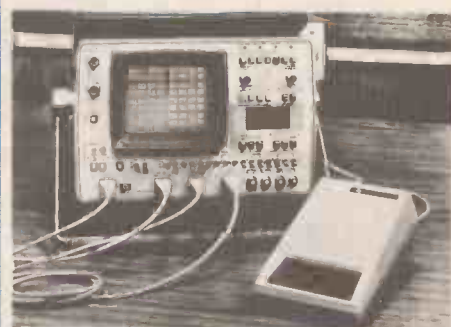
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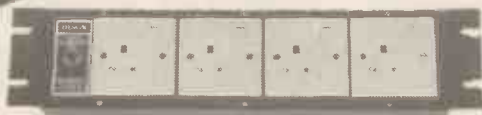


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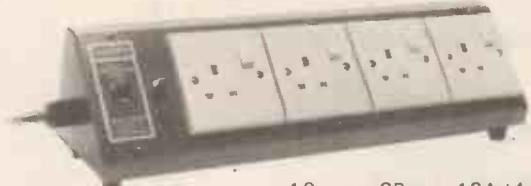
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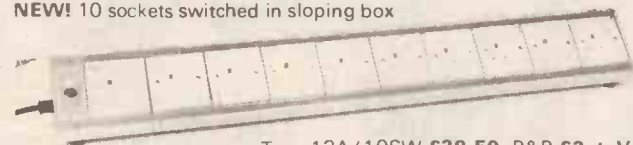
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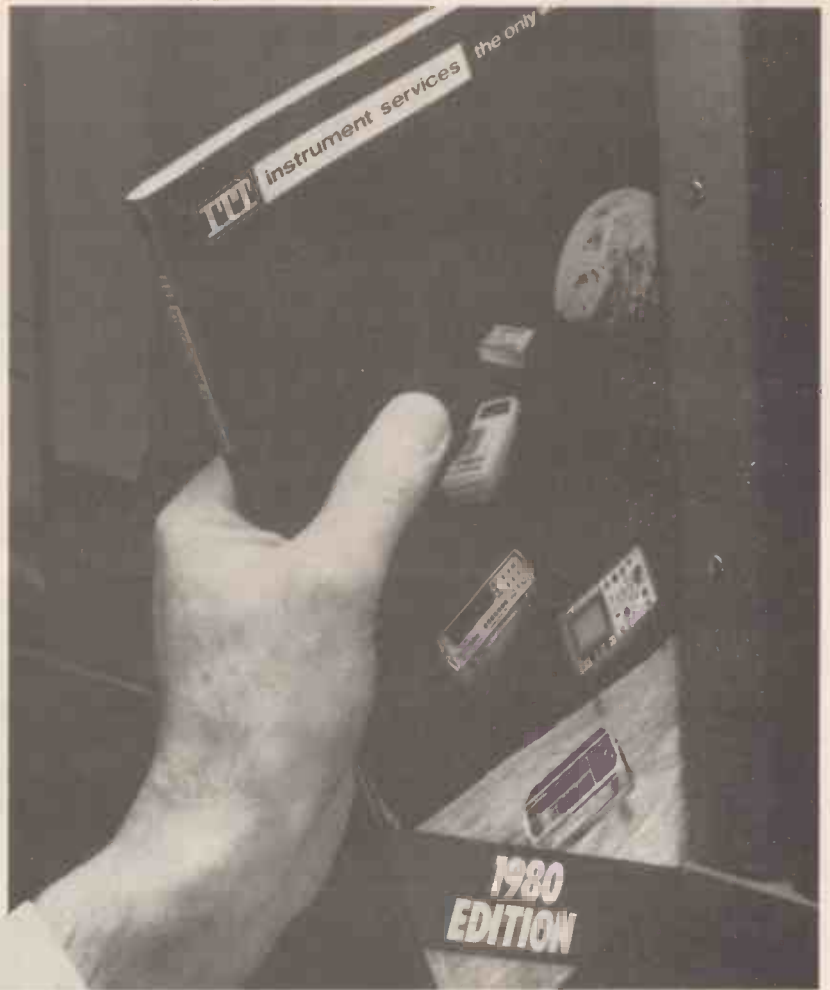
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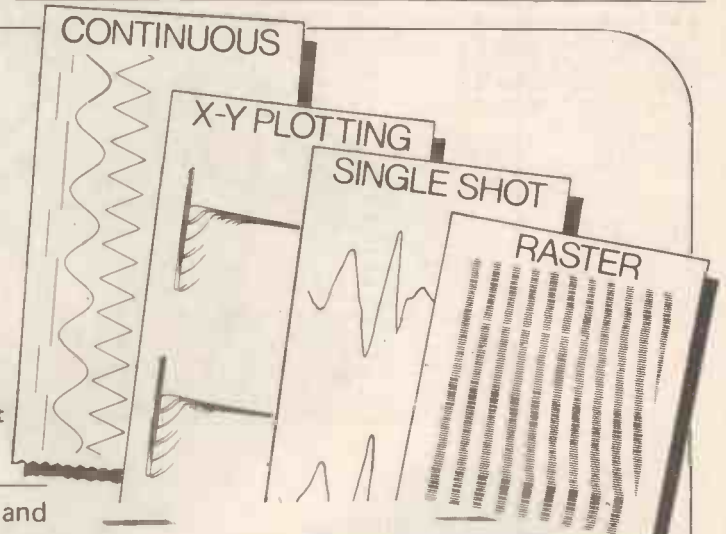
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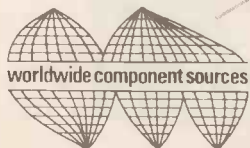
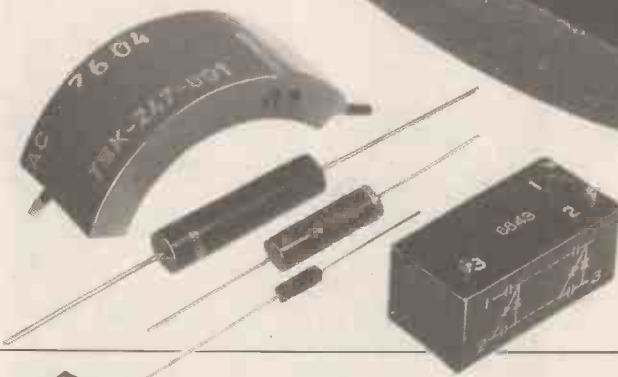
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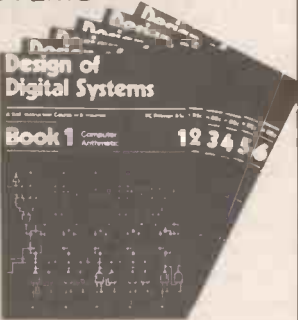
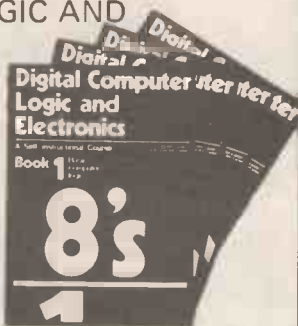
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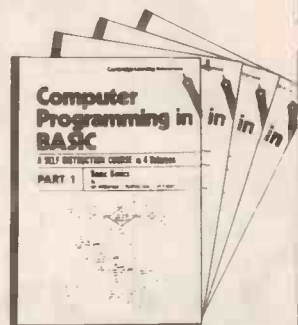
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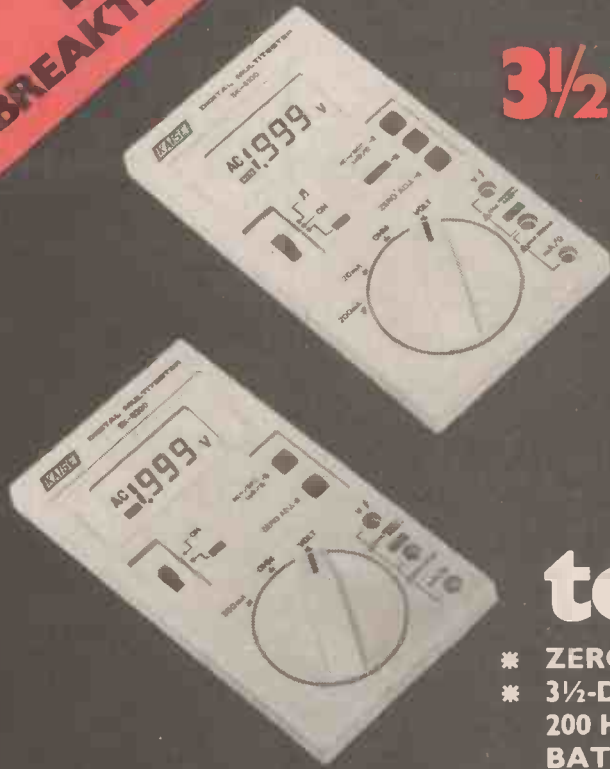
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BUZZER – Continuity Test	✓	✓		
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An ideal arm would have zero effective mass and infinite compliance.

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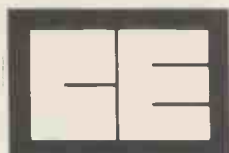
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- ★ 3 Way Active Crossover (single channel) £32.60

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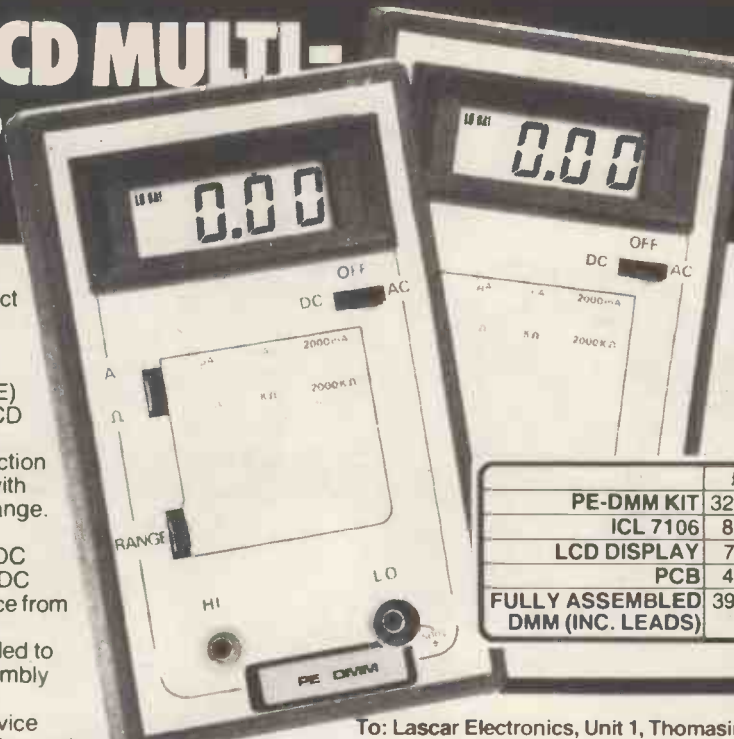
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The Kit contains all parts needed to construct the multimeter plus assembly instructions, battery and test leads.

We also offer a calibration service (£5.00 + VAT) and a trouble-shooting and calibration service (£7.50 + VAT). Various other component parts are also available as listed.

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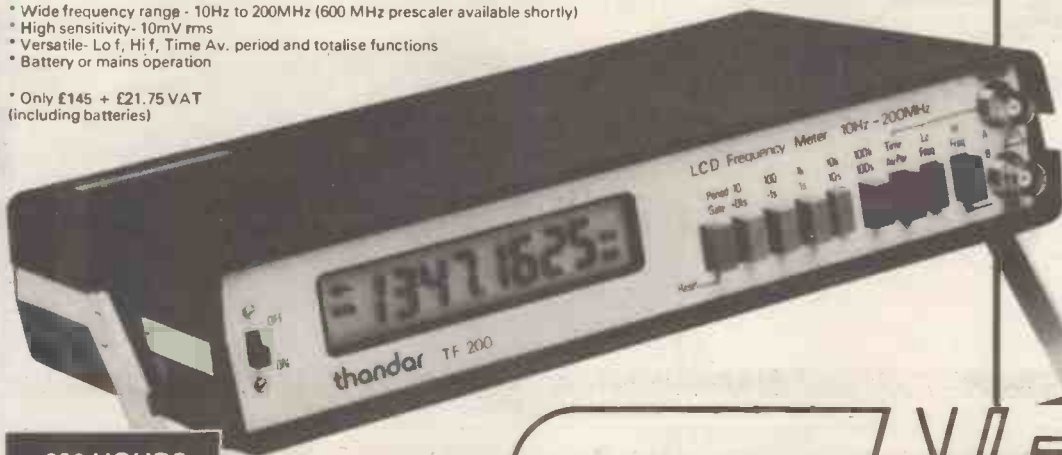
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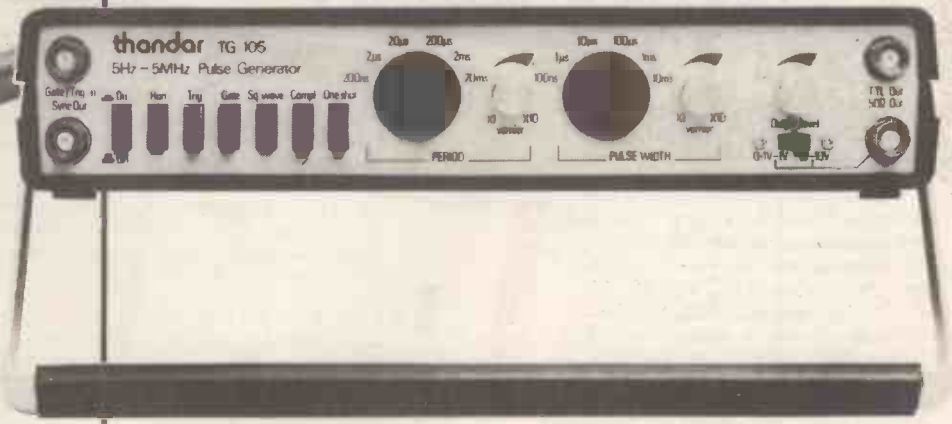
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ZX80 and manual: £69.52
VAT: £10.43
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Please note: many kit makers quote VAT-exclusive prices.

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

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

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

'Excellent value' indeed!

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

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

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

The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. It immediately proves what a good job you've done; connect it to your TV... link it to an appropriate power source*... and you're ready to go.

Your ZX80 kit contains...

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

Optional extras

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

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

The unique and valuable components of the Sinclair ZX80.

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

The unique Sinclair BASIC interpreter offers remarkable programming advantages:

- Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability - takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input-to request a line of text when necessary. Strings do not need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up 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.

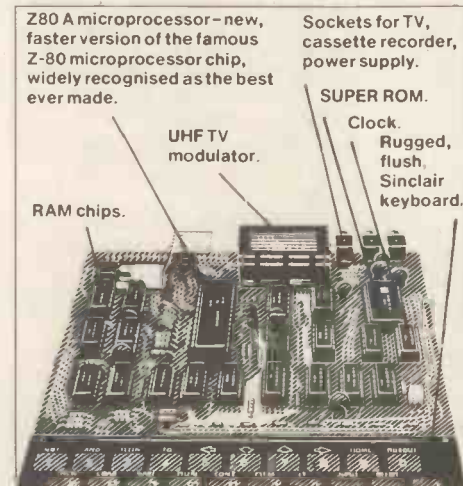


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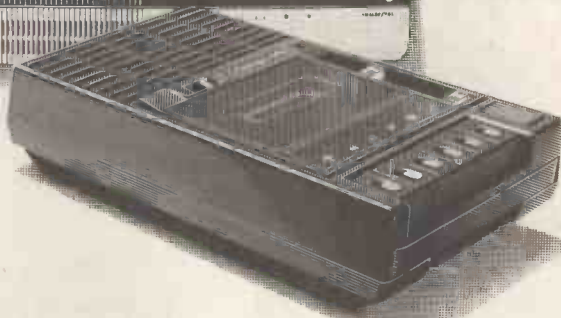
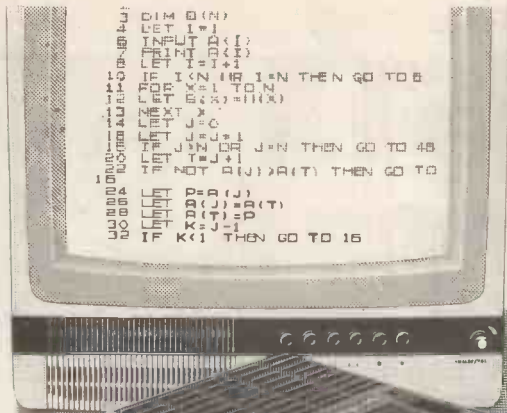
The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly 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 advertisements in Personal Computer World, Electronics Today International, and other journals.

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.

The Sinclair ZX80. Kit: £79.95. Assembled: £99.95. Complete!

The ZX80 kit costs a mere £79.95. Can't wait to have a ZX80 up and running? No problem! It's also available, ready assembled and complete with mains adaptor, for only £99.95.

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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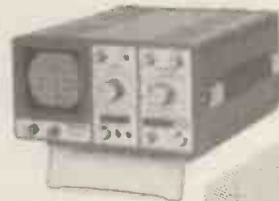
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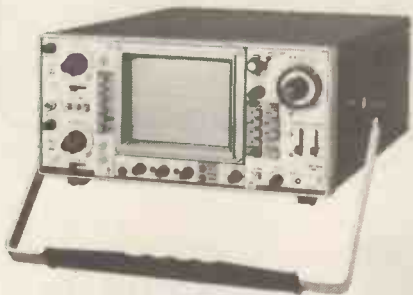
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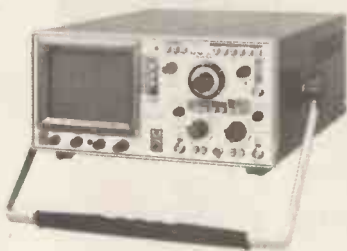


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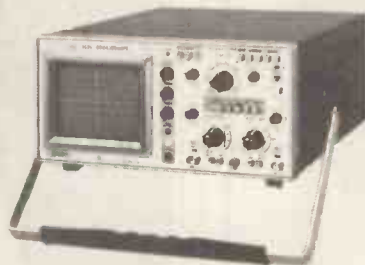
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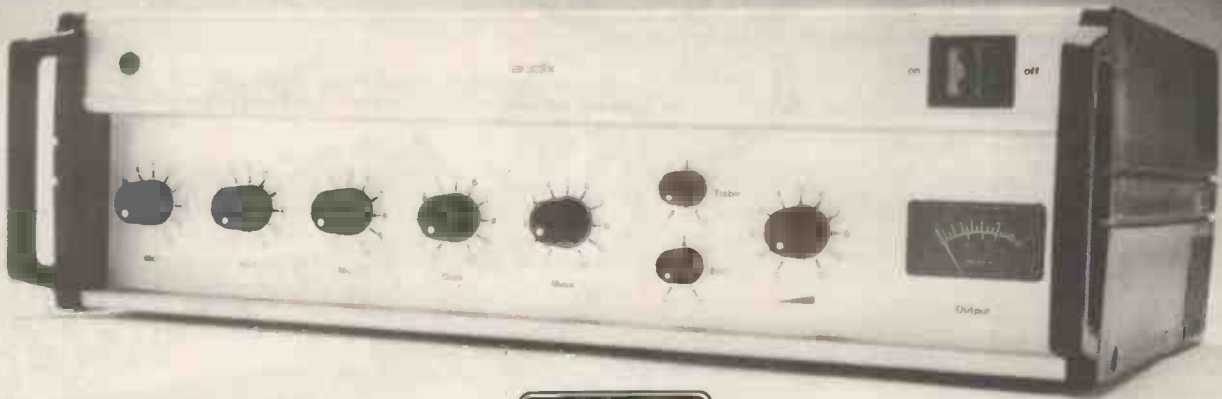
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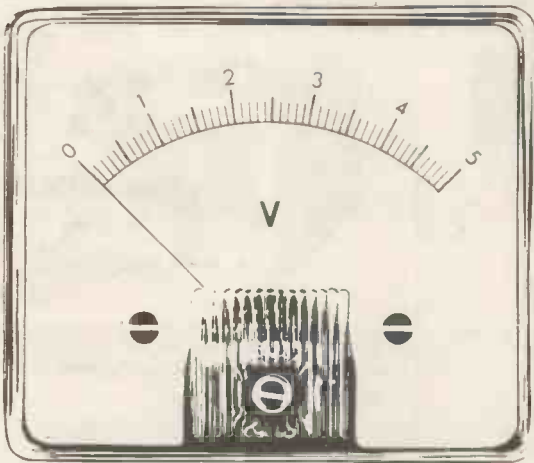


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After a couple of preview comments, it seems that many of you are waiting to hear about the matching HMOSFET power amplifier for the Mk III tuner. Well, it's out at last - complete with twin-toroidal PSUs for comfortable 80W RMS per channel, over 100W 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/outs. 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/remote control, tape dubbing, switched monitor etc. 80dB S/N+, THD $^{-75}$dB or better. Pluggable PU equalization boards, tone control override. Price for complete unit about £149 ex VAT.

Radio/Audio/Communications Modules

LW-MW-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

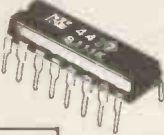


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CA3089E	2.11	HA1197	1.61	SD6000	4.31
CA3189E	2.53	CA3123E	1.61	TDA4420	2.59
HA1137W	1.95	TDA1072	3.09	MC1330P	1.38
HA11225	2.47	TBA651	2.53	MC1350P	1.38
HA12412	2.81	TDA1090	3.51	KB4412	2.24
KB4420	1.95	TDA1220	1.61	KB4413	2.24
TBA120S	1.15	TDA1083	2.24	KB4417	2.53
KB4406	0.80	TDA1062	2.24	MC3357P	3.16



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 have developed a range of output devices and drivers that ought to revolutionise opinions and attitudes towards the design of all LF amplification systems. We have a new 48 page application note (£1.50 inc) and complete sets of parts, modules and now the new complete PA system (see above).
 25K133 120v N-ch 100W MOSFET £6.33 2SJ48 Pch complement £6.33
 25K135 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
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Radio Control ICs We have various RC ICs, including NE544 NE5044, and two new ones from OKI
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 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
 Contain yourselves, RF fans ! Not yet ready for a full launch until autumn but reviewed here:-
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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.

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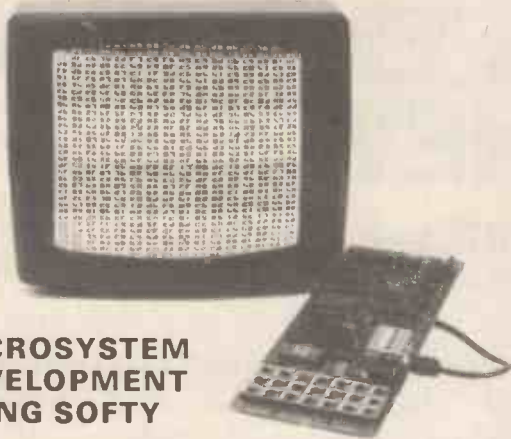


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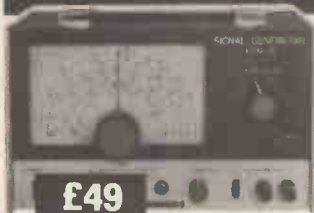
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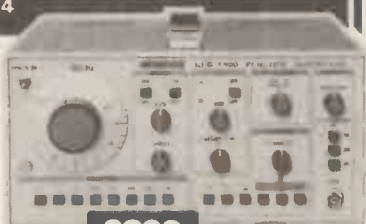
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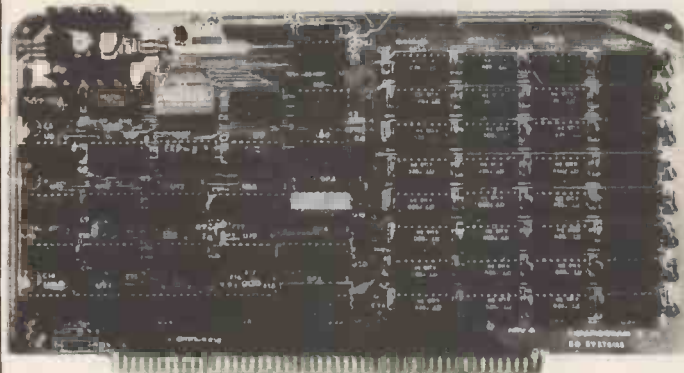
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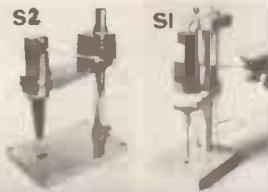
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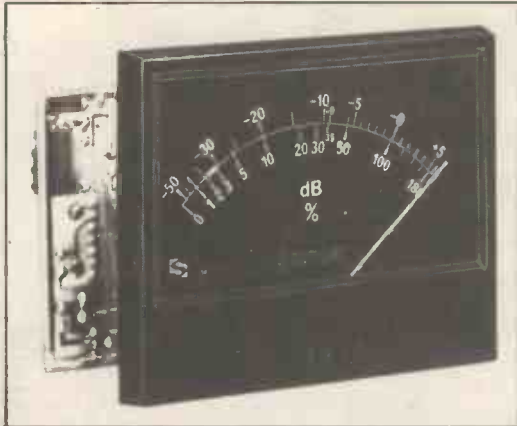


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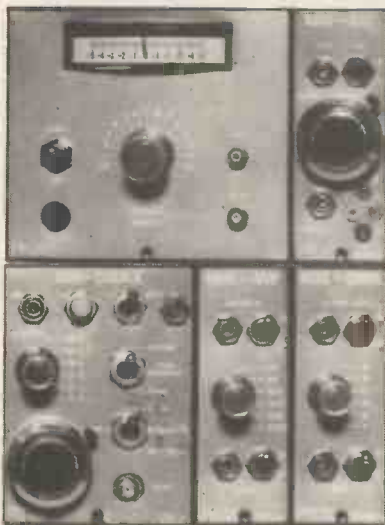
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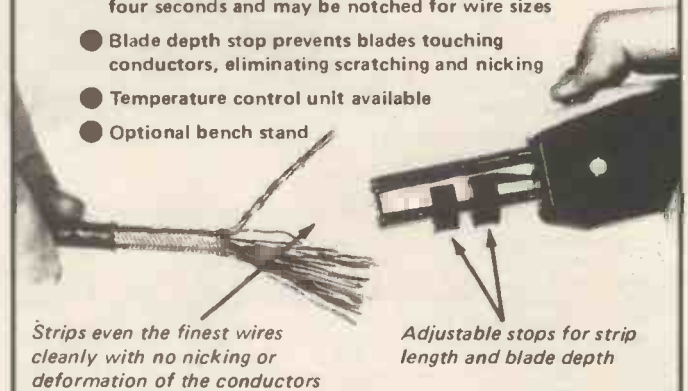
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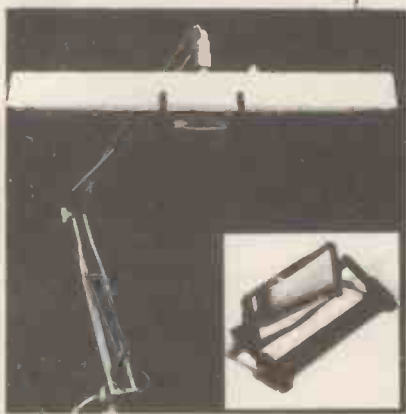
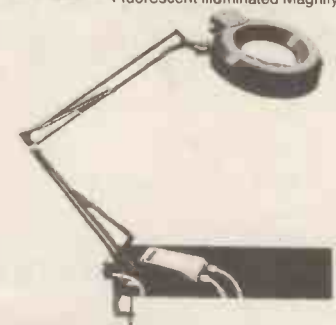
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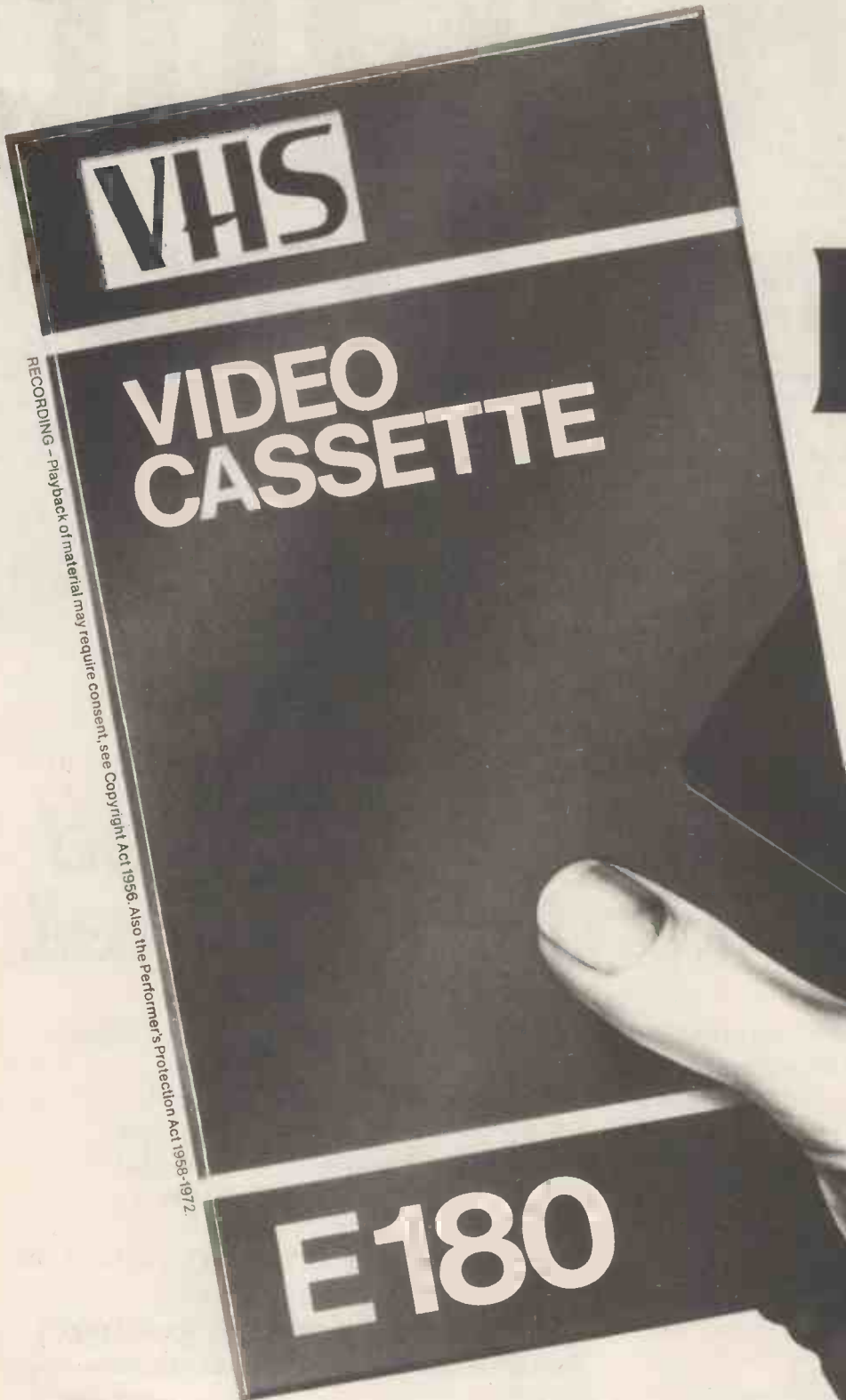
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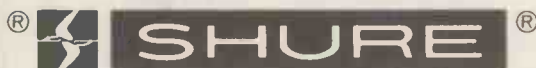
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Democratic, parliamentary government is a fine thing. Matters of consequence to the community cannot be left to the whims of dictators, unless they happen to be of an unusually benevolent disposition. The imposition of taxes, the control of education, health care, transport – all must be discussed and arranged in a properly democratic manner. But, when ministers are seen to shy away from the decision which must be taken when the talking stops, one can sometimes begin to wish for a benevolent despot, or at least a well-heeled entrepreneur.

In America, Japan and one or two European countries, thousands of millions of pounds worth of investment have been used to build vigorous research, development and production programmes in integrated-circuit technology. In the UK, Sir Keith Joseph hesitated over the second £25 million for Inmos. He would clearly have preferred the company to raise the money from private sources, but only discerned "flickers of interest" from private enterprise. That the interest is only a flicker does not show the City in a particularly adventurous light – it evidently likes to apply its risk capital in an area of slightly less risk – but the decision has to be accepted.

Since the original plan to fund Inmos to the tune of £50 million was made, the company has lived up to its promises and is on schedule with its US operation: nothing has changed. Although the original decision was made by a Labour government, there seems to be no reason why the Tory incumbents should wish to throw away the first £25 million by holding back the second. Inmos have said that they have already lost £36 million in the time spent hawking over the second instalment. If it had not been forthcoming, Inmos would almost certainly have survived, but as an American company, possibly raising money from US sources.

The question of whether we need Inmos has been raised. It is somewhat late in the game, after all, to start competing with the established giants,

particularly as the said giants are pretty well entrenched in Britain already. One American view is that Europe has no need of a semiconductor manufacturing capability; the application is all, so they say, so why not leave the supply of raw materials – chips – to others? One hesitates to appear churlish in the face of such altruism, but the Americans ought not to be asked to shoulder the whole burden of mountainous profits from semiconductor making.

They do have a very good point, of course. Software and applications development do not run away with the millions in the way that chip design, manufacture and marketing can in the early stages. The UK is already rather good at software (less so at industrial application) so perhaps we should concentrate on this side of the "microelectronic revolution".

If there were a choice, that would possibly be a sensible one. But is there a choice? Is it really in our best interests to leave to foreign companies the conception, design and manufacture of supplies which we are constantly being told will be central to our future economy? Will we then be supplied with the devices we want or those we are told to want? Will we be supplied at all? Having already seen control of many of our established industries pass from our hands in an involuntary way, it hardly seems reasonable to forego a chance of holding on to one of such significance.

It may be that the pathetically small investment in Inmos which is all that is possible, unless private enterprise becomes more enterprising, is far too little and about fifteen years too late, but however small a UK microelectronics industry finds itself to be when the situation stabilizes, a nucleus of capability strong enough to supply special needs and, more important, to attract the necessary brain power, must be kept. This is a decision which carries extremely long-term consequences: future options should not be limited by further haggling over the petty cash.

The floating bridge

New design principle for audio amplifiers

by R. M. Brady

This article describes a design principle which has the advantages of the bridge amplifier but none of its disadvantages. A simple amplifier which drives four ohm, 15-watt speakers using power from a 12-volt car battery is described in part 2 and test results are included. The design is further applied to a 200-watt version suitable for group use,

Bridge amplifiers offer many potential advantages over single push-pull amplifiers: high power, high voltage swing for moderately low-voltage components, lower power dissipation in each transistor, and the capability of operating with high impedance loads, thereby reducing transmission losses and permitting a high damping factor. They are almost essential if power supply voltage is limited as, for example, with a car battery. Present designs, however, are necessarily of complex and cumbersome manufacture, making them expensive and not so reliable. They also have limited bandwidth and poor distortion performance, because of the close coupling between individual halves of the amplifier.

One half controls the instantaneous potential of one output terminal with respect to earth, and the other does the same job on the other terminal. The new system uses one amplifier to control the difference between output terminal potentials, and a second, cheaper amplifier to control a quantity which could loosely be called the sum of these voltages. This amplifier acts merely as a "slave" to the first one, enabling a full voltage swing to occur, but not in any way directly affecting the required output. The second amplifier is capacitively by-passed at high frequencies, where a full voltage swing is not so important in audio work. This bypassing prevents the instability for which bridge amplifiers are renowned.

The simplest version of the circuit requires that the earth (i.e. chassis, screening and mains earth) be floating, changing potential with respect to the power supply. Although this is unusual, it is perfectly safe and acceptable provided steps are taken to prevent stray

mains currents from passing through the system.

It turns out that the design of both component amplifiers may be considerably reduced in complexity by using this system. Extras, such as current protection, may be added easily and far more simply to the floating bridge than to conventional amplifiers

The new system has the following advantages over conventional bridge amplifiers:

- wider bandwidth and lower distortion
- optimized voltage swing, because

both amplifiers must bottom before the output is affected

- saving in cost and complexity
- one output terminal may be earthed
- possibility of using two floating bridges to make a bridge-bridge amplifier

The next section presents the system in block diagram form, contrasting it with a conventional bridge amplifier configuration, and then sub-dividing the circuits for tracing through the feedback loops of the whole system, prior to reading the later paragraphs. The circuits are rather unconventional,

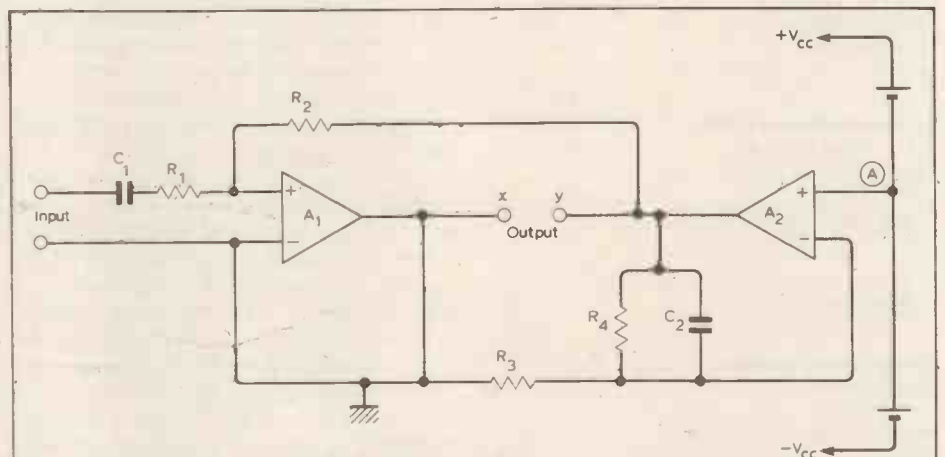


Fig. 1. In version A, A_1 is a high quality amplifier which controls the difference between output terminal voltages, $x - y$, while A_2 is a cheaper amplifier which controls the sum $x + y$ so that full voltage swing can occur. Note the unusual position of the earth. (x and y are potentials with respect to point A.)

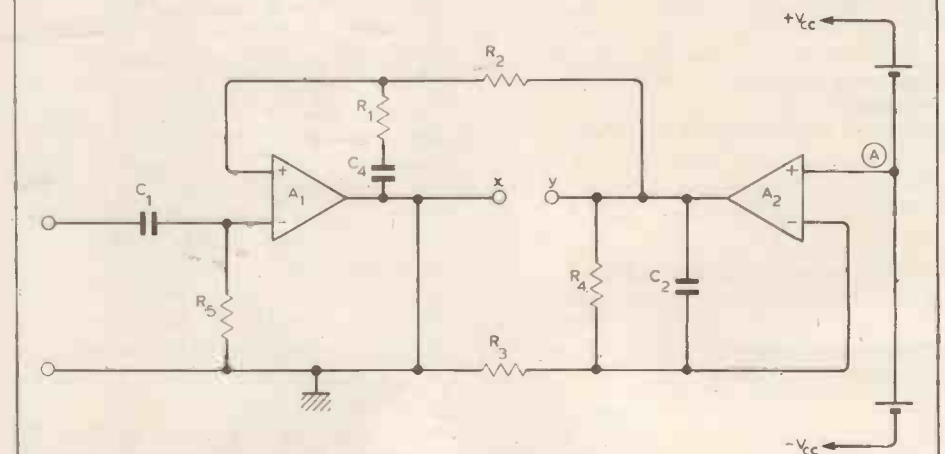


Fig. 2. Version B of the floating bridge amplifier is similar to version A, but has a different input configuration.

and if you do, you may find it good advice to forget temporarily the electronics you have already learnt, and to investigate the circuits from first principles.

Block diagram analysis

Two alternative but similar arrangements of the bridge amplifiers are shown in Figs 1 & 2. Amplifiers are inverting and non-inverting and A_1 is insensitive to the state of the power supply. Output terminals are labelled x and y as shown, being instantaneous potentials with respect to point A, and in both cases the feedback loops are arranged so that at low frequencies A_1 controls the value of $x-y$, and A_2 controls the value of $xR_4 + yR_3 \approx x+y$. Capacitor C_2 by-passes A_2 at high frequencies, where large voltage swings are unnecessary. Circuit A, Fig. 1, inverts the signal whereas circuit B, Fig. 2, does not.

First consider a simple-minded approach to a conventional bridge amplifier, Fig. 3. Feedback loops are arranged so that if V is the instantaneous input voltage then $x=GV$ and $y=-GV$, and the output across the load is $x-y=2GV$. Remembering the close coupling between individual amplifiers, imagine that x rises for some reason because of effects in A_1 . This causes A_2 to turn on, to keep y constant. The fact that A_2 has turned on affects the value of x , causing A_1 to react each time there is a small phase shift, which can easily be amplified by this mechanism and cause unwanted oscillation. Hideous things can happen at the cross-over point where both amplifiers must conduct simultaneously. The new system almost completely eliminates this coupling effect.

Effect of A_1 in circuit A Fig. 4 shows A_1 and its associated feedback loop. For the present A_2 can be regarded as a sink which will accept any current generated by A_1 . In the quiescent state, A_1 stabilizes $x-y$ to its own (ideally zero) offset voltage. Imagine that the potential y rises with respect to x for some reason. The potential at the + input to the amplifier remains at almost earth potential x , so that there is a voltage across R_2 which tends to make a current pass into the + input. This causes A_1 to turn on in such direction as to make a current pass from x to y through the load impedance*, thereby reducing the value of $y-x$ and stabilizing the system. Amplifier A_1 is acting as a virtual earth amplifier, and its voltage gain is R_2/R_1 . Because A_1 is insensitive to supply voltages, then any change in potential y with respect to the power supply will not be noticed by A_1 (apart from stray capacitance effects**). As the potential

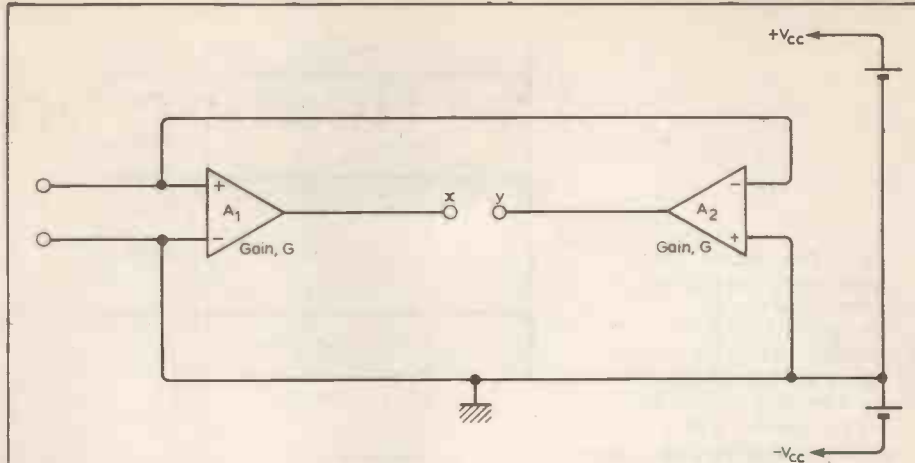


Fig. 3. In the conventional bridge amplifier A_1 and A_2 are identical good quality amplifiers arranged so that output x is proportional to the input and output y is the negative of this. It enables a high maximum voltage swing to occur for a given power supply, but is expensive and prone to instability.

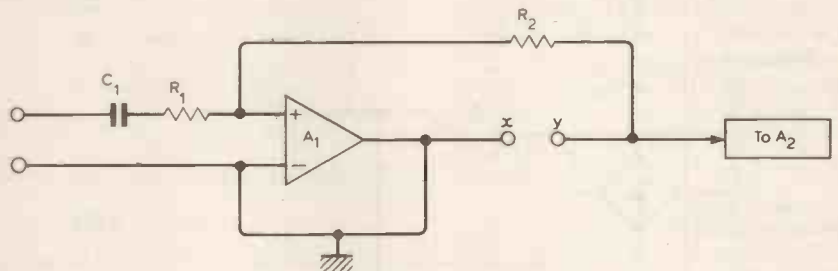


Fig. 4. A_1 amplifier of version A. Ignoring the earth connection, imagine voltage y rises; feedback is arranged so that this causes a current to flow into x , causing x to rise, and so restoring the correct output $x-y$ (i.e. negative feedback). As there is only one earth connection it cannot short out any currents! Amplifier gain is R_2/R_1 .

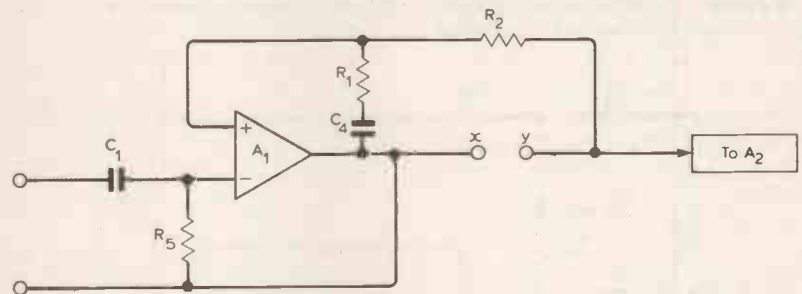


Fig. 5. A_1 amplifier of version B, similar to that of version A, but with slightly different input. Amplifier gain is again R_2/R_1 .

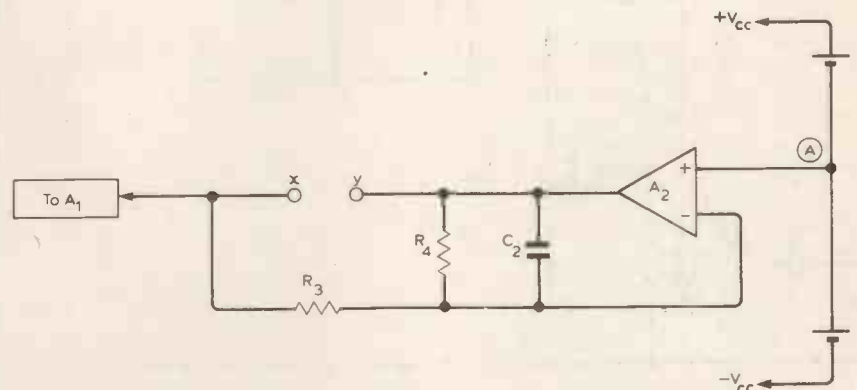


Fig. 6. Cheap amplifier A_2 controls the sum $x+y$. Normally, this must control the current so that $y=-x$, which would be the case if $R_3=R_4$. At high frequencies full voltage swing is not so important and C_2 gives feedback so that y remains constant; this greatly simplifies design.

*Remember Kirchhoff's Law; if current is supposed to disappear down the earth line, where is the circuit supposed to be completed?

**There is also a low frequency coupling, discussed in part 2

Fig. 7. Operation of the circuit when over-driven with a large signal. Cheap amplifier A_2 is arranged to bottom before the full voltage is reached. This enables a full voltage swing to occur in the output, but bottoming of A_2 does not affect the output.

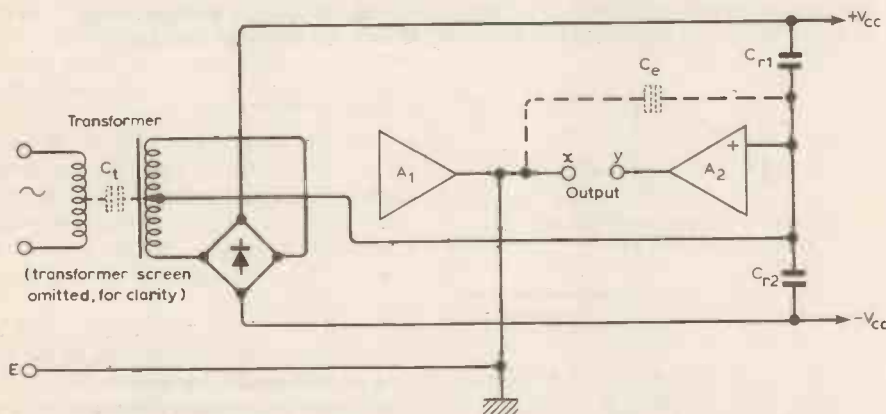
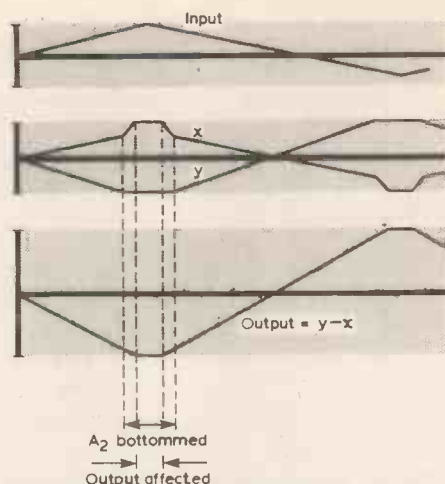


Fig. 8. Simple power supply arrangement in which C_s is stray between earth and the power supply, C_t is the transformer capacitance between the mains and secondary; if an earthed screen is not included then mains currents could pass, destroying the amplifiers. A conventional power supply can be used if a change-of-origin preamplifier is included.

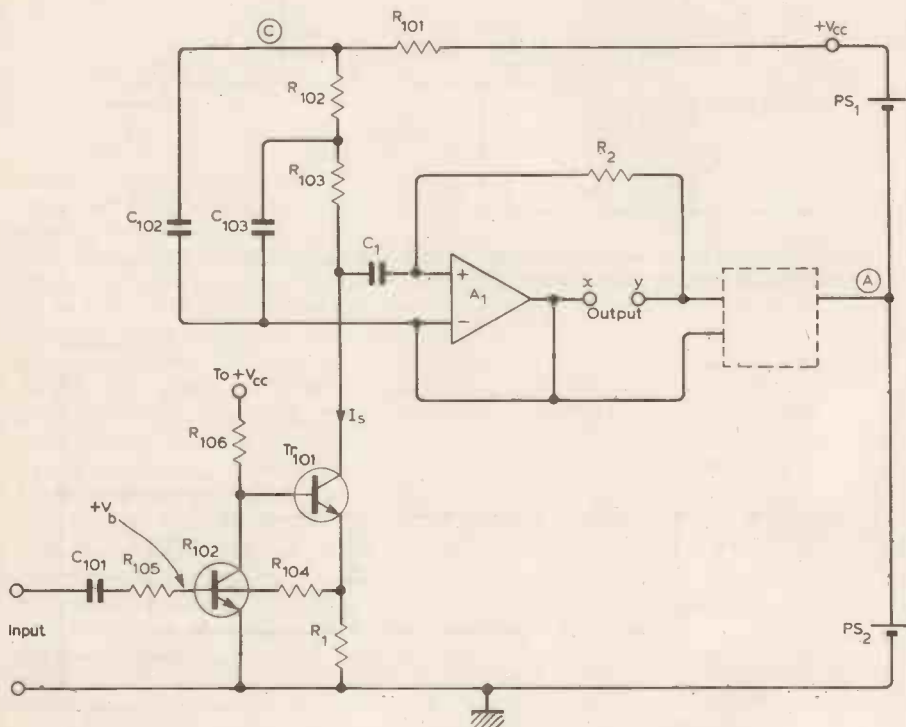


Fig. 9. Change-of-origin preamplifier. Earth is connected to the power supply negative rail, so many floating bridges can be operated on the same power supply. Preamplifier converts the signal into current I_s which passes through R_2 from an a.c. point of view. Output $x - y$ is therefore $I_s \times R_2$.

y with respect to the power supply is the only thing which is affected by A_2 , then A_1 is decoupled from A_2 . This confers a high degree of stability on the circuit, and enables A_2 to be of cheap design, with poor distortion performance, in what will remain a high fidelity system.

Effect of A_1 in circuit B. Fig. 5 shows A_1 and its associated feedback loop. Resistor R_5 is large-valued, providing bias, so that d.c. conditions are identical with those for circuit A. Imagine that the input voltage rises. This causes A_1 to conduct in such a direction as to cause y to rise with respect to x. Negative feedback is applied through R_2 , causing the potential of the + input to rise until it equals that of the - input, and the circuit stabilizes. This happens when the value of $y-x$ is R_2/R_1 times the input voltage. A_1 is again decoupled from A_2 .

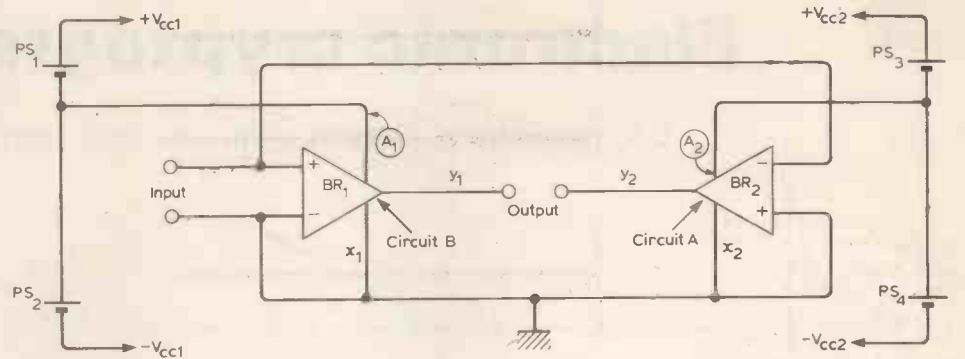
Effect of A_2 . Fig. 6 shows A_2 and its feedback loop; C_2 by-passes A_2 at high frequencies. Resistance R_4 will be set nearly equal to R_3 so that at low frequencies A_2 controls the potential of y in such a way that $x+y$ is always equal to the potential at point A. This corresponds to the voltage swings experienced in conventional bridge amplifiers, and has the advantage that the power dissipation is shared equally between component amplifiers. In practice, however, R_4 will be set slightly larger than R_3 , so that at low frequencies, A_2 bottoms shortly before A_1 does so. This enables a full voltage swing to occur, and is illustrated in Fig. 7. The system can cope with a poor quality design of A_1 , without the required output being appreciably affected. Cost savings can be quite large in this area.

Earthing arrangements. Fig. 8 shows a typical power supply arrangement. Capacitors C_r are reservoirs, C_e the stray capacitance between earth and the bulky components of the power supply, and C_t the stray capacitance between primary and secondary of the transformer.

An apparent problem as regards bandwidth is the effect of capacitance C_e between earth and the floating power supply. Much of this will be contributed by the transformer, and so it is hard to eliminate. A typical value in a design which is not particularly fussy about reducing this capacitance, is around 500 to 1000pF. This capacitance is effectively put across the output, because of the effect of the capacitor in the feedback loop of A_2 , and is thus in parallel with a load of typical impedance 8 ohms. It thus only becomes significant at frequencies above about 20MHz and so can be ignored.

The effect of C_t is potentially more serious. Mains current can potentially pass from live, through C_t , via the rectifier to the power rails, through the transistors of A_1 and A_2 , and to earth. The high mains voltages involved are capable of destroying the semiconductors in A_1 and A_2 . However, it is easily seen that, whilst the system is working

Fig. 10.
Bridge-bridge amplifier for the real power maniac! BR_1 and BR_2 are both floating bridge amplifiers, and each have their own power supply. They are connected together similarly to a conventional bridge amplifier (so care with instabilities!). Available voltage swing is four times the voltage of each part of the power supply.



correctly these currents are safely passed. The feedback loop of A_2 causes the potential y to follow that of the power supply, if it rises with respect to x (i.e. earth). Such a rise in y causes A_7 to conduct so as to safely pass any such mains currents. But this does not apply at switch-on, or on failure of some component. It is thus highly desirable to insert an earthed screen, between primary and secondary of the transformer.

A further safeguard, which is necessary for highly inductive loads anyway, is to insert reverse-biased diodes between x and each power rail. This prevents the e.m.f. on the collector of any transistor in A_1 from exceeding the power supply e.m.f. and also prevents any transistors from being reverse-biased. However, if a good screen is included, and any inductive loads are by-passed by the usual C-R network, then this is unnecessary.

Further application: Change of origin device

This section describes how the amplifier can be included in a stereo arrangement, avoiding the unusual earthing arrangement of Fig. 8, and also describes a bridge-to-bridge circuit. It is included here because it follows on naturally from the block-diagram treatment which the bridge amplifier has so far received. If you wish to see how the block-diagram amplifier actually looks in real circuits and actual components you may prefer to jump to part 2 and come back to this section later.

The earthing devices so far described are fine, provided only one amplifier is used with each power supply. Any attempt to operate two such amplifiers from the same supply would result in each A_1 shorting out the other A_1 . Fig. 9 shows circuit A with a modification so that many such amplifiers can be operated using one power supply. The input is with respect to the $-$ rail. A similar modification could be made to circuit B type floating bridges.

The transistors are arranged with d.c. feedback, so that in the quiescent state $I_s = V_b/R_b$, where V_b is the base-emitter

voltage of Tr_{102} . From an a.c. point of view, they act as a virtual earth amplifier, so that the a.c. signal I_s is equal to $(R_{104}/R_{105}) \times V_{in}/R_1$, where V_{in} is the input voltage.

Because of the effect of C_{102} , C_{103} , R_{101} and R_{102} , a constant current passes through R_{103} , and any a.c. variations in I_s are caused by A_1 to pass through R_2 , so that the output e.m.f. is $(R_{104}/R_{105})(V_{in}/R_1)R_2$. Thus the gain is $R_{104}R_2/R_{105}R_1$.

There is no possibility of coupling between the pre-amplifier and bridge amplifier stages, provided that Tr_{101} is sensibly positioned so that its collector is far away from, or screened from, the rest of the control circuitry, and provided that the capacitance between collector and base of Tr_{101} is small. Even with a large capacitance here (say a maximum of 100pF), then a small capacitor between collector and base of Tr_{102} could safely be included, thus damping out any interaction. This precaution is probably unnecessary: for example, if ZTX304 is used for Tr_{101} , then a working voltage of 70V can be used, but there is a capacitance of only 6pF between collector and base.

Components C_{101} and R_{101} are unnecessary in actual circuits because there is a semi-stabilized voltage point already in the circuit for A_1 which may be used (point C in Fig. 14, part 2). In practical circuits, R_{104} and R_{105} could be replaced by some frequency-dependent circuit: for example, a tone-control or a high or low-pass filter.

Fig. 10 shows the circuit of a bridge-bridge amplifier. Amplifiers BR_1 and BR_2 represent complete bridge amplifier circuits, with inputs $+$ and $-$ and point A, and outputs x_1 , x_2 , y_1 , y_2 and points A_1 and A_2 . x is connected internally, in both feedback loops to the "earth" input, but a connection is shown externally for clarity.

Using a "change of origin" device, many bridge-bridge amplifiers could be operated from two supplies, but note that each such two-bridge must carry the same signal. If A is the instantaneous output voltage $x-y$ from one amplifier and B is the output of a second such bridge amplifier connected to the same supplies, then a bottomed state

will be reached when the total available supply voltage becomes equal to the largest of A, B and $A-B$. In the case where A is approximately equal to B then the third condition is never satisfied, and each amplifier can work independently.

If low-level signals are used which require sharp peaks, then this system could be used for carrying a number of different signals — but the high level signal will be clipped, and the low-level signal will not be clipped (if working into a similar load).

The use of change of origin with a two-bridge is likely to be restricted to specialized applications, such as for group P.A. where many amplifiers are required to carry the same signal.

Practical circuits will be given in a second part of this article.

Micro '81

A call for papers has been issued for the Microsystems 81 conference, being held at the Wembley Conference Centre, London from March 11-13, 1981. The first two days are intended for design engineers and those involved in designing and implementing microsystems of all types. Scope includes case studies, communications, design aids, distributed processing, industrial control, interfacing, multimicroprocessors, project management, real time languages, signal processing, software development, standards and testing. The third day is devoted to personal computers and small business systems and their use in commerce, industry and education. Synopses of papers for consideration should be sent by September 12, 1980 to Robert Parry, Microsystems 81, PO Box 63, Westbury House, Bury Street, Guildford, Surrey GU2 5BH.

Microsystems 81 is owned by IPC Business Press and sponsored by *Computer Weekly*, *Microprocessors and Microsystems*, *Practical Computing* and *Systems International*.

Electronic cryptography

Codes, ciphers, communications and computers

Lively controversy in the USA about the degree of security provided by the new NBS data encryption standard poses the question: might data security be better served by going to one of the proposed "public key" systems? The debate has an important bearing on data transmission in the UK, as well as in the USA.

Pat Hawker provides background information as a reminder that even clever coding systems may not be quite as secure as you think.

The marriage of communication technology and computers has proved a fruitful alliance that has already led to many profound advances in the technology of information collection, collation, processing and distribution, affecting government, commerce, industry and not least the citizen concerned with living under the shadow of his electronic dossier. But increasingly important in this cosy family relationship are those out-of-wedlock twins: cryptography and cryptanalysis. This simile is not altogether fanciful: the first true electronic computer, Colossus, was created by Turing and Flowers for that wartime temple of the black art at Bletchley Park.

Diffie and Hellman have pointed out in an important tutorial contribution to the subject that "Until recently cryptography has been of interest primarily to the military and diplomatic communities. Private individuals and even commercial organisations have rarely considered it necessary to resort to encryption for protection of their communication, and those that have, have seldom done so with particular care." The traditional commercial telegraphic code books were developed primarily to reduce the number of words that needed to be transmitted; used in isolation they did nothing to ensure privacy.

But the whole concept of electronic mail, centralized information storage linked with multiple visual display units, the implications of digitalized packet-switching telecommunication networks and the general growth of information technology together pose an increasingly significant threat to the privacy of the individual and to commercial confidentiality.

Electronic storage and transmission

of information has opened the way to new forms of traditional crimes — data theft, industrial espionage, sabotage, fraud by deception — and to potential invasion of privacy of the individual. The act of communicating so much information between different locations not only vastly increases the extent and variety of information available to a determined eavesdropper but the same modern technology also makes eavesdropping easier and relatively less costly.

It is not solely a question of data-processing technology. The use of microwave radio relays rather than cable, combined with direct long-distance dialling, allows the interception of public and defence telecommunication traffic without the need for physical tapping of wires and without the eavesdropper being in proximity to the target of his surveillance. The ability to program a computer to select from a flood of messages only those containing key words or specific addresses or telephone or telex numbers makes possible far more selective eavesdropping.

Communication technology, admittedly, discourages the casual listener by multiplexing large numbers of circuits on a single bearer or by the use of high transmission speeds, including burst techniques, and by confining radio signals to narrower, sharper beams and increasingly higher frequencies. But none of these techniques can be expected to defeat the determined eavesdropper. Techniques of steganography, which seek to conceal the very existence of communication, such as pseudo-noise or frequency-hopping transmission or information concealed on sub-carriers within conventional transmissions, cannot be guaranteed to elude for long the attention of listeners equipped with spectrum analysers and the like.

While this article doesn't intend to probe the sensitive area of official monitoring and surveillance services, some idea of the scope of signals intelligence (SIGINT) can be gained from the simple statistic that 40,000 of the Collins R390 family of general-purpose h.f. communication receivers were manufactured post-1950: not all, but a considerable proportion, are likely to have been used for American surveillance work.

The capture by the North Koreans of American cryptographic equipment on the USS Pueblo is said to have made possible the decoding of an enormous store of messages intercepted in previous years — and to have led to the attempted counter-coup of the Hughes deep-sea recovery vessel Glomar Explorer and its vastly expensive efforts to raise the sunken Russian submarine off Hawaii. The Russian "bombardment" of the US embassy in Moscow with microwaves appears to have been an attempt to prevent the Americans intercepting microwave trunk systems, in the manner alleged to have been carried out by the Russians in Washington DC and at consulates in other parts of the USA, almost certainly aided by computer selection of circuits of particular interest.

Modern data transmission, commercial as well as official, is thus facing an increasing desire for better security that can be provided only by cryptography. Messages need to be enciphered in a code that cannot be economically read by an eavesdropper and that conveys sufficient proof of authenticity. Any cryptographic system that is less secure than the users believe represents a major risk. A code thought to be secure invariably tempts users to transmit information that, were such a code not available, would never be entrusted to radio or cable. During World War II the Germans fastened a small plaque on their military radios "Feind hoert mit!" (the enemy listens also) but were so convinced of the security of their Enigma and other secret writing machines that they were prepared to communicate not only tactical information, whose importance would rapidly evaporate, but also strategic and logistic information that remained of value even when it took days or weeks to recover the plain text. This does not mean that all codes need to be absolutely secure, provided that they delay sufficiently the recovery of the plain text or involve the codebreakers in an unduly large and unjustifiable operation.

The techniques of cryptography have progressed from hand codes to machine codes to on-line, all-electronic systems, but the changes in technology have not invalidated the classic principles of the craft.

Basics of cryptography

Over the years cryptography has acquired a specialized terminology that sets it apart from communication engineering with its more familiar signal coding, pulse code modulation and error detection and correction codes. For the history and development of codes and ciphers read Kahn's *The Codebreakers* (the original hardback edition contains more technical material than the later paperback). Here only a few terms and techniques relevant to modern electronic cryptography are discussed; more details are in the tutorial paper by Diffie and Hellman.

The term cryptography covers both codes and ciphers; in essence a code consists of changing a message into pre-arranged code blocks, for example five-letter or five-figure groups, with each group representing a word or phrase of the original message, known as the plain text. The coded message thus is not directly related to the number of letters or words in the plain text but unless further manipulated any given code group always represents the same phrase. Radio operators, for example, are familiar with the international Q-code which overcomes language difficulties and reduces transmission time but is not intended to provide privacy. An ordinary telephone directory is a form of codebook as a complete address can be reduced to a unique STD number. (However, it would be virtually impossible to decode the number without making an exhausting search through a directory, arranged only in alphabetical order of names.) Codes based on words and phrases are less readily automated than ciphers, though codes may be used within a cipher where personal privacy is needed.

Ciphering is the process of changing the plain text letter by letter so that the enciphered message still contains the original text but with either the position of the letters changed (transposition cipher) or new letters substituted (substitution cipher). Each process may be carried out more than once or a combination of both processes may be used. A simple substitution cipher could consist of simply moving each letter in the plain text a few places along the alphabet (e.g. putting a D for an A, E for a B, etc). This, however, would be extremely vulnerable to cryptanalysis — the art of breaking enciphered messages — by somebody not in possession of the cipher; language structure renders a simple substitution cipher little more than a child's puzzle. Simple transposition ciphers are similarly vulnerable.

To make substitution ciphers more secure, it is common practice to use different substitution alphabets to encipher successive letters of the plain text (polyalphabetic ciphers). For example an A might be changed to B in one position in the plain text but could be any other letter elsewhere. Most modern ciphers are based on poly-

alphabetic substitutions (or the equivalent in digital terms). The degree of security depends on the use of many substitution alphabets to avoid regular repetition of the use of any one of them. While the use of polyalphabetic ciphers greatly increases security, it brings about a need for the users to have some form of key or running key that is not available to the eavesdropper.

It is a feature of any complex cipher that the users need some form of aide-memoire or key to decipher the message, just as a code book or other form of memory is needed for codes. This may take many forms: book ciphers may use words or letters taken in some way from the pages of a readily available book; proverbs or poems may be committed to memory; special key blocks to provide running keys may be printed in a miniature book or pad; in electronic systems a key generator providing a specific stream of 0 or 1 can be in a potted, sealed module.

Historically a further form of secret writing has been important: concealed codes or ciphers, more correctly termed steganography where the users endeavour to conceal the existence of the secret communication. These vary from invisible inks, pin pricks (punctured codes), letter codes with short messages concealed in a long letter, and microdots to radio transmission techniques such as pseudo-noise forms of spread spectrum.

In a complex ciphering system there are two secrets that will, at least initially, be unknown to the eavesdropper: the general form of the substitutions and transpositions (the algorithm) and the key, Fig. 1. To recover the plain text, both need to be known and it may not be necessary for the users to keep both secrets from the eavesdropper. In electronic systems for commercial use, it may even be advantageous to establish and publish an agreed algorithm, the security of the cryptosystem then depending upon the key. It will then be

essential that the key should not become available to the eavesdropper and it is necessary to enforce strict rules of key management and key distribution.

One-time systems

To be secure a polyalphabetic cipher needs to use a large number of different substitute-alphabets so that each is repeated only rarely. Ideally the same substitute-alphabet should be used only randomly: the users need to be instructed by means of a running key which substitute-alphabet to use for each letter of the plain text, and these instructions should, if possible, be given in a truly random sequence; in other words the sequence indicated by the key should never reoccur. In practice this can be done by means of a "one-time pad" or "one-time tape" containing strings of random letters, figures or binary digits. Such a key may indicate to the user by how much each letter should be shifted along the alphabet; a form of addition (but unlike arithmetical addition with no carry-forward): see Fig. 2.

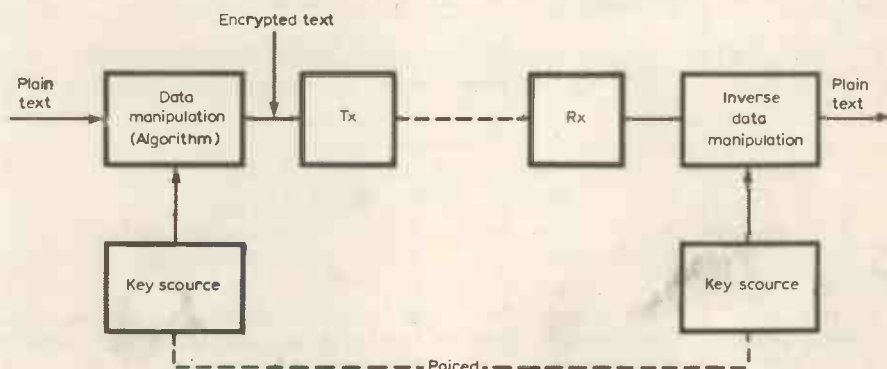
A true one-time system is unconditionally secure and will defy all forms of cryptanalysis.

Cipher machines

For centuries, most encryption was done painstakingly by hand, aided sometimes by simple abacus-type machines and the liberal use of squared paper. Polyalphabeticity, first proposed in 1466 by the Italian architect Leo Battista Alberti, at the request of the Pope's secretary, gradually established itself as the dominant form of high-grade encryption and was the basis for the first successful coding machines and later for on-line machines. A series of early rotor machines were devised from about 1916 by Hebern, Koch, Damm and Scheribus and a basically similar machine but using six wheels and a drum or cage to generate the key was developed by Hagelin in 1934.

Most machines had a number of interchangeable rotors, electrically wired between input and output contacts as to form a whole series of polyalphabetic substitution ciphers. With say six rotors, there can be some 26^6 letters before

Fig. 1. Simplified outline of conventionally encrypted communication link in which the same running key is used for encoding and decoding with the same form of algorithm.



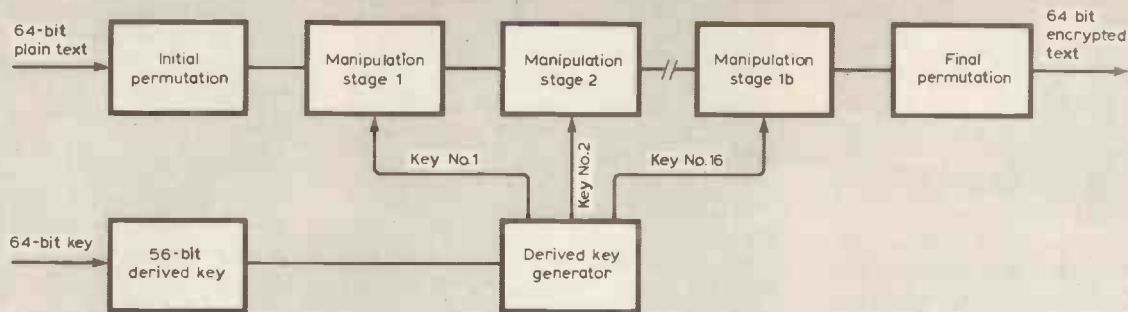


Fig. 4. Basic outline of the NBS data encryption standard in which the plain text is divided into 4-bit bytes and subjected to 18 stages of substitution and transposition.

emphasis is on making the transformations of the plain text so complicated that even with massive computer power it would be totally uneconomical to search out all possible solutions; such ciphers are then termed computationally secure. However not all ciphers that are thought to be secure against computer attack may be so in reality. According to Martin Hellman, "At present mathematicians lack the tools for proving systems to be computationally secure and the history of cryptography demonstrates all too well that supposedly unbreakable systems have hidden flaws".

Security of codes

The so-called one-time pad, that is to say the provision of truly random paired keys of unlimited length, has long been accepted as one of the few systems that are unconditionally secure. The use of such a system however involves many practical difficulties, including the production and distribution of the pads or tapes. If used for multiple-address messages then the loss of one pad puts the entire system in jeopardy; if operated only with paired-users the production and distribution costs become formidable. Physical security of machines is important and personnel may sometimes be suborned.

In practice the cage and keywheels of the Hagelin machine and the rotors of Enigma, Sigaba and the British Typex machines provided the workhorses for high-grade traffic until the development of purely electronic, on-line systems based on digital techniques.

Many systems may be relatively impregnable against a listener who has access only to the enciphered messages, but may be fallible if some or all of the plain text of some of the messages is known. There are various ways in which this situation may arise, either from system faults, human errors or by deliberately inducing the user to send a message of which at least some words will be known to the codebreaker. Then again it is usually necessary for the sender to include key groups which provide instructions for the decoder, or indicate the priority of the message and which may reduce its security. The techniques of traffic analysis, particularly when applied to military communications, can provide valuable in-

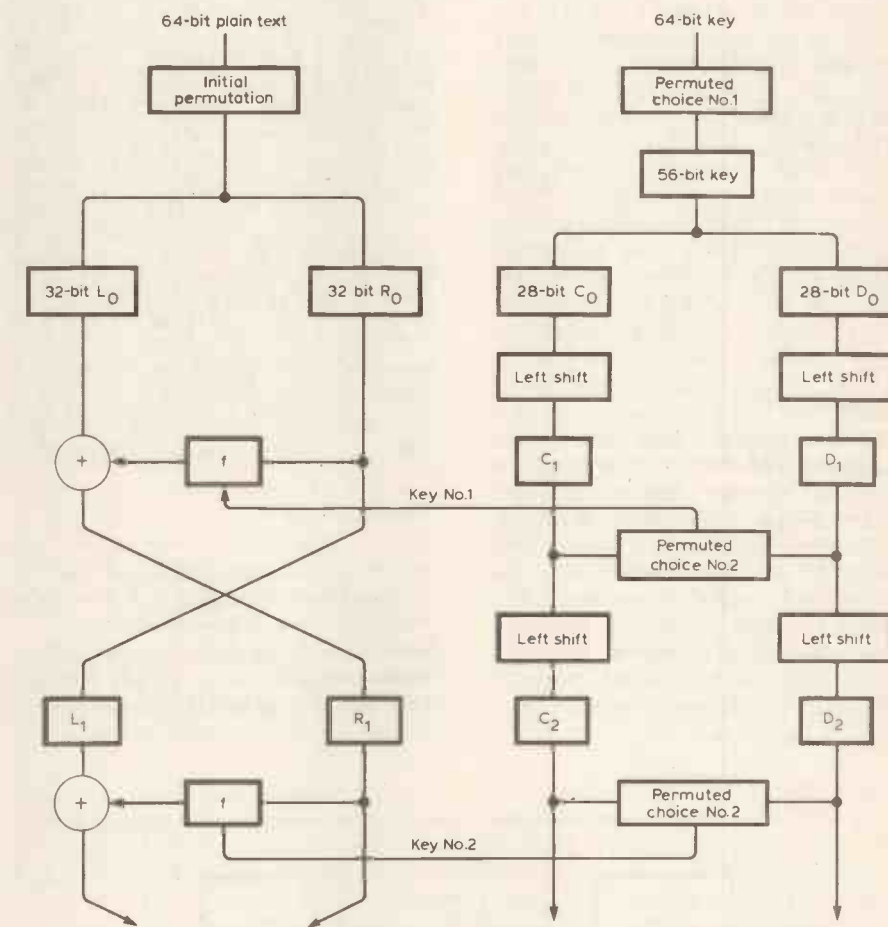


Fig. 5. Basic arrangement of DES shows the form of structure of the data manipulation and derived key generation; pattern is repeated many times and provides non-linear logic.

telligence even when the code remains unbroken. Deception techniques, including the holding and subsequent re-transmission of an operational message at a different time, or (where the code can be broken) the alteration of its contents may be less applicable to the commercial than the military scene, but cannot be disregarded altogether. Deception operations which were aided by the use of codes thought to be secure or in which warning check signals were disregarded included the now well-known British "Double-Cross" and the German "North Pole" exploitation of radio links.

Human fallibility, including failure to operate strictly the signalling rules of a system, plays an important role in cryptanalysis. It was once my experience to decode a message made secure by a one-time pad with a plain text that read: "Hawker is not repeat not to have access to the code books". When I duly presented this to the addressee, he laughed and told me to continue decoding his messages as before! Humans have a habit of defeating systems.

The existence of a communications channel carrying coded messages provides a strong temptation to unauthor-

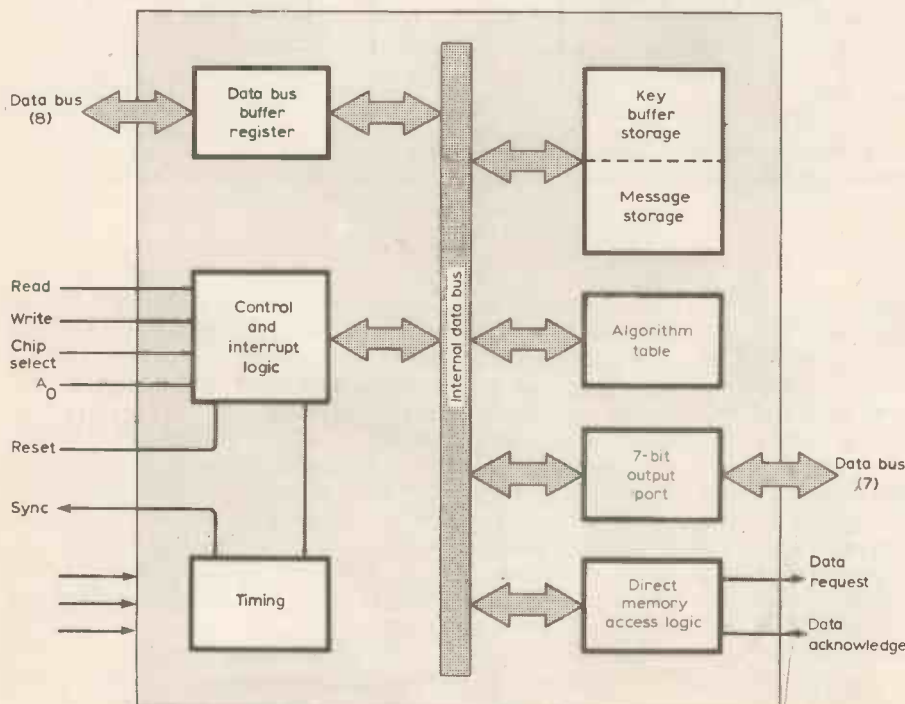
ised users, who seek access to the channel for their own purposes. When the Americans built an elaborate defence microwave network in Vietnam it was regularly used and much appreciated by the Viet Cong. At a lower level, signals personnel may establish their own private networks of communication.

Data encryption standard

During the past few years the relatively open study of modern cryptography, particularly by IBM and at Stanford University, California, is leading to a better understanding of the requirements of systems for the protection of commercial and administrative data transmission. The IBM work has led directly to the establishment of a data encryption standard (DES) for the safe transmission of sensitive (but not highly classified) information. DES is based on work by IBM, including six years development work by Tuchman and Meyers of the Communications Systems Development Laboratory in Kingston, New York originally for a cash-dispensing scheme for a London bank. The US National Bureau of Standards with the advice of the American National Security Agency have established the Standard and provides a test bed for the validation of hardware based on this complex non-linear algorithm device design is checked for malfunctions and to ensure that the output can never contain the key or plain text. However, the establishment of DES has already sparked off a vigorous debate as to the degree of security it provides and whether it would not have been better to develop an alternative, probably more secure, system of a new form of cryptosystem, known as "public-key" systems (third column).

DES provides a ciphering algorithm or set of rules involving both substitution and transposition techniques and capable of being implemented in current l.s.i. technology: Figs 4, 5 and 6. Each data block passes through 18 data-manipulation stages in which 16 different internal coding keys are derived from a 56-bit main key (with 64-bit input coding). This provides 2^{56} or 10^{17} keys, presenting a codebreaker with the need for a truly massive search, always provided that nothing is known about the enciphering key. Diffie and Hellman, advocates of the public key system, pointed out that knowledge of even a quite small part of the basic key would greatly reduce the search required, and that l.s.i. technology now makes it possible to contemplate searches of gigantic proportions. They postulate a decoding machine using a million l.s.i. chips, that could search 10^{12} keys per second, so that even the full 10^{17} keys could be searched in about a day. This modern version of "Colossus" would cost an estimated £10-million, with an average cost per solution of about £2500. While only a very few organisations, including governments, could positively contemplate building such machines, the mere possibility tends to send shivers down the spines of those who are intending to trust their data security to the NBS standard. There is some suspicion, reflected in

Fig. 6. Simplified arrangement of the NBS-certified Intel 8294 data-encryption 40-pin l.s.i. chip which forms a microprocessor peripheral capable of implementing DES up to speeds of 640 bits/second or at higher speeds by parallel connection of devices.



American comments, that the National Security Agency may not be over-keen to promote the adoption by the business community of codes that they could not themselves break and that they persuaded IBM to opt for a 56-bit key. Memories die hard of NSA's Project Shamrock which is alleged to have scanned all telegraph and telex traffic passing in and out of the United States for key words (British readers feeling complacent should recall the 1967 cable-vetting furore).

Several systems using basically similar techniques have been proposed or developed for application to computers, including home computers, where no data transmission is involved, to prevent unauthorised users from withdrawing information or to prevent software piracy. An 80-bit key is used by Cryptext for a low-cost home computer system and a cryptomicroprocessor has been proposed by Best. The idea is to encipher computer programs or stored data and then decipher them as each instruction is fetched for execution.

Public-key systems

Although the DEC algorithm is being widely, if at times hesitantly, welcomed by industry and commerce, and suitable l.s.i. devices are appearing on the market and incorporated in systems, it has to be accepted that it is a system of limited security, even though nobody has yet proved publicly that this is the case. An alternative family of novel cryptographic techniques, known as "public key cryptography" has recently been advocated on the grounds of providing greater security in the long-term, although at present it is at a less advanced state of development.

Public-key systems were first proposed by Merkle, Diffie and Hellman at Stanford University; in these, only the addressess would hold the deciphering key which would not be available to the person enciphering the message or date, Fig 7.

It is claimed that public-key systems overcome the problem of distributing key generators or one-time tapes by separating the enciphering and deciphering functions. In effect they provide a technique by which the sender of the message enciphers it for a particular addressee without herself having the ability to decipher it. The rather convoluted mathematics of public-key cryptography has been set out in some detail by Hellman in *Scientific American* (August 1979) and no attempt is made to reproduce here the 10-page explanation given here.

But, in brief, several systems have been proposed in which the family of enciphering transformations can be separated from the family of deciphering transformations in such a way that given a member of one family it is not feasible to find the corresponding member of the other. Front-runners among these systems are the

RSA public-key cryptosystem devised by Rivest, Shamir and Adleman (whose initials make up the "RSA") and so-called "trapdoor knapsack" system by Merkle and Hellman (trapdoor is meant to indicate a one-way or irreversible function, while the term knapsack is derived from a class of mathematical puzzles that require the solver to determine how many rods of the same diameter, but of differing lengths, would completely fill a given knapsack).

In practice, a public directory would indicate the addresses's encryption key number but not his private individual decryption key. The system depends on the mathematics of number theory, that is the study of the properties of integers. Encryption-decryption "mates" are established by using integers that separate the two algorithms. In a much simplified sense, the system can be thought of as depending more on multiplication than the traditional polyalphabetic shifting (addition) of the running key and the plain or partly coded texts as already outlined in Figs 2 & 3.

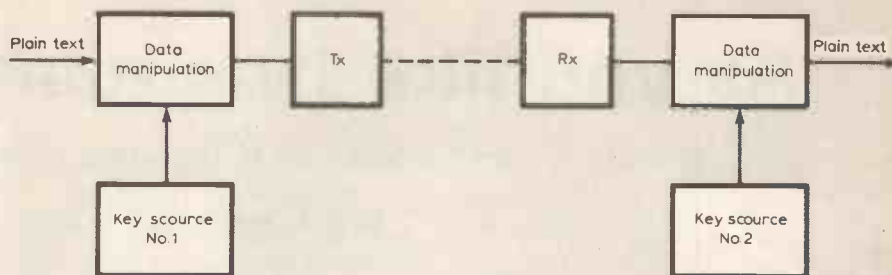
In the RSA system, developed at MIT, the security is based on the concept that multiplying is easy to a computer but factoring is extremely difficult. For example, whereas two 100-bit factors can be multiplied electronically in a fraction of a second, the reverse process of factoring them might take a million years even with a one-microsecond instruction time.

All the public key systems that have been proposed face the criticism that compared with the systems based on the DES they are only at a relatively early stage of development — and for this reason may never be fully developed for commercial applications.

An advantage of public key techniques is that they are "read only" systems and so, for example, would not permit data read out from remote instruments (in say a host country) to be doctored en route. Yet at the same time a decryption key could be made available to the host country. Similarly they can also provide an authentic digital signature as it is no longer possible for an addressee, himself or at any of his terminals, to encipher a message purporting to come from the addressor as, of course, can be done with all conventional cryptosystems. The public-key approach clearly has many attractions, especially in eliminating or reducing many of the problems of key distribution and key management.

Secure — but how secure?

At the 1979 British Association meeting, Sir Noman Lindop, former chairman of the Home Office data protection committee claimed that the UK lags behind Europe in enforcing legislation to protect the public from the abuse of computer-stored personal data and that we are becoming "an illicit data haven." While security of data transmission is only one aspect of this subject, it is one



that seems likely to be of increasing concern to systems designers. As David Kahn states in his introduction to *The Codebreakers* — "codebreaking is the most important form of secret intelligence in the world today". Its ramifications are now spreading well beyond the confines of the military, diplomatic and intelligence communities.

Codebreaking can be helped by analysis of the electrical interference radiated by nearby coding equipment or even by directing strong radio signals at the equipment and then analysing what occurs, rather as analysis of the sounds emitted by electromechanical coding equipment could provide an eavesdropper with valuable clues as to its operation. Cryptanalysts are by no means restricted to theoretical methods of solving codes, and for example an electrical fault, or irregular pulse shapes may provide useful information.

Many electronic engineers in the UK are today directly concerned with the implementation of data protection systems; the current American controversy about DES, however, shows the desirability of drawing on the past, pre-electronic history and experience of cryptography. Nobody wants to keep re-inventing the wheel, or more importantly, re-inventing square wheels. The disasters as well as the successes of British cryptography should not be forgotten. How many lives and ships might have been saved if, for example, the Admiralty had heeded Lord Louis Mountbatten's advice, when he was Fleet Wireless Officer in the 1930s, to develop machine codes offering greater security than the hand codes then in use? In the outcome the broadcast instructions to the British and Allied merchant ships were read by the German Beobachter-Dienst until the autumn of 1943 and many of the Royal Navy messages were read in the first year of World War II.

Those American cryptographers concerned at the danger of uncritical acceptance of NBS's DES by industry concur that this is a difficult system to break and that it could well fulfil all normal commercial requirements for the next 5-10 years — but stress that users must recognise that it provides only limited security against a determined eavesdropper. The greatest danger of a cryptographic system remains, as always, the false sense of security it may give. □

Fig. 7. Simplified outline of a public key system in which the key and basic algorithm used by the sender can be publicly known but each user keeps secret the decoding key. The form of data manipulation used by the sender prevents decoding except by a holder of the particular decoding key for which the message is enciphered.

Further reading

The following sources have been used *passim* in this article:

Whitfield Duffie and Martin E. Hellman, Privacy and authentication: an introduction to cryptography, *Proc IEEE*, vol. 67, no. 3, March 1979 (with extensive bibliography).

Martin E. Hellman, Mathematics of public-key cryptography, *Scientific American*, August 1979.

Harvey J. Hinden, LSI-based data encryption discourages the data thief, *Electronics*, June 21, 1979.

John Beaston, One-chip data-encryption unit accesses memory directory, *Electronics*, August 2, 1979.

Harvey J. Hinden, New security planned for data, *Electronics*, August 16, 1979.

Bob German, Encryption the key to security, *Electronics Weekly*, September 12, 1979

Miniature, ten-line telephone exchange.

Several small errors, for which we apologize, crept into this article in the August issue. Firstly, the open contact of A_1 on p.42 should go to the open contact of D_2 , not the junction of FC_2 and the 470ohm resistor. Secondly, the make contact connected to the closed contact of D_2 is FC_1 , not FC_2 . Lastly, in Table 2 on p.45, the relays operated on called-line 2 are SB and HB.

As you like it: circuits or fields

An introduction to Poynting's Theorem

by D. A. Bell, F.Inst.P., F.I.E.E.

Like Faraday [Maxwell] looked upon the role of conductors in electricity as a minor one, since they served only as terminations of the lines of force of the surrounding electric field.

Encyclopedia Britannica

Physics offers several other examples of dual representation – light waves and photons, electrons as particles or waves (electron diffraction) – but only in electrical phenomena are the two dual representations, circuit and field, always and exactly interchangeable. It is only in the present century that there has been such a tremendous development in the techniques of circuit analysis, while earlier scientists such as Faraday (1791-1858), Maxwell (1831-1879) and Poynting (1852-1914) regarded fields as pre-eminent. (It should be added that fields involve the use of vectors, and often difficult geometric problems, whereas circuits involve only the algebraic manipulation of one-dimensional quantities.) The development of waveguide and associated techniques, for which circuit representation is impracticable, may tend to redress the balance.

The first question asked nowadays is "Are fields real?" Those who ask this question overlook the fact that the established alternative to fields is action-at-a-distance. We are so used to the idea of gravitational attraction that it needs an Einstein to remind us of the problem which much concerned people before Newton, namely how can the sun exert a force on a planet across millions of miles of empty space? Electric and magnetic fields were introduced to 'explain' similar remote forces in electromagnetic phenomena and Maxwell showed that such fields could be propagated as waves, in empty space as well as in material media. (See "No radio without displacement current", *Wireless World*, August 1979.) Evidence in support of this idea of electromagnetic fields is the fact that their velocity of propagation can be observed. An interesting example of this is that a circular loop of wire acquires radiating properties, i.e. becomes a useful frame aerial instead of simply an inductor, when the time taken for the magnetic field to spread from one side of the loop to the other becomes a significant part of the period of the alternating current which is producing it.

So acceptable is the concept of fields and waves in substitution for action-at-a-distance that scientists are now looking for gravity waves (without much success so far). It is true that discarding the "luminiferous aether", which was supposed to be an all-pervading medium supporting electromagnetic waves, means that fields which were originally thought of as "states of stress in a medium" must now be regarded as "properties which exist in space", but is this more difficult to accept than other indispensable concepts of modern physics, such as the wave nature of the electron and the quantisation of energy? The difficult concept of wave mechanics (sometimes described in terms of "waves of probability") provides the theoretical basis for the whole of modern solid-state technology. Einstein's proposed solution of the problem of gravitational action-at-a-distance was to enhance Newton's law, that a force-free moving body continues in a straight line, by replacing "straight line" by "shortest line in 'curved' space" with the 'curvature' being due to the presence of mass. The 'curvature' of space by the presence of mass is just as far from everyday experience as fields in empty space. Whichever way you go, modern physics demands faith in something which is not comprehensible in term of everyday experience: the laws of physics demand acceptance because they produce a coherent structure of theory which accords with all experimental evidence.

Let us now look at the simplest example of the circuit/field equivalence, namely the energy stored in a charged capacitor made up of two plane parallel electrodes separated by a dielectric which may be anything from a

vacuum to high-permittivity ceramic (Fig. 1). From a circuit viewpoint we say that the work done in transferring charge q from one plate to the other is qv where v is the potential difference between plates at the time of transfer. Since v increases as the charge builds up the total work done (and therefore energy stored) is expressed in terms of the final charge and potential difference as

$$W_c = \frac{1}{2}QV \quad \dots \dots \dots (1a)$$

$$= \frac{1}{2}CV^2 \quad \dots \dots \dots (1b)$$

using the relation $Q=CV$. But according to the theory of electromagnetic fields, the energy stored in the dielectric is $\frac{1}{2}DE$ per unit volume where E is the electric field-strength and D is a field quantity equal in magnitude to the charge per unit area of the conducting surface bounding the field ("the surface on which the lines of force end", as Faraday and Maxwell would have said). But E is V/d and D , being equal to the charge per unit area of plate, is Q/A ; and the volume occupied by the field is dA . Thus the total field energy should be

$$W_f = (dA)(\frac{1}{2}DE)$$

$$= (dA)\frac{1}{2}(Q/A)(V/d) = \frac{1}{2}QV \quad \dots \dots (2)$$

which is the same as (1a) so the equivalence works in this case. A minor caveat is that the formula " $\frac{1}{2}DE$ per unit volume" has been rigorously proved only for the average over an infinite volume (because the proof depends on the rates at which different vector field quantities vanish at infinity) but it has always worked when applied to particular finite cases.

But what is the significance of the extra field quantity D which was slipped into the derivation of equation (2) and was said to be equal to the charge density at the boundaries of the field? In a well behaved dielectric (linear and isotropic) D is simply equal to ϵE where ϵ is the dielectric constant of the medium. But what is the dielectric constant of a vacuum? This is where we tend to get a conflict between physicists and engineers. Physicists used to use the c.g.s. system of units, in which the dielectric constant of vacuum is unity and so D is equal to E in a vacuum. (Before assuming that they are the same thing, as well as being equal in magnitude, note that it was the rate of change of D , not E , which Maxwell called displacement current.) Some physicists argue that they must be identical, because the only physical entities which really exist

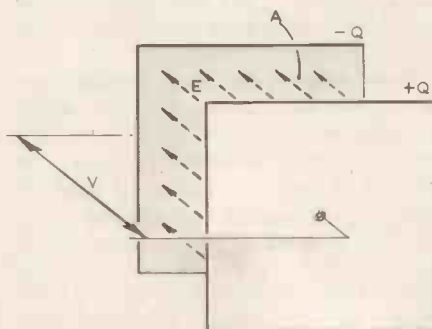


Fig. 1. Electric field and charges in a parallel plane capacitor.

are space and sub-atomic particles; and the difference between D and E in a material medium is due to the reactions to the field of the various charged particles in the medium. From an engineering viewpoint, however, it is convenient to split the fields between "cause" and "effect", the former being independent of the nature of the medium. In electrostatics the total value of D integrated over a surface is equal in SI units* to the enclosed charge from which the "flux of electric induction" D originates (Gauss's theorem). This is always true, whatever the medium, so D can be regarded as a primary field which emanates from charge, the "cause" of any observed phenomenon. Then the electric force field E is an "effect" of which the magnitude is found by dividing D by the dielectric constant ϵ of the medium, which for a vacuum is $\epsilon_0 = 8.854 \times 10^{-12}$. (The units are farads per metre.) The reason why ϵ_0 is not made unity in the SI system is to enable the system to incorporate ampere, metre, kilogram and second as basic units. One can test directly the inverse-square law of force between two concentrated charges, but one will need a constant of proportionality like the gravitational constant in the formula for the gravitational force between two masses. If the formula for force between two charges

$$\text{Force} = \frac{q_1 q_2}{4\pi\epsilon r^2} \dots (3)$$

is to apply with force in newtons, charge in coulombs and distance in metres, then for a vacuum ϵ must be given the value cited above for ϵ_0 . The right-hand side of equation (3) can be split by introducing electric field of force E :

$$\text{Force} = q_1 E_2$$

where

$$E_2 = \frac{q_2}{4\pi\epsilon r^2} \dots (4)$$

The subject of magnetism has been confused by the use of permanent magnets and is more complicated because the simple (scalar) relationships of electrostatics have to be replaced by vector relationships. The equation for the element of force between two current elements of lengths dl_1 , dl_2 and current strengths i_1 , i_2 is

$$dF = \frac{\mu}{4\pi} \frac{i_1 dl_1 \times i_2 dl_2 \times a_r}{r^2} \dots (5)$$

where heavy type indicates vector quantities, a_r is a unit vector in the r direction and the crosses indicate vector or cross products rather than arithmetic multiplications. This also can be split into a current and a field of magnetic force,

$$dF = i_1 dl_1 \times B_2 \times a_r$$

where

$$B_2 = \frac{\mu}{4\pi} \frac{i_2 dl_2}{r^2} \dots (6)$$

If B is uniform along the length of a current-carrying conductor, and

* SI units are an international set of units, by now universally adopted, which are mostly identical with m.k.s. units.

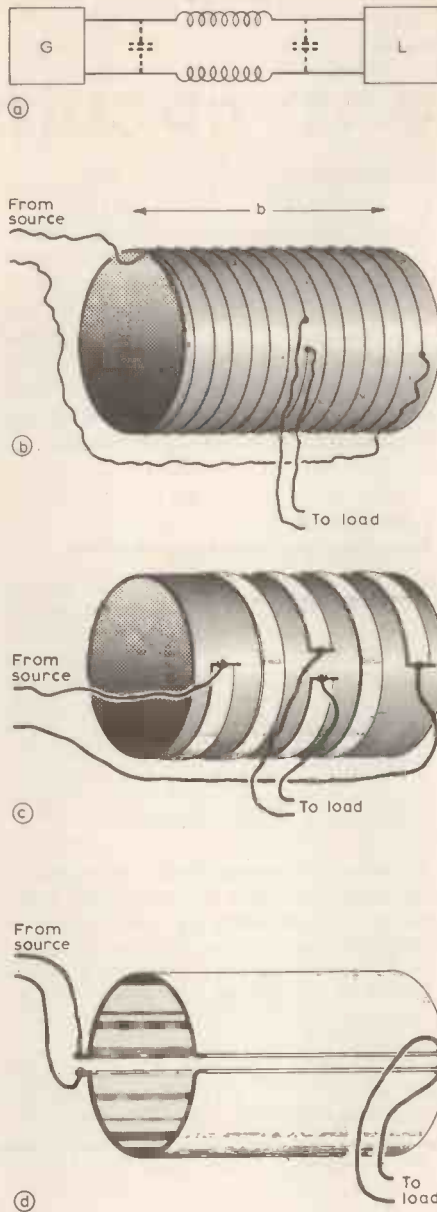


Fig. 2(a). Equivalent circuit of a source G connected by a transmission line to a load L ; (b) circuit of (a) simulated with a multi-turn centre-tapped inductor; (c) as (b) but winding of inductor reduced to a few turns; (d) inductor winding reduced to a single centre-tapped turn. (The connecting wires are only indicative and not at all practical.)

throughout at right angles to it, equation (6) can be simplified to an arithmetic relation

$$F = Bil \dots (7)$$

which can be used, for example, to predict the force on the coil of a moving-coil loudspeaker. From Maxwell's fourth equation, expressed in terms of H and D rather than B and E ,

$$\text{curl}H = J + \frac{dD}{dt} \dots (8)$$

we see that H depends only on currents and charges (J is current density) and is independent of the medium. Engineers have long regarded H as a "cause" and called it magnetomotive force, while the

magnetic flux B is regarded as an "effect": one has to provide the appropriate magnetomotive force in order to establish the desired flux in a given magnetic circuit. Unfortunately the electric and magnetic systems are not quite symmetrical since in the electric system field D is continuous across a boundary between different media, but in the magnetic system field B is continuous. This is related to the point that 'lines' of D terminate on electric charge while 'lines' of B are always closed loops.

After this lengthy digression to establish electric and magnetic fields we can come to Poynting's theorem (proposed by J. H. Poynting in 1883) that the flow of energy in an electrical system which is usually expressed as the circuit quantity vi can alternatively be expressed in terms of the power flow per unit area of a surface drawn through the electric and magnetic fields surrounding the conductors. In vector notation this flow is represented by the Poynting vector

$$P = E \times H \dots (9)$$

The vector P is at right angles to the plane containing E and H and its magnitude is $EH \sin \theta$ where θ is the angle between E and H ; and in most cases of interest E and H are at right angles so that the magnitude of P is simply EH . The coaxial cable provides an example in which the fields are known and limited in extent (within the cable); but it involves a little mathematics to deal with the radial non-uniformity of the fields and has therefore been relegated to the appendix. A strip transmission line provides an example with simple rectangular geometry (if one neglects fringing at the edges) and provides an opportunity to enlarge on the measurement of H in amperes per metre.

The circuit shown in Fig. 2(a), with the inclusion of the capacitances in dotted lines, is the lumped equivalent circuit of a transmission line between a source G and a load L . Note that we are not in any way restricted as to frequency. The source G may be simply a battery supplying d.c. or an a.c. generator; and the load may be simply a resistance or a complex impedance. In the latter case there may be a phase angle between electric and magnetic fields, but this is taken care of by the fact that the Poynting vector uses instantaneous values of field and the average power flow is to be found by averaging P over a complete cycle of the alternating current. In Fig. 2(b) the inductive part of the equivalent circuit is shown as a solenoid of length b wound with a fairly large number n_1 of turns of thin wire carrying a small current i_1 . The load is inserted at the centre of the inductance. If end effects are neglected, the magnetomotive force is

$$H = n_1 i_1 / b \dots (10)$$

In Fig. 2(c) the coil has been re-wound with a small number n_2 of turns of copper strip carrying a larger current i_2 .

As long as $n_2 i_2$ is equal to $n_1 i_1$, the value of H will be the same. In Fig. 2(d) the process has been pushed to the limit, with only one turn. Alternatively the changes can be thought of as taking the original winding with groups of different numbers of turns in parallel instead of in series. Clearly the number of turns, or the series/parallel connection of turns, does not matter as long as the total current circulating around the solenoid is kept constant. For Fig. 2(d) in particular one can write

$$H = i/b \text{ amperes/metre} \dots\dots\dots (11)$$

It is a simple matter to squash the inductor of Fig. 2(d) into the strip transmission line of Fig. 3. The magnetic field in the space between conductors will remain unchanged at $H = i/b$ A/m. Assuming for the moment that the resistance of the transmission line is negligible so that the potential difference between the two strips is v throughout the length, then with separation d the electric field is $E = v/d$ volts/metre. The magnitude of the Poynting vector for power flow per unit area through a cross-sectional surface is

$$P = EH = (v/d)(i/b) \dots\dots\dots (12)$$

But this is per unit area and the area of cross-section is bd so the total power flow is $bdP = vi$.

If the voltage drop along the line is not negligible, the conditions near the upper strip are as shown in Fig. 4. The electric field no longer consists only of the component v/d normal to the strip:

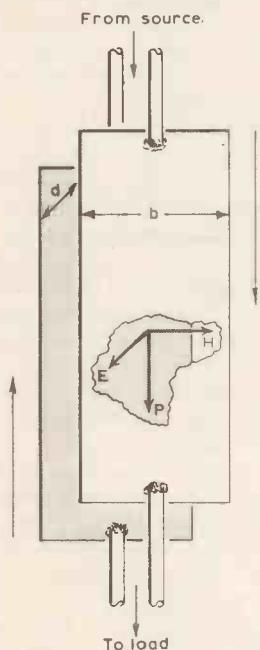


Fig. 3. Strip transmission line.

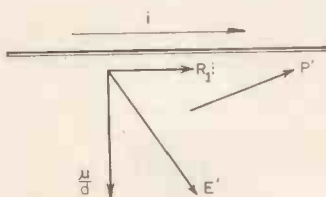


Fig. 4. Directions of fields and of Poynting vector near a lossy plane conductor.

there is also the component $R_i i$ corresponding to the volt-drop per unit length of conductor. The resultant electric field is E' and consequently the modified Poynting vector P' does not point straight along the gap, but has a component (proportional to $R_i i$ and H and therefore to $i^2 R_i$) pointing into the conductor. This indicates a flow of energy from the field into the conductor which matches the $i^2 R$ loss. The Poynting vector method of calculating power flow is always exact, and you may use either the circuit or the field calculation, whichever is more convenient. One obviously uses the field calculation for waveguide and radiation problems.

APPENDIX

Power flow in a lossless coaxial cable.

A cross-section of a coaxial cable having inner and outer radii a and b is shown in Fig. A1. Calculation is simplified if it is assumed that (a) the working frequency is so high that one can neglect penetration of the currents into the conductors and (b) resistive voltage drop along the length of the conductors is negligible. (In fact conditions (a) and (b) are not independent since the skin depth depends on the resistivity.) At distance r from the centre the magnetic field is

$$H = i/2\pi r \dots\dots\dots (A1)$$

We know that the electric field is greatest at the inner surface and decreases towards the outer, but its relationship to the difference of potential v between the two surfaces is not obvious. By using Gauss's theorem as in the procedure for finding the capacitance between coaxial cylinders it can be found that at radius r

$$E = v/r \ln(b/a) \dots\dots\dots (A2)$$

(\ln is the symbol for a natural logarithm, otherwise denoted by \log_e .) The power flow

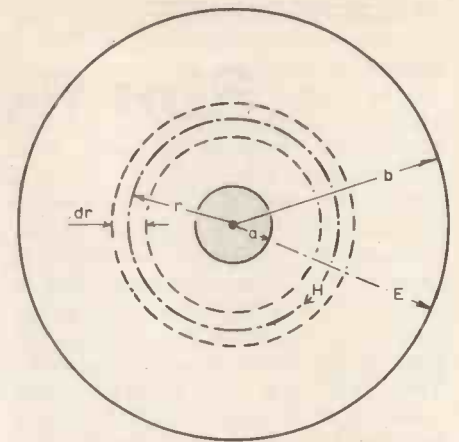


Fig. A1. Cross-section of coaxial line with inner and outer conductors of radii a and b . The direction of power flow, $E \times H$, is into the paper.

dW through an annulus between radii r and $r + dr$ is given by the magnitude EH of the Poynting vector multiplied by the area $2\pi r \cdot dr$ of the annulus. (The direction of the Poynting vector is of course parallel to the axis of the coaxial system.)

$$dW = EH \cdot 2\pi r \cdot dr = iv \cdot dr/[r \ln(b/a)] \dots\dots\dots (A3)$$

The total power flow is then

$$W = \frac{iv}{\ln(b/a)} \int_a^b \frac{dr}{r} \dots\dots\dots (A4)$$

But the value of the integral is $\ln(b/a)$ so $W = iv \dots\dots\dots (A5)$

If the resistance of the conductors is significant, then just as in the case of the strip line there will be a component of E parallel to the length of the system and a component of the Poynting vector pointing into the conductors to account for the $i^2 R$ loss. \square

BOOKS

Telecommunication System Engineering, by Roger L. Freeman, is described as "a textbook and ready reference for the student, practising engineer, planner and telecommunication engineer." The view of telecommunications adopted is the widest possible, since in 480 pages radio is only allotted 66, which does seem a little cavalier, to say the least. The main body of the book is therefore concerned with the communication over telephone circuits of voice messages, data and facsimile, in analogue and digital forms.

In the field the author sets out to cover it is difficult to imagine a more complete treatment, starting as it does with a diagram of two telephones, a cable and a battery, and finishing with the concept of digital data networks and the economical technical planning involved in national networks. The author is American, which may mean that some transatlantic terms are unfamiliar, although he has used the UK engineers' term 'bearer,' for example, to denote the signal-carrying medium. The book is published at £17.70 in hardback by John Wiley and Sons Ltd, Baffins Lane, Chichester, West Sussex, PO19 1UD.

Practical Hi-Fi Sound, by Roger Driscoll, is the latest in a long line of books intended to clarify the absurd technospeak so carefully built up by makers of sound equipment. The main difference between this one and a great many of the others is that this author keeps his object well in mind and does not fall prey to the temptation to show his own technical superiority.

The treatment is not detailed, but rather seeks to answer the questions which would be asked by someone who wanted to know some of the background to the present state of audio equipment. The two introductory chapters are concerned with musical sounds and their reproduction, being followed by two sections on equipment, including building instructions for a loudspeaker. The acoustic performance of the listening rooms is dealt with in the final chapter. The book fulfils its avowed purpose admirably and can be recommended. It costs £6.00 and is published by Hamlyn, Astronaut House, Hounslow Road, Feltham, Middlesex, TW14 9AR.

Simple alternatives to the monostable

Using low-cost gates for non-critical timing circuits

by D. Price

In comparison with other i.cs, c.m.o.s. monostables are rather expensive, the 4528 package costing about £1 for two circuits. In a non-critical situation, for example when a reset pulse is required, cheaper solutions are available.

A 4093 NAND Schmitt trigger, costing about 16p per gate, provides the basis for a satisfactory alternative. Referring to Fig. 1, the high input impedance of a c.m.o.s. gate ensures that, in the absence of other constraints, the voltage at B follows the voltage at A. However, gate protection diodes and the bias resistor modify the voltage performance in the following way. After a long quiescent period, the input voltage V_B will be high and the output low. If a negative pulse is applied by G_1 , the input to G will go low and the output will go high. After a time determined by R and C, but not equal to RC, the output will fall. The input potential must be kept low for the duration of the pulse, otherwise the output will be prematurely terminated. A positive going excursion from G_1 will drive V_B above the power supply rail but, as soon as a voltage of $V^+ + 0.5V$ is reached, the gate protection diode starts to conduct and dissipates any excess charge. The circuit is therefore quickly reset. If the resistor is taken to the negative rail, all of the pulse directions are reversed.

The output pulse length is determined by R and C. As an approximation, assume that the trigger point of the gate is half way between the two power rails. Using the formula $V = V^+e^{-t/RC}$, and substituting $V = V^+/2$ gives $e^{-t/RC} = 1/2$. Therefore, $t \approx 0.57RC$.

This principle can be used with two inputs simultaneously as shown in Fig. 2, which gives two gated monostables. However, the NAND property of the gate will not allow the resistors to be connected to the negative rail.

If a slow fall time can be accepted, which is often the case, an ordinary gate can be used as shown in Fig. 3 where a three input NAND becomes a trio of gated monostables costing about 2p each. If an inverted output is required, replace the NAND with an AND gate or take all of the resistors to the negative rail and use a NOR gate.

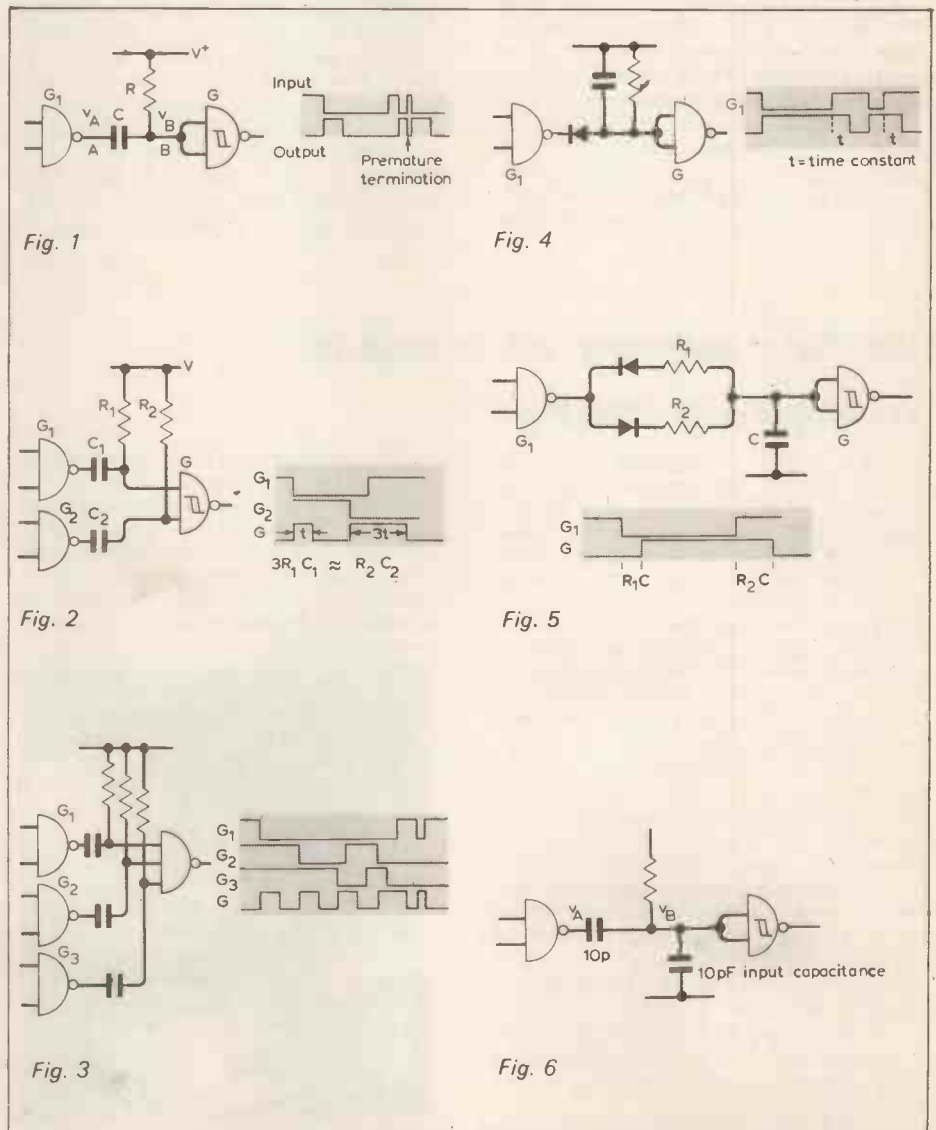
During the off transition of the gate, both output transistors are switched on and are dissipating power. For this reason, long time constants, i.e. slow tran-

sitions, should be avoided. Adding a diode to the external components of the above circuits produces a monostable which is activated while the input is low, and the RC time constant occurs after the input goes high, see Fig. 4. A somewhat more complex arrangement can provide two time constants as shown in Fig. 5. Although this circuit is not a conventional monostable, it is useful if, for instance, a delayed switch on and off is necessary.

A wide range of RC values can be used with c.m.o.s. but, to avoid excessive dissipation and possible damage to the gate protection diodes, capacitor

values below 100nF should be used. This does not apply to Fig. 4 and 5 as the circuits do not use the gate diodes. At the other extreme, less than 10pF may cause trouble due to the c.m.o.s. input capacitance, see Fig. 6. The voltage induced at N_B by a negative transition of V_A is $1/2V_A$, and this may not activate the Schmitt trigger. If the trigger is activated, the time constant will be much shorter than anticipated.

Almost any resistor value above 1kΩ can be used, and for long time constants a reverse-biased diode is a useful high value resistance. The resistance limit of $10^9\Omega$ is set by the input impedance of the gate.



NEWS OF THE MONTH

'More work on spectrum utilization needed' says CCIR chief

Not enough effort is being put into finding better ways of utilizing the radio spectrum, according to Richard Kirby, director of the CCIR. Speaking at a recent IEE conference in London devoted to this subject he said that studies of spectrum utilization ought to be better recognized as a legitimate and challenging discipline of communication science. Many university faculties and research budgets did not recognize this fact. "The subject may be seen only in a limited perspective of radio interference protection, a necessary but mundane appendage to system development. Or, if seen in a broader perspective, as fundamental study to expand the utility of the spectrum as a resource, there is a question of support; return on investment is uncertain, indirect, and long-term. It is clear that there are not very many Ph.D. theses on spectrum utilization topics. Some of the best talent in communication science ought to be encouraged to explore and develop this field. It would seem to me that the IEE is in a good position to foster this".

Earlier Mr Kirby gave an outline of the work in this field that the CCIR (a permanent body of the ITU) will be doing in the aftermath of the 1979 World Administrative Radio Conference at Geneva. He indicated

five main areas: bandwidth-efficient modulation, frequency re-use, domestic and regional satellite systems, the role of h.f. and improvement of equipment standards from the point of view of spurious emissions and unwanted responses.

"First, as regards bandwidth-efficient, interference-resistant modulation: the dominant trend to digital systems for terrestrial and space systems alike, mobile, fixed, and ultimately even television, is being greatly spurred by the rapid development of very large scale integrated circuitry . . . Spread spectrum has already proven advantages for rejection of narrow-band interference and reduction of interfering power spectral density. It remains to be seen whether, by the additional processing gain of correlation codes, an ensemble of spread-spectrum systems can share a given band of spectrum more efficiently than narrow band signals. The new processing technology should have a great bearing on "multi-user communications", i.e. techniques by which one or more transmitters are simultaneously communicating with one or more receivers over a common channel in the radio spectrum. "Packet radio", a related random-access concept, is promising not only for

data, but also for speech. A resolution of the WARC has asked the CCIR to give special attention to studies of these new digital techniques which could lead to a whole new approach to channel assignment and the possibility of greatly expanded use of the spectrum compared with present-day frequency division. At the same time, there is increased emphasis on bandwidth conservation schemes. Some television bandwidth compression techniques are very promising. More conventionally, single-sideband is finally being seriously considered for sound broadcasting. The CCIR has been asked to intensify its studies of means of transition to single-sideband broadcasting". The coming h.f. broadcasting conference, while committed to double sideband for the next plan, also had on its agenda the specification of an s.s.b. system suitable for future broadcasting.

"Frequency-re-use is the objective of some of the most important developments in antenna systems for satellites and terrestrial communications alike. It is also the motivation for important propagation research, especially at frequencies below 40GHz where the main features of propagation are already known. Questions such as how much polarization discrimination can be achieved in practice, as under rainfall conditions, and how small antenna beamwidths can be maintained through the atmosphere, might at one time have been considered second-order questions. They are now central to frequency re-use, as are anomalous propagation effects such as ducting and scintillation."

One of the most important technical topics for the future of radio communications was the efficient use of the geostationary satellite orbit. "One method to increase the efficiency of the use of the orbit is by reduction of inhomogeneity. Sharing is more difficult, less efficient, among a variety of beamwidths, power levels, and receiver sensitivities than among a homogeneous set of these system requirements. So only a degree of homogeneity can be sought, in terms of the range of certain parameters. Other aspects being studied are the level of permissible inter-network interference, and the antenna characteristics for both earth stations and satellites." The CCIR preparatory work for a satellite conference in 1984 was centered on a CCIR working party, which would now also consider methods for ensuring equitable access for all countries to the geostationary satellite orbit.

The h.f. part of the spectrum was "seen as the most economical method for thin route intermittent communications which do not yet justify microwave or satellite links . . . It may remain most susceptible to congestion and interference. There is a considerable technical challenge here to make systems more interference resistant."

New Racal company set to cash in on cheque-less banking

A further step in the trend to electronic banking methods has been taken with the formation of a new company, Racal-Transcom Ltd, which the company claims will be a prime mover in eliminating the need for cheque books and paperwork in many financial transactions.

The systems which Racal Transcom intends to introduce will be designed to eliminate much of the paper work which possible users such as banks, credit companies, finance houses, airlines and retail organisations have to cope with.

Announcing the formation of the new company, Ernest Harrison, chairman and chief executive of the Racal Electronics Group said, "Electronic funds transfer will have a major impact on the retail world, and its international growth potential is extremely large. Eventually it could affect almost everyone who makes a purchase, pays for a service or uses a bank."

Racal-Transcom is a subsidiary of Racal-Datacom of Salisbury, Wiltshire and the design team responsible for the development of the new systems over the last two years will be located in separate premises on the same site.

A Racal-Transcom point-of-sale terminal being demonstrated in a busy supermarket. The customer is using a hand-held device to key in her personal code which, for security, must correspond with the encoded account number on her banker's card, which is placed in the terminal. The customer's bank account is automatically debited and the shop's account credited for the goods purchased.



Open Channel (CB) implications in decisions about model control band

Announcing the government's intention to exempt users of model control transmitters, metal detectors and pipefinding equipment from the need to licence such equipment, the Home Secretary said that current holders of licences would be able to "pursue their hobbies exactly as now, and that . . . this will lead to less bureaucratic control and greater freedom for individuals."

He said that he would be bringing forward proposals in the next few months in relation to the Wireless Telegraphy Act 1949 and at a later stage to identify other categories of radio device which can be dealt with similarly.

Approximately 93,000 licences for model control equipment had been issued up to the end of 1979 and when the new regulations come into force, these licences will be formally revoked. A simplified form of the existing operating conditions will be used so that frequency and output power requirements will remain unchanged. In general, users of the model control band (27MHz) are restricted to 1.5W radiated power, and the current licence fee is £2.80 for a five-year period.

The licence fee for pipefinders and metal detector equipment is £1.40 for five years and the number of licences issued has risen from 2,000 in 1972 to 150,000 in December 1979, reflecting the substantial growth in the use of such equipment by treasure-hunting enthusiasts. However, exemption of metal detectors from licence requirements does not in any way absolve users from the need to obtain permission to enter, search and dig land and to keep off protected archaeological sites.

Equipment will no longer be subject to the

type-approval procedure, so the exempting regulations will set out the simple technical conditions which will have to be met so as to avoid interference to other radio users. The conditions will be framed so that they cover all existing type-approved equipment.

Almost simultaneous with William Whitelaw's announcement was Timothy Raison's disclosure that the Home Office had received 7,800 letters on the subject of c.b. and 40 petitions carrying thousands of signatures. In replies to questions he said that the annual cost to the Post Office of investigations into complaints of interference to "non-broadcast services" and into all forms of illicit installation or use of radio equipment, was about £1 million. The costs incurred in dealing with illicit use of 27MHz were not recorded separately and "no figures are available for the cost of controlling imports of prohibited equipment."

He also revealed that from 1st January to 30th April 1979, 94 persons were prosecuted in connexion with unlicensed installations or use of c.b. equipment at 27MHz, and a further 135 cases are pending. In 1978 a total of three persons were convicted of such offences and in 1979 the total had risen to 91. Minister of State at the Treasury, Peter Rees, disclosed that 721 sets were seized by Customs and Excise in the first quarter of 1980 and a total of 2,250 during 1979.

One interpretation of these official trends might be that the government wishes to give no more than the appearance of movement on the Open Channel issue. With c.b. enthusiasts becoming more vocal as a result of continuing stalling tactics from both government and Home Office (the discussion document promised in April has not

materialized), it may be that licence exemption for model users is a red herring designed to, on the one hand, suggest more freedom of access (it is only an official sanction) to the spectrum, and on the other hand to consolidate the decision not to introduce Open Channel at this frequency.

De-regulation could have the effect of encouraging more widespread use of 27MHz by modellers, who might then very jealously guard their spectrum "slot", perhaps even introducing a "self-policing" activity . . . "Kamikaze model aircraft crashes in flames on illicit radio shack."

The only positive conclusion to be drawn from these government pronouncements is that something may well happen at some future date, having been duly considered and fully costed.

News in brief

The Mobile Radio Trade Association, formed in 1978, was set up with the intention of obtaining for its members effective representation with both manufacturers and statutory bodies. The association's aims and an outline of the facilities it can offer to interested companies or fleet operators are available from its offices at 9-11 Lower Addiscombe Road, Croydon, Surrey, Tel: 01-680 4444. The annual membership subscription is £50 plus v.a.t.

South London College will be running a course of eight lectures, the first starting on 14 October, 1980 and the last on 2 December 1980, entitled "Optical Fibre Communications." The course is intended to provide a comprehensive technical introduction to optical communication devices and systems and their application to multi-channel telephony and wideband services. The course fee for London students is £9 and applications should be made to A. A. Rowlands, South London College, Knights Hill, London SE27 0TX. Telephone 01-670 4488.

Plessey expands and contracts

The Secretary of State for Industry, Sir Keith Joseph, officially opened the Plessey p.c.b. plant at South Shields on July 11th, and also formally introduced the new company — Plessey Circuits Ltd.

The aim of the plant, which represents an investment of £5 million, is to produce mainly plated-through-hole (p.t.h.) p.c.bs on a large scale for marketing in the UK and in Europe at competitive prices by using modern masking, etching and plating techniques and a production line which is almost completely controlled by a central computer. V.d.us, strategically placed at each point in the line, give all the information required by the process operator including audible "cautions" and "warnings" of out-of-tolerance conditions such as high etch bath temperature, etc.

The plant has a production capacity of over 2.5 million p.c.bs a year and currently has a workforce of 185 people, which is expected to rise to 300. Plessey pre-tax profits for the year ended March 31, 1980, were 30% up at £60.1 million. In a cold and precise paragraph released in June, the company also refers to "extraordinary items . . . (£4.7 million) . . . "which includes the cost of eliminating the loss-making businesses of Garrard and Plessey Automatica Electrica Portuguesa. Losses have also been eliminated on Strowger activity at Edge Lane."

Part of the new facility at Plessey Circuits Ltd, South Shields, showing the drilling and routing area. Eight-spindle drilling / routing machines are in use, providing a hit-rate of up to 350 per minute, with routing rates of 4ft per minute to a positional accuracy of plus or minus 0.0008 in. Tool change is automatically controlled by computer.





Fifty years ago, this 211 lb. wonder, the Blattnerphone, was used to record and reproduce a speech by King George V on a 6mm steel tape. This tape recorder, which was featured during May at the Bridgwater Exhibition (Admiral Blake Museum) 'Broadcasting in the Twenties and Thirties' is considered by some to have been the first suitable for broadcasting.

Unsuspected gremlins at work in hospital computing

According to an item in Reports on Research (Massachusetts Institute of Technology), computer-based administrative and medical information systems in hospitals in the US, are prone to interference by hospital staff. In some cases this interference, which is often accomplished through subtle processes such as non-co-operation in schemes to change from manual to automatic systems, is detrimental to the running of hospitals and may be detrimental to the health of patients.

Alan Dowling, a doctoral candidate in health management and management information systems at MIT's Sloan School of Management, defines staff interference as "instances where a member of the hospital staff deliberately acts or fails to act, so as to oppose, retard, hinder or impede a system's implementation." He says the interference can be overt or covert, violent or non-violent and can range from "passive non-co-operation to physical destruction."

Dowling conducted a survey of 40 hospitals and as a result of findings decided that this form of interference had occurred in at least half of them. He believes the reasons for this behaviour are more complicated than simple resistance to change, although this is an underlying factor. He cites other causes such as human organizational problems which the system may aggravate, difficulty in dealing with hardware and software problems, insufficient resource support for the implementation effort, lack of user involvement, changing staff reward structures and failure to meet staff expectations because of "overselling" the system.

As the number of hospitals attempting to change to computer-based systems grows, so the negative aspects of computer-bashing may be more seriously felt, with direct effect upon patient care. The problem isn't unique to hospitals, according to Dowling, and is fairly widespread in industry, but emerges as

more serious in hospitals, where there is a "high rate of turnover among system vendors", suggesting that these problems are generally being ignored.

Where patient care is concerned, as Dowling points out, potentially life-threatening situations could result from a practitioner basing treatment on erroneous data. In his report, he traces three case histories of interference and isolates five major forms of interference. The most common form, he says, is passive resistance, in which a staff member deliberately fails to co-operate with other staff members or system specialists who are trying to implement the system.

In one hospital, the chiefs of several medical departments, themselves opposed to one aspect of a system, quietly ignored the requirement to make their staff available for system training over a prolonged period.

Two-way radio installed in caves

The network of caves below the site of Nottingham Castle is to be served by a two-way radio system, the equipment being supplied by Pye Telecommunications for the City of Nottingham's Technical Services Dept.

These caves are open to the public for guided tours and as a result of difficulties experienced by elderly visitors negotiating the slopes and bends, as well as for security purposes, the city's administrators decided to install a base station at ground level, supplemented by several "Pocketfone" portable two-way transceivers.

The scheme will enable guides, who are not permitted to leave their parties once underground or send a member of the party for help, to summon medical aid instantly.

Marconi to supply military equipment to China

A £40 million contract for the supply of electronics equipment "for defence purposes" has just been signed by Marconi Avionics and China.

The contract calls for delivery of equipment and associated trials and includes the establishment of some manufacture under licence in China. The main body of the work, which the company says will create several hundred skilled jobs in Kent, Essex and Hertfordshire, will consist of engineering, production, on-site trials and product support.

Marconi supplies avionics systems for 150 different aircraft and, in addition to supplying a wide range of electronic equipment for aviation, industrial and military applications, has already established the production of fuel flow measurement equipment under licence in China.

News in brief

Illegal c.b. operator Thomas Hanson, whose callsign is Captain Beaky, will be getting his transmitter back from the Home Office investigators who confiscated it after a raid on his car. Although he was fined £80 for installing and using the equipment in a vehicle, the magistrates at York, where prosecuting council Julian Hay had asked for the £200 set to be forfeited, refused to make such an order.

The International Broadcasting Convention (IBC) will be held from 20 to 23 September 1980 in Brighton, at the Metropole Hotel. Further information is available from the IBC Secretariat, IEE, Savoy Place, London WC2R 0BL.

Newcastle upon Tyne Education Authority is running a course which is designed to prepare students for the Radio Amateur's Examination (RAE). The course begins in September 1980 at Gosforth Secondary School and will run every Tuesday from 7 to 9 p.m. Candidates for the May/June examinations may sit for them at the school and any enquiries should be addressed to the Principal, Gosforth Adult Association, Gosforth Secondary School, Newcastle upon Tyne or by telephoning Newcastle upon Tyne 668439.

Industrial and Trade Fairs Ltd, have announced plans to hold Components '81 at Earls Court, from 9 to 12 June 1981. The event will be known alternatively as the Electronics Components Industry Fair and the company is to invest £400,000 in what the exhibition director, Frank Winter, describes as "a major event on a scale comparable to the Munich and Paris events and to establish and maintain the international credibility for the industry." Full details can be obtained from Industrial and Trade Fairs Ltd, Radcliffe House, Blenheim Court, Solihull, West Midlands B91 2BG.

Universities and companies to unite in industrial robot programme

At a recent press conference held at the headquarters of the Royal Society, officials of the Science Research Council announced a £500,000 five-year programme funding in industrial robotics.

The plans outlined by Peter Davey, the programme co-ordinator, will involve the realisation of university-bred ideas by companies interested in both development of the robots and their exploitation in manufacturing industry. The council says that UK industry has seriously lagged behind its overseas competitors in taking up robotic techniques and current research activity is "sparse". The main aim of the projected programme, according to Davey, will be to "leap-frog" the present generation of robots and devices and to provide the research necessary to take full industrial advantage of the technique as it emerges in the mid 1980s.

A number of vital areas of activity had been identified, including the development of fast-acting tactile, visual and aural sensory devices, modular robot construction, better, cheaper and lighter actuators and linkages and work on the effects of wear on accuracy. Other vital areas of interest include optimization of robot dynamics, research on safety aspects and the development of standards.

The first collaboration will take place between Warwick University, the Basingstoke-based company, Lansing-Bagnall (fork-lift truck manufacturers) and GEC. Lansing-Bagnall's interest lies particularly in the need to produce free-roving industrial vehicles, to replace those currently in use which are controlled by taut wire or by optical means. GEC comes into the picture as the company which will promote the so-called "intelligence" in the machine. The technical problems to be investigated and developed are coincident with those of com-

puting in general — communication problems such as pattern recognition, analysis and processing, speech recognition and generation, improved graphics and displays etc. — typical microprocessor application problems.

Comments were made at the press conference concerning the current main application of industrial robots — in the automotive industry. It was felt that although there is considerable exploitation of robots in this field, the natural growth area lies in flexible manufacturing systems, where a large number of different product types will be demanded by an increasingly sophisticated market.

In response to a question concerning the application of robots to difficult or dirty jobs, such as mining, Mr D. H. Roberts, of GEC, said that such an application could not be



Not quite the shape of things to come as foreseen by H. G. Wells or Isaac Asimov, but a working robot called Commander Bill. Developed by the Research Group at Warwick University, the robot has been specially designed to operate over rough terrain and to negotiate steps.

considered in the same light as manufacturing needs. He emphasized this by commenting on questions dealing with the possibility of domestic robot development by saying that "Britain will not go broke if the domestic robot does not emerge, but it will if the industrial robot does not."

Peter Davey felt that, in any event, the domestic robot would have to exist in a very dirty environment, which might preclude cost-effective development of peripheral equipment.

The SRC has produced a handbook outlining plans for the robotics development programme, which includes a summary of the main areas of activity. A firm building robots may be a suitable partner in the scheme if it acts as a "window" through which the academic group may be aware of not just one, but a number of potential applications which can benefit from the proposed work. On the other hand, there are few such firms in the UK and those that do exist tend to be preoccupied with the problems involved in producing their current models.

University or polytechnic groups wishing to take part in the programme, or firms seeking links with such groups, should contact the programme co-ordinator as early as possible to discuss in outline the proposed area of research, and the chance of a formal application being successful. If both factors appear promising, a grant application should be prepared on form RG2 with a supporting case not exceeding 6 pages clearly defining the objectives of the research, the methodology to be employed, project milestones and staff and equipment required.

Also attached should be a letter from senior management in the partner firm to support the programme of work and to give detailed costings of staff, equipment and facilities etc.

Grants will normally be made for periods up to 3 years, or perhaps 4 in special cases. Deadlines for completion of the final application are the SRC's normal ones of 1 April, 15 September and 15 December in any year.

Further details are available from Mr P. G. Davey, Co-ordinator of Robotics Programme, Rutherford and Appleton Laboratories, Chilton, Didcot, Oxfordshire OX11 0QX. Tel. Abingdon (0235) 21900, ext. 6106.

Catching Halley's Comet by the tail

Giotto, the 14th century Italian painter, who was also noted for his observations of Halley's Comet in 1301, is to be commemorated in a related event — the interception of the comet by a satellite. At least, this is the hope expressed by the British Aerospace Dynamics Group, who, under contract to the European Space Agency, have recently completed a feasibility study of the operation.

The satellite, to be called Giotto, will be based upon the GEOS-1 and GEOS-2 designs, and if everything goes according to plan, will be launched early in 1985 or 1986, when the comet makes one of its 76-yearly appearances in the night sky. The object of the mission will be to obtain data from instruments aboard the satellite on the chemical composition of the "coma" region surrounding the nucleus as well as that of the tail. Photographs will be taken of the nucleus and measurements will also be taken of the comet's magnetic field.

In order to make the checks effective, the satellite must pass within 1000km of the nucleus and since only a few hours of observation will be possible, prediction of accurate orbits is vital to the success of the operation. A solid propellant rocket motor will be used to inject the satellite into the comet's orbit and data will be transmitted nearly 100 million miles back to Earth.

A spokesman of British Aerospace Dynamics pointed out that, important as the mission is, there is no guarantee that it will be approved, although recent events seem encouraging. The appropriate ESA committee met in mid-July and gave a favourable report, but has yet to decide how the undertaking will be funded and managed. A definite decision is expected by September 1980.

Government go-ahead for Inmos as censure motion falls

The second charge of £25 million pounds due to Inmos, the state microcircuit company, is to be released by the government and will be supplemented by further amounts up to 22% of this amount depending upon where the production plant is sited in South Wales.

Announcing the plans for Inmos at the crucial moment in the debate on the Opposition's motion of censure on July 29, Mrs Thatcher said that the plans are expected to create 2,000 new jobs. In addition, seven "enterprise" zones will be set up in areas of economic and physical decay.

Sir Keith Joseph said that he had spent a long time over the decision because of the

question of siting the new factory. It had originally been the intention to site it in Bristol, where Inmos already has a technological centre. A report on this delay was given in News of the Month in *Wireless World* August 1980.

Both the government and the NEB, of which Inmos is a subsidiary, are reported to be looking for private sector involvement as soon as possible and Sir Arthur Knight, the NEB's chairman, said that he expected the company to be self-financing by 1984. Sir Keith also announced that there will be a second UK production plant set up and, like that in South Wales, will manufacture advanced memory devices.

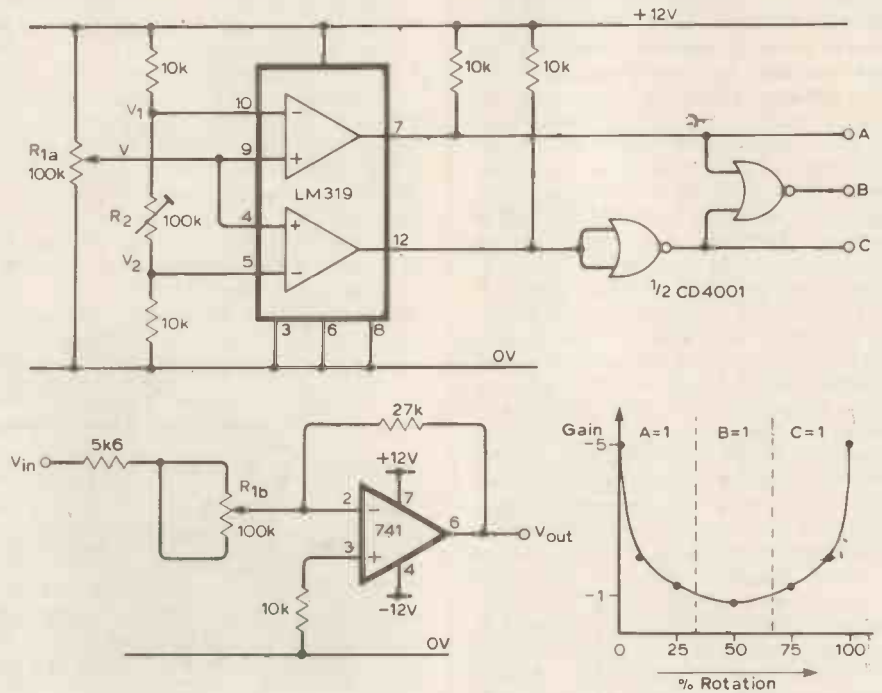
CIRCUIT IDEAS

Flexible rate control

This circuit may be useful for digital tuning or a model control which requires reverse, stop, forward and speed functions from one potentiometer.

Resistor R_{1a} controls digital outputs A, B and C via two comparators so that A is 1 when $0 < V < V_1$, B is 1 when $V_1 < V < V_2$ and C is 1 when $V > V_2$. The ratios of A, B and C, shown on the graph, can be varied by R_2 . R_{1b} controls the analogue output symmetrically about the centre of rotation. The control is non-linear and varies most rapidly at the extremes of rotation.

In some applications it may be more useful for R_{1b} to control a RC oscillator.
D. C. Hopkins
Newcastle
Gwent



Parallel binary multiplier

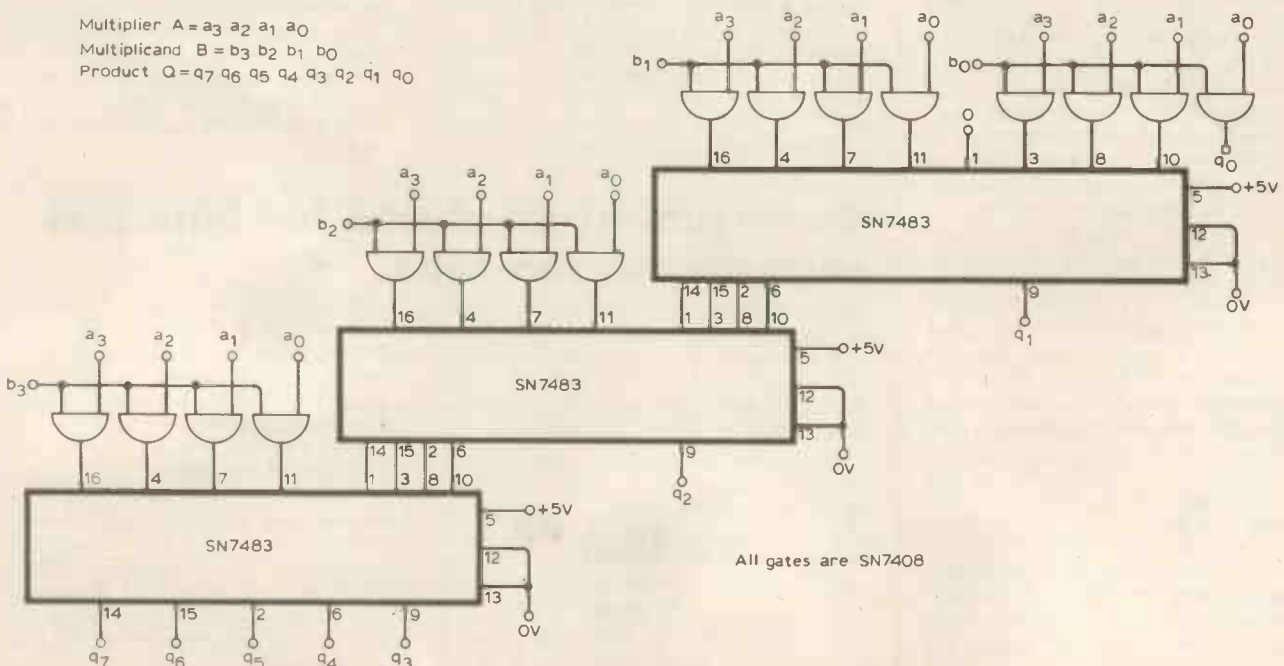
Binary multiplication is usually performed by repetitive addition using serial and/or parallel operations. Be-

cause parallel multipliers are faster, they are preferable for computing applications. This circuit is a 4×4 -bit parallel multiplier which operates in a similar way to conventional written multiplication. The 8-bit product is

generated in less than 60ns, and at around half the cost of dedicated circuits such as the 74284 and 285.

Imaddin Al-Bazz
University of Technology
Iraq

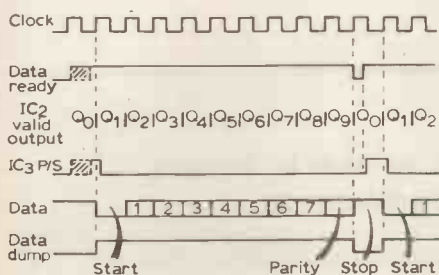
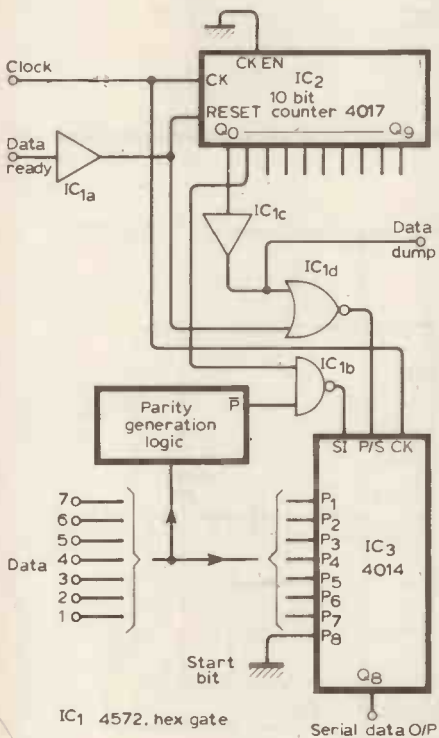
Multiplier $A = a_3 a_2 a_1 a_0$
 Multiplicand $B = b_3 b_2 b_1 b_0$
 Product $Q = q_7 q_6 q_5 q_4 q_3 q_2 q_1 q_0$



Asynchronous serial data transmitter

When information needs to be sent asynchronously using a start-stop bit format, but the application does not justify a standard u.a.r.t. i.c., this data transmitter can provide a simple solution.

When data is available, the Data Ready line goes high, which removes the reset from the counter and sets the shift register in the parallel mode. At the next positive going clock edge, the start bit and seven data bits are loaded into the shift register, Q0 goes low, Q1 goes high,



and IC3 reverts to the serial mode. The parity generator output is enabled by Q1, and, on the next clock edge, the parity bit is shifted into the serial input of IC3. A further clock edge sets Q1 low, so the serial input of IC3 is held high which produces the stop bit state. Therefore, the serial output consists of a start bit, seven data bits, a parity bit and at least one stop bit. A negative going pulse on the Data Dump output indicates that data has been transmitted and the circuit is ready to accept the next byte.

P. M. Gilbert
Malmesbury
Wilts.

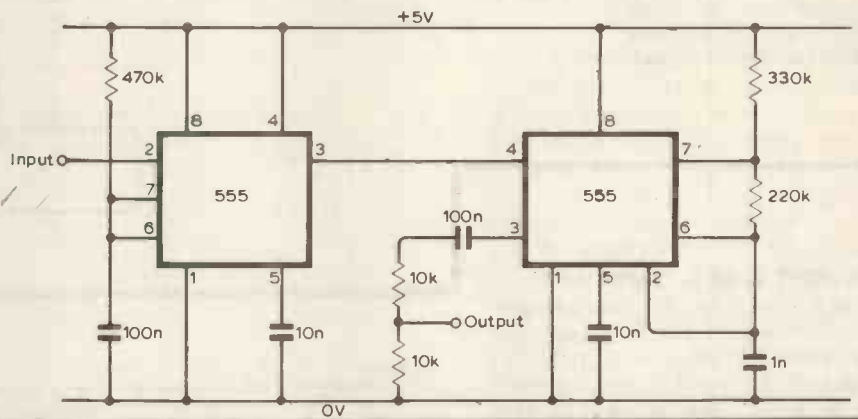
Keyboard sounder

When using a keyboard it is helpful to have an audible indication that an entry has registered. This circuit was designed for the scientific computer, and gives a bleep through the television loudspeaker.

An input 555 is connected as a monostable and, when triggered, gives a 50ms pulse. The second timer is con-

nected in the astable mode, and gives a burst of 2kHz when enabled by the monostable. The input requires a negative going pulse, which is available from pin 17, NMI input, of the Z80. The output is fed to the volume control of the v.d.u.

M. A. Wheatley
Maidenhead
Berkshire



Adding capacitance ranges to a multimeter

Capacitance ranges can be economically incorporated in 3½ digit l.c.d. multimeters based on the ICL7106. A 4066 is used to generate a square wave with the same frequency as the display backplane drive, and with a pk-to-pk amplitude defined by the internal 2.8V reference of the 7106. A second 4066 forms a full-wave synchronous rectifier. One inverter is required and is formed by an exclusive-OR gate because three gates are needed to drive the decimal points.

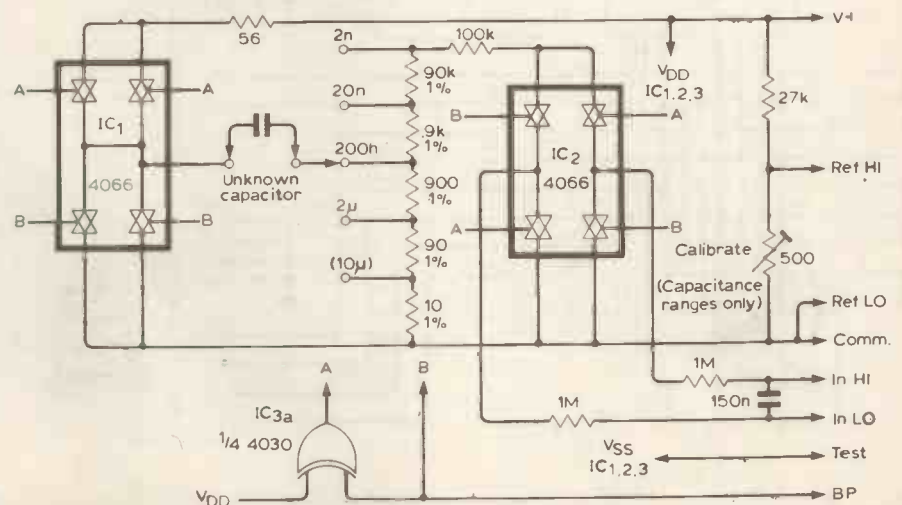
The circuit uses precision shunt resistors and offers good linearity up to about 10µF. Beyond this value the linearity deteriorates rapidly because the capacitor no longer has time to charge or discharge completely during each half cycle.

The 7106 operates on the dual-slope

principle and, for correct operation, the clock frequency should be adjusted or crystal controlled to reject mains pickup by making the integration interval an integer number of mains cycles. An important advantage of this circuit is that ripple, at twice the backplane frequency, across the 150nF capacitor is automatically rejected in the same way. However, the backplane frequency should be several Hertz removed from the mains frequency to prevent a l.f. beat which would cause fluctuations of the capacitance reading. The clock frequencies listed below provide good stability, even when unscreened test leads are used.

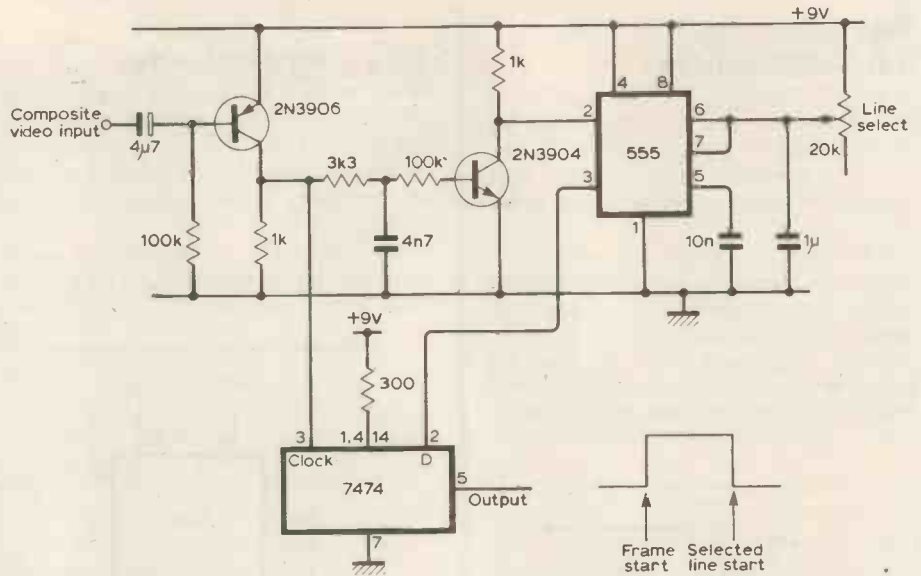
J. B. Cole
Houston
Texas

Mains frequency	Clock frequency	Backplane frequency	Readings sec ⁻¹
50Hz	50kHz	62.5Hz	3.1
60Hz	40kHz	50Hz	2.5



Video-line trigger

An individual video line or group of lines can be displayed on an oscilloscope by using this simple trigger circuit. The 555 monostable is triggered by a frame pulse derived from the mixed syncs, and generates a pulse of up to 20ms. The flip-flop synchronizes the end of this pulse with the next line sync. pulse to prevent display jitter. Current consumption is typically 30mA. P. Newman and M. Tierney Southern General Hospital Glasgow

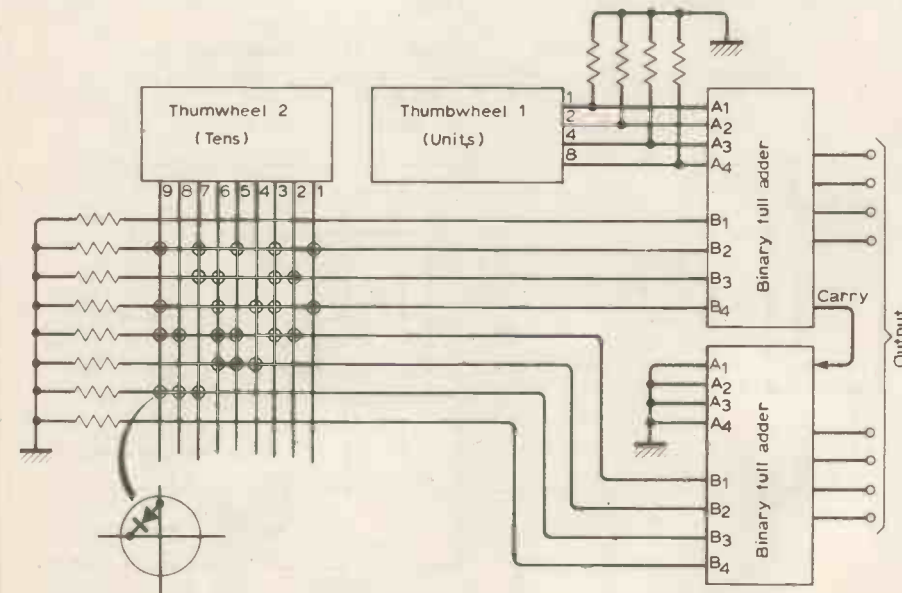
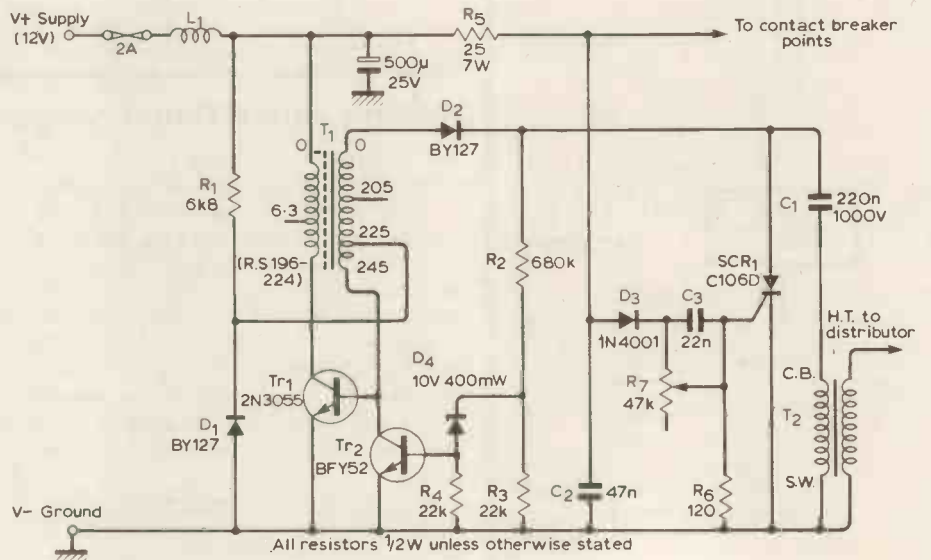


Efficient c.d.i. system

This capacitor-discharge ignition system is based on R. M. Carter's transistor converter, Circuit ideas, Nov. 1975. Tr_1 is biased on by current through R_1 , which causes collector current to pass through the primary winding of T_1 . Positive feedback from the secondary winding increases the collector current and, at saturation, insufficient base current turns Tr_1 off. Energy stored in the magnetic field of T_1 passes through D_2 and into C_1 . This oscillation continues until the charge on C_1 is sufficient to switch Tr_2 on, which then inhibits Tr_1 .

The discharge circuit uses a conventional thyristor design. D_3 , C_3 and R_7 form a debounce circuit, and R_7 can also act as a rev. limiter. Because the inverter has a quiescent current of about 175mA, it will happily run from two alkaline cells.

W. K. Todd Colchester Essex



Decimal to binary conversion

If it is necessary or convenient to load data via thumbwheel switches, this circuit provides a cheap method of conversion provided numbers from 0 to 99 are sufficient. The units thumbwheel is an ordinary b.c.d. type, and the tens thumbwheel is a decimal output version. Each decade feeds the appropriate number into the binary adders, which can be c.m.o.s. or t.t.l.

I. H. Math Alexandria Dunbartonshire

Transient recorder — 2

Control and timing signals

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

The logic required for the address counter is shown in Fig.9. The address lines A_1 to A_8 are set low by the reset button. When the counter is enabled, the address counts from 0 to 255 and IC_{33} produces an end signal to mark the end of a single sweep. If the load signal is taken low, the address presented to the external address input appears on A_1 to A_8 . Therefore, any memory location can be addressed by an external device.

For normal operation the manual/auto switch is set to the auto position. However, if the contents of the memory need to be examined one word at a time, the manual position is selected. After operation of the reset button, the contents of the first memory location will be displayed on the readout. Operation of the manual clock-switch advances the address by one and displays the contents of the next location.

The circuit shown in Fig.10 provides timing signals for the sample, a-to-d

conversion, word storage sequence and the clock signal required for the address counter. Clock 1 and clock 2 outputs, which are t.t.l.-level square-wave signals at the same frequency as the sampling rate, are produced by the voltage-controlled function generator IC_{35} . Five overlapping frequency ranges, are provided and variation within each range is achieved by adjusting a $2k\Omega$ potentiometer which is calibrated from 1 to 11. Frequency variation is roughly linear with potentiometer variation, and a ten-turn potentiometer with a turns counter was used in the prototype. The low-frequency limit is adjusted first by setting the turns counter to 1 and setting the potentiometer to give the correct frequency. The upper limit is set by turning the potentiometer to 10 and adjusting R_5 to give the correct frequency. The 470 pF capacitor may require trimming due to stray capacitance.

A separate +15V regulator supplies

the oscillator i.c. to prevent modulation of the main +15V line by the clock. This additional regulator also improves the stability of the clock frequency. The main power supply in Fig.11 uses two regulators to provide four supply rails.

Increasing the memory

If a larger memory is required, additional stages must be incorporated in the address counter so that the extra memory locations can be addressed. For example, if a third 74193 counter is connected to IC_{32} , in the same way as IC_{32} is connected to IC_{31} , then 12 bits will be available which can address up to 4096 memory locations. IC_{33} will need additional inputs so that the end output is in the low state only when the last memory location is addressed.

If pairs of 256×4 -bit memory blocks are used to construct an 8-bit memory, the address-input lines, data-input and data-output lines should be connected in parallel. The chip-enable and output-disable lines of each pair of memory blocks can then be driven by the outputs of a decoder whose inputs are the address lines of the additional counter stages. The decoding logic ensures that only one pair of memory blocks is active at a time. An alternative scheme, which is more expensive but reduces the amount of wiring required, is to use 1024×4 -bit memory blocks.

Operation

To operate the transient recorder, select auto mode and push the reset button. For recording, select a suitable input sensitivity and sampling frequency, and operate the arm button. In this state the input is continually sampled and the digital word is displayed by the l.e.d.s. With no input present, the a-to-d converter's full range can be observed by adjusting the offset control. With an input signal connected, the recorder is triggered manually or by a 5V high-to-low edge at the trigger input. Triggering may not occur immediately due to the free-running clock, however, it will occur within one sample period and the exact triggering point is identified by a positive edge at the trigger-acknowledge output. Information stored in the first memory location corresponds to the sample taken immediately before this output. Therefore, although the recorder may not trigger immediately, the stored data is valid from receipt of the trigger signal, and in some cases up to a sample period before this. When all of the memory locations have been filled with data, the recording l.e.d. turns off.

To display the contents of the memory on an oscilloscope, select repetitive mode and a suitable playback rate, i.e. the sampling frequency. When the analogue output is connected to an oscilloscope, recorded data is displayed as a continuous periodic waveform. To plot the data on a chart recorder, operate the reset button, select the

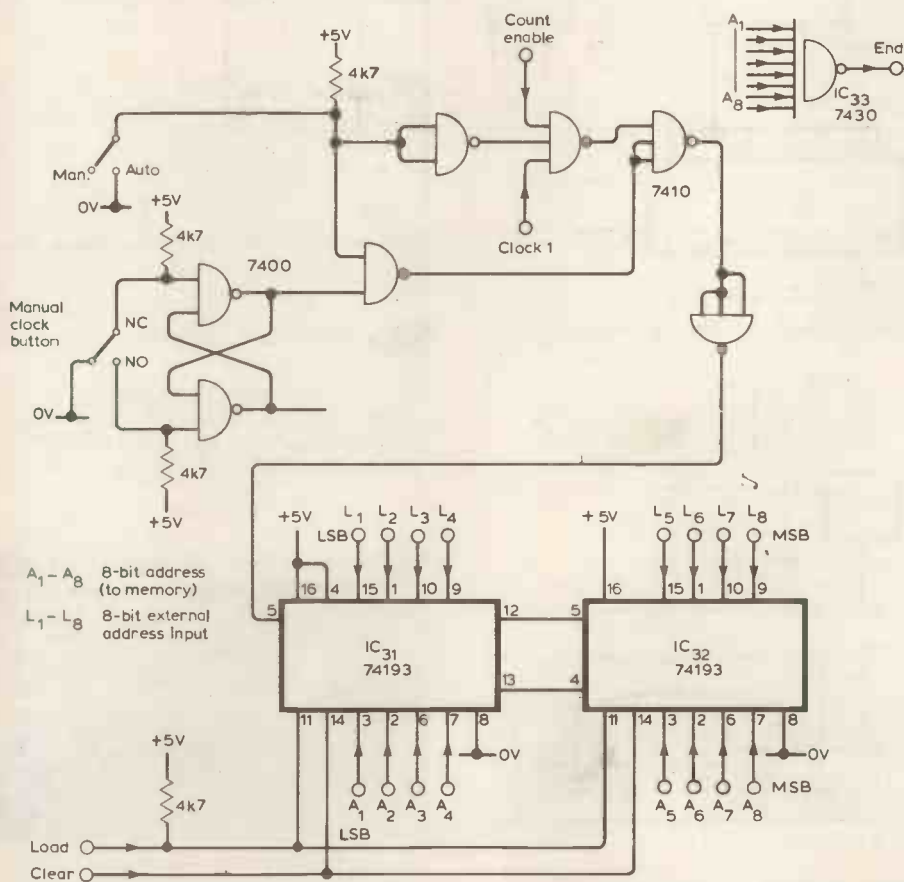


Fig. 9. Counter logic controls the 8-bit memory address.

single-sweep mode and a low playback rate suitable for the response time of the chart recorder.

Operation of the trigger button then produces a single sweep of the memory contents.

If the recorder is armed unintentionally the reset button can be used, but memory location 0 will have become contaminated.

Fig.12 shows an input and output triangle waveform of the recorder and illustrates the smoothing effect obtained by switching in the low-pass filter. Fig.13 shows a pressure impulse

received by a microphone from a loudspeaker. This excitation pulse was obtained from a generator triggered by the trigger acknowledge output of the transient recorder.

Construction of this design is straightforward, but the following precautions should be noted. If a metal case is used it should be connected to earth and also to 0V from the power supply. Even with a low-field transformer, mains-frequency voltages are induced in the chassis, so it is worthwhile to isolate the earth side of the a.c. input socket from the main chassis and con-

nect it to the 0V rail of the input amplifier. This ensures that voltages induced in the chassis do not appear in series with the input signal. Because BNC sockets were used on the prototype, it was found more convenient to isolate the front panel. Separate power supply leads, including 0V, should be used for each board, with connexions made to busbars on the power supply board. If a hexadecimal display is required, suitable i.e.d. types are available such as the TIL311 which can be driven directly by the data-output lines. □

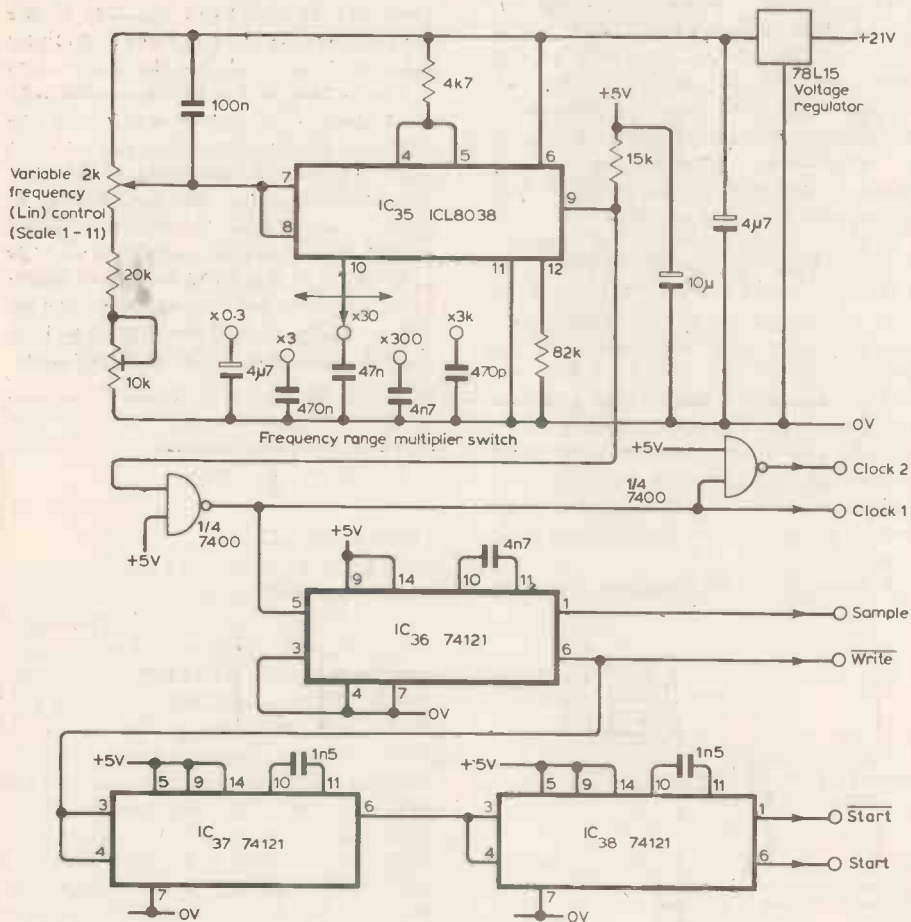


Fig. 10. Clock and timing circuits provide signals for sampling, a-to-d conversion and storage.

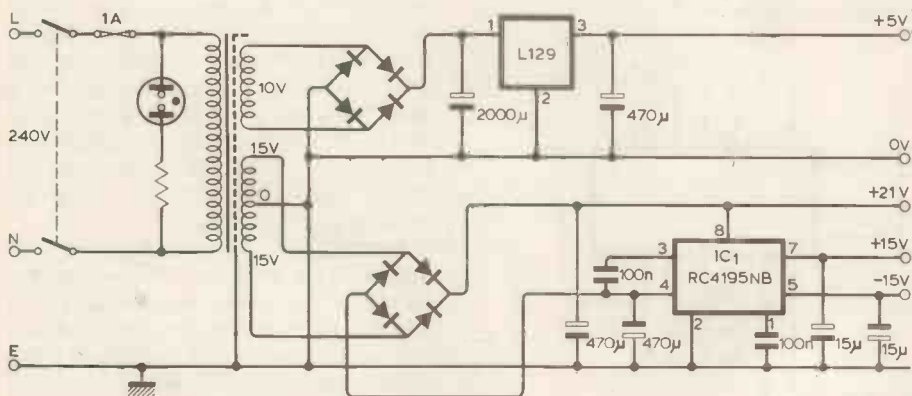


Fig. 11. Power supply. The L129 regulator should be mounted on a heatsink, and a toroidal transformer is recommended.

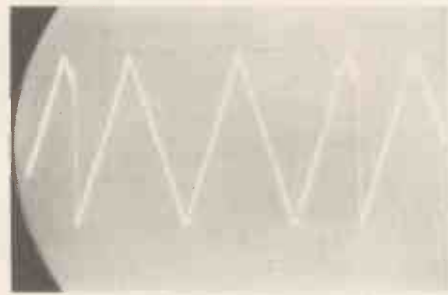
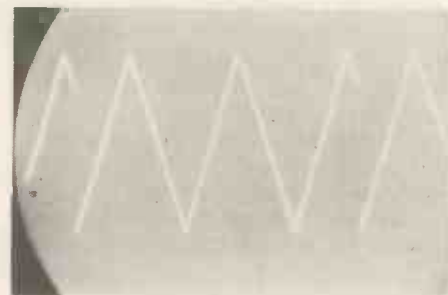


Fig. 12. (a) Input test waveform at 240Hz, (b) output waveform from d-to-a converter after sampling at 24 kHz, (c) output waveform after filtering.

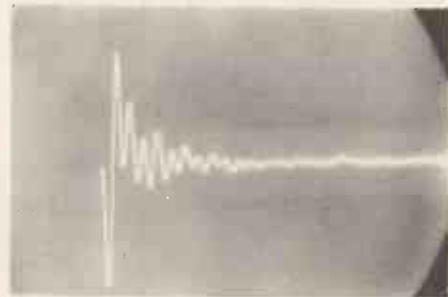


Fig. 13. Impulse response of a loudspeaker system measured using the transient recorder.

Designing with microprocessors

4 — The synchronization problem

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

This article explains the need to synchronize the internal operation of the microprocessor chip with the responses of peripherals. Software and hardware methods of doing this are outlined. Their step-by-step implementation will be discussed in later articles.

When data is to be transferred between two devices, the transmitting device, before it outputs the data, must ensure that the receiving device is able to accept it, otherwise the data will be lost. As communicating devices generally operate at different speeds, their operation must be synchronized, if system malfunction due to speed mismatch is to be avoided. The set of circuits and signals used for this purpose are referred to collectively as *interfaces*. The block diagram of an interface involving two devices, a data source and a data acceptor, is shown in Fig. 1. Its function is to monitor the status signals of the two communicating devices and to generate their command signals in the correct sequence to ensure that they operate in step with each other. In practice an interface accepts external signals for such purposes as initiating a data transfer, putting the system on alert, and so on.

A clear understanding of the synchronization problem and of the available solutions is essential for the design and implementation of microprocessor-based systems, and indeed of any system. We shall start by first describing the nature of the synchronization problem in microprocessor-based systems.

The synchronization problem in microprocessor-based systems is probably best illustrated by considering the steps involved in using a character printer to produce a hard copy of a block of 32 characters stored as bytes in consecutive locations in memory. A simplified block diagram showing the flow of information through a microprocessor chip is shown in Fig. 2 (a). The routing of the data through the microprocessor chip, instead of transmitting it directly to the printer, allows such functions as code conversion, formatting, parity checking and so on, to be performed on the data prior to printing. If no processing is required, a direct link (d.m.a. link) between memory and

printer may be established, as we shall discuss in a future article.

The operation of our system, which consists of fetching each byte from memory into the microprocessor chip and printing it, is shown in Fig. 2(b). The flowchart of the software required to fetch and print each byte is shown in Fig. 3. Its implementation in the case of the Motorola 6800 (see instruction set in Appendix), is shown overleaf.

Reference to the manufacturer's manual (1)* indicates that the execu-

tion time of a fetch/print loop (statements in locations 0005 to 000F) requires 24 machine cycles. If we assume the execution time of a machine cycle to be around $1\mu\text{s}$, the characters will be output to the printer at the rate of around 40,000 per second — far too fast for character printers, which typically will be operating at 30 characters per second. The outputting of data to the printer faster than it can accept it will clearly result in a large proportion of it getting lost. It is therefore necessary for the designer not to output a character to the printer until it is ready to accept it. The most straight-

*See also Appendix

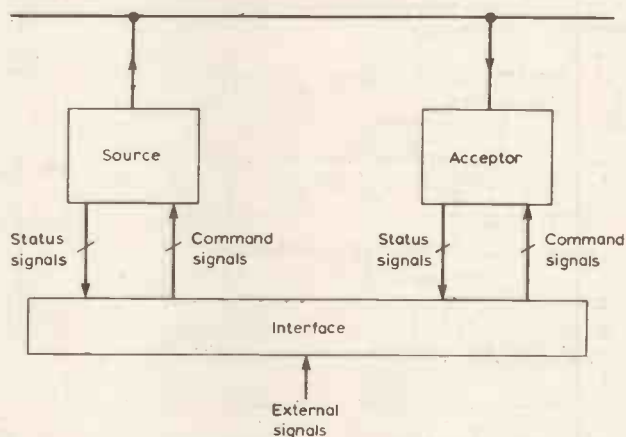


Fig. 1. Block diagram of an interface.

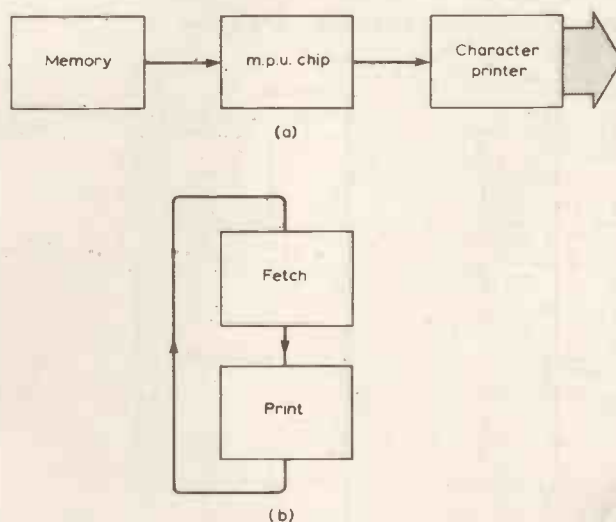


Fig. 2. Block diagrams showing (a) data flow and (b) fetch/print cycle.

Implementation of Fig. 3 processes in Motorola 6800

forward method is to stretch the fetch/print cycle in Fig. 4. This delay can be implemented using either software or hardware; in the first case we shall refer to it as *software wait* and in the second case as *hardware wait*.

Software wait is implemented by means of a programming loop during which the status of the printer is read into the microprocessor chip and tested. If the printer is found to be busy, the process is repeated. When the printer becomes ready (indicated by its status signals), the microprocessor exits the software wait loop, as shown in Fig. 5. Note that the wait loop may be entered either before or after the print operation.

The step-by-step implementation of microprocessor-based systems using software wait will be discussed in the next article.

Hex address	Hex listing	Mnemonics	Comments
0000	CE	LDX # \$U350	Load the index register with the initial memory block address
0001	03		
0002	50		
0003	C6	LDAB # \$20	Load the block length (hex 20) into accumulator B — hex 20 = decimal 32
0004	20		
L1: 0005	27	BEO L2	Go to L2 if acc. B is zero
0006	09		
0007	A6	LDAA \$0,X	Load the next byte to be printed into acc. A
0008	00		
0009	B7	STAA \$0400	Print the byte in acc. A
000A	04		
000B	00		
000C	08	INX	Increment the memory block address
000D	5A	DECB	Decrement the block length
000E	20	BRA L1	Go to L1
000F	F5		
L2: 0010	3F	SWI	End

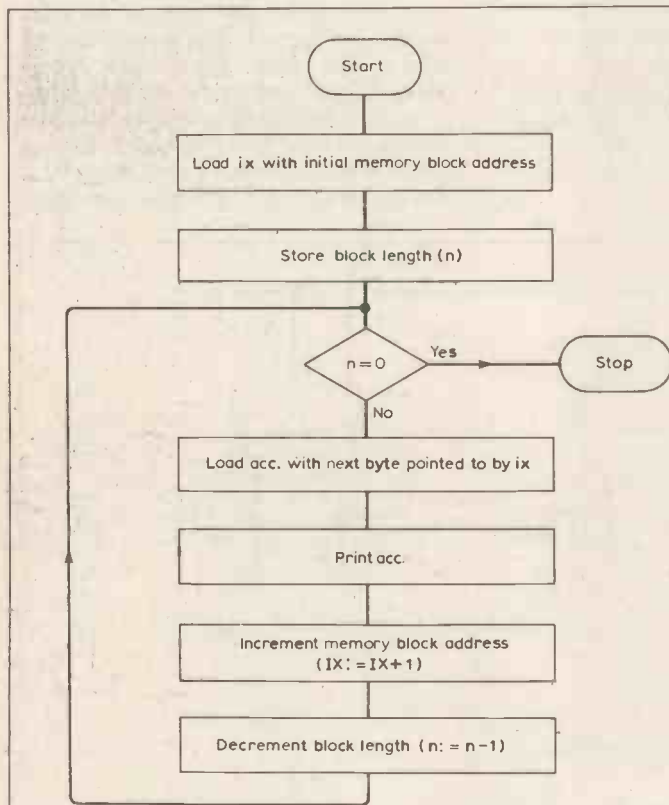


Fig. 3. Flowchart for printing a block of n characters stored in memory.

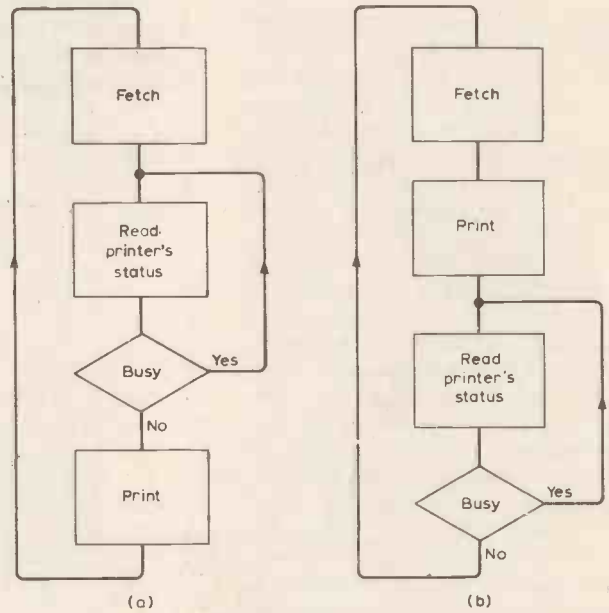


Fig. 5. Flowcharts of software wait loops (a) with wait loop entered before print operation, (b) entered after print operation.

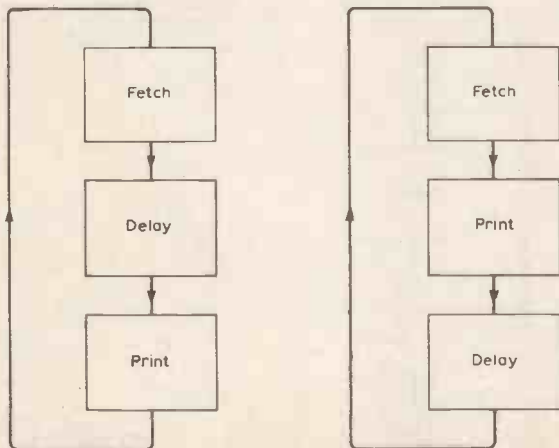


Fig. 4. Stretched fetch/print cycle.

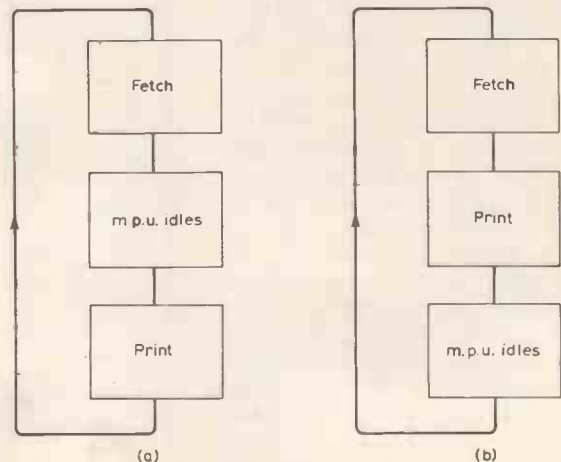


Fig. 6. Flowcharts of hardware wait loops implemented (a) before and (b) after print operations.

Hardware wait is implemented by causing the microprocessor chip to enter into *idling state*, during which all the microprocessor activities are suspended without turning off the clock. As in the case of the software wait, the hardware wait may be implemented either before or after the print operation — see Fig. 6.

We shall refer to the idling state as a *wait state*. The microprocessor may

remain in a wait state indefinitely. The wait state is entered by pulling a specified pin on an m.p.u. high or low.

Examples. Pulling pin 23 low puts the Intel 8080 in the wait state, and pulling it high brings it out of the wait state — see Fig. 3 in article 1.

In the case of the Motorola 6800 the wait state is entered at the end of the current instruction by pulling pin 2 low.

Pulling pin 2 high brings it out of the wait state. The Intel 8085 uses pin 35 in the same way as pin 23 is used in the case of the Intel 8080.

Reference

1. "M6800 Microprocessor System Design Data," Motorola 1976.

Design and implementation of test-and-skip systems will be the subject of the next article.

INDEX REGISTER AND STACK		IMMED			DIRECT			INDEX			EXTND			INHER			BOOLEAN/ARITHMETIC OPERATION						
OPERATIONS	MNEMONIC	OP	~	=	OP	~	=	OP	~	=	OP	~	=	OP	~	=	BOOLEAN/ARITHMETIC OPERATION						
Compare Index Reg	CPX	8C	3	3	9C	4	2	AC	6	2	BC	5	3				(X _H /X _L) - (M/M + 1)	•	•	⑦	↑	ⓑ	•
Decrement Index Reg	DEX													09	4	1	X - 1 → X	•	•	•	↑	•	•
Decrement Stack Pnt	DÉS													34	4	1	SP - 1 → SP	•	•	•	•	•	•
Increment Index Reg	INX													08	4	1	X + 1 → X	•	•	•	↑	•	•
Increment Stack Pnt	INS													31	4	1	SP + 1 → SP	•	•	•	•	•	•
Load Index Reg	LDX	CE	3	3	DE	4	2	EE	6	2	FE	5	3				M → X _H , (M + 1) → X _L	•	•	⑨	↑	R	•
Load Stack Pnt	LDS	8E	3	3	9E	4	2	AE	6	2	BE	5	3				M → SP _H , (M + 1) → SP _L	•	•	•	↑	R	•
Store Index Reg	STX				DF	5	2	EF	7	2	FF	6	3				X _H → M, X _L → (M + 1)	•	•	⑨	↑	R	•
Store Stack Pnt	STS				9F	5	2	AF	7	2	BF	6	3				SP _H → M, SP _L → (M + 1)	•	•	⑨	↑	R	•
Idx Reg → Stack Pnt	TXS													35	4	1	X - 1 → SP	•	•	•	•	•	•
Stack Pnt → Idx Reg	TSX													3D	4	1	SP + 1 → X	•	•	•	•	•	•

JUMP AND BRANCH OPERATIONS		RELATIVE			INDEX			EXTND			INHER			BRANCH TEST									
OPERATIONS	MNEMONIC	OP	~	=	OP	~	=	OP	~	=	OP	~	=	BRANCH TEST									
Branch Always	BRA	20	4	2													None	•	•	•	•	•	•
Branch If Carry Clear	BCC	24	4	2													C = 0	•	•	•	•	•	•
Branch If Carry Set	BCS	25	4	2													C = 1	•	•	•	•	•	•
Branch If = Zero	BEQ	27	4	2													Z = 1	•	•	•	•	•	•
Branch If > Zero	BGE	2C	4	2													N > V = 0	•	•	•	•	•	•
Branch If >= Zero	BGT	2E	4	2													Z + (N > V) = 0	•	•	•	•	•	•
Branch If Higher	BHI	2F	4	2													C + Z = 0	•	•	•	•	•	•
Branch If < Zero	BLE	22	4	2													Z + (N > V) = 1	•	•	•	•	•	•
Branch If Lower Or Same	BLS	23	4	2													C + Z = 1	•	•	•	•	•	•
Branch If < Zero	BLT	2D	4	2													N > V = 1	•	•	•	•	•	•
Branch If Minus	BMI	2B	4	2													N = 1	•	•	•	•	•	•
Branch If Not Equal Zero	BNE	26	4	2													Z = 0	•	•	•	•	•	•
Branch If Overflow Clear	BVC	28	4	2													V = 0	•	•	•	•	•	•
Branch If Overflow Set	BVS	29	4	2													V = 1	•	•	•	•	•	•
Branch If Plus	BPL	2A	4	2													N = 0	•	•	•	•	•	•
Branch To Subroutine	BSR	8D	8	2														•	•	•	•	•	•
Jump	JMP				6E	4	2	7E	3	3								See Special Operations					
Jump To Subroutine	JSR				AD	8	2	BD	9	3								See Special Operations					
No Operation	NDP													01	2	1		Advances Prog. Cntr. Only					
Return From Interrupt	RTI													3B	10	1		See special Operations					
Return From Subroutine	RTS													39	5	1		See special Operations					
Software Interrupt	SWI													2F	12	1		See special Operations					
Wait for Interrupt	WAI													3E	9	1		See special Operations					

CONDITIONS CODE REGISTER		INHER			BOOLEAN OPERATION			CONDITION CODE REGISTER NOTES												
OPERATIONS	MNEMONIC	OP	~	=	BOOLEAN OPERATION			5	4	3	2	1	0	CONDITION CODE REGISTER NOTES						
Clear Carry	CLC	0C	2	1	0 - C	•	•	•	•	•	•	•	R	①	(Bit V) Test: Result = 10000000?					
Clear Interrupt Mask	CLI	0E	2	1	0 - I	•	R	•	•	•	•	•	•	②	(Bit C) Test: Result = 00000000?					
Clear Overflow	CLV	0A	2	1	0 - V	•	•	•	•	•	•	R	•	③	(Bit C) Test: Decimal value of most significant BCO Character greater than nine? (Not cleared if previously set)					
Set Carry	SEC	0D	2	1	1 - C	•	•	•	•	•	•	•	S	④	(Bit V) Test: Operand = 10000000 prior to execution?					
Set Interrupt Mask	SEI	0F	2	1	1 - I	•	S	•	•	•	•	•	•	⑤	(Bit V) Test: Operand = 01111111 prior to execution?					
Set Overflow	SEV	0B	2	1	1 - V	•	•	•	•	•	•	S	•	⑥	(Bit V) Test: Set equal to result of N + C after shift has occurred					
Accumtr A ← CCR	TAP	06	2	1	A ← CCR	•	•	•	•	•	•	•	•	⑦	(Bit N) Test: Sign bit of most significant (MS) byte of result = 1?					
CCR ← Accumtr A	TPA	07	2	1	CCR ← A	•	•	•	•	•	•	•	•	⑧	(Bit V) Test: 2's complement overflow from subtraction of LS bytes?					

- LEGEND:**
- OP Operation Code (Hexadecimal);
 - ~ Number of MPU Cycles;
 - = Number of Program Bytes;
 - + Arithmetic Plus;
 - Arithmetic Minus;
 - Boolean AND;
 - M_{SP} Contents of memory location pointed to be Stack Pointer;
 - + Boolean Inclusive OR;
 - ± Boolean Exclusive OR;
 - M Complement of M;
 - Transfer Into;
 - 0 Bit = Zero;
 - 00 Byte = Zero;
 - H Half-carry from bit 3;
 - I Interrupt mask
 - N Negative (sign bit)
 - Z Zero (byte)
 - V Overflow, 2's complement
 - C Carry from bit 7
 - R Reset Always
 - S Set Always
 - ↑ Test and set if true, cleared otherwise
 - Not Affected
 - CCR Condition Code Register
 - LS Least Significant
 - MS Most Significant

- CONDITION CODE REGISTER NOTES:**
(Bit set if test is true and cleared otherwise)
- ① (Bit V) Test: Result = 10000000?
 - ② (Bit C) Test: Result = 00000000?
 - ③ (Bit C) Test: Decimal value of most significant BCO Character greater than nine? (Not cleared if previously set)
 - ④ (Bit V) Test: Operand = 10000000 prior to execution?
 - ⑤ (Bit V) Test: Operand = 01111111 prior to execution?
 - ⑥ (Bit V) Test: Set equal to result of N + C after shift has occurred
 - ⑦ (Bit N) Test: Sign bit of most significant (MS) byte of result = 1?
 - ⑧ (Bit V) Test: 2's complement overflow from subtraction of LS bytes?
 - ⑨ (Bit N) Test: Result less than zero? (Bit 15 = 1)
 - ⑩ (All) Load Condition Code Register from Stack. (See Special Operations)
 - ⑪ (Bit I) Set when interrupt occurs. If previously set, a Non Maskable Interrupt is required to exit the wait state.
 - ⑫ (ALL) Set according to the contents of Accumulator A.

Table above is continuation of the Appendix.

Development of a satellite terminal

Experimental system for tv reception

by S. J. Birkill

Development of the author's satellite terminal started in 1975 with the introduction of instructional tv broadcasting to villages in India. The results of his original experiments were published in March 1976. This article describes how the terminal has been modified to receive microwave transmissions, and shows a selection of the author's more recent results.

During 1975 NASA's ATS-6 began a one-year SITE experiment of instructional tv broadcasting to village communities in India. As the transmissions were at 860MHz in the familiar u.h.f. broadcast band, the signals did not need

specialized reception techniques, but just a suitable antenna, low noise amplifier and tv receiver equipped with a wideband f.m. demodulator. The SITE broadcasts ended in August 1976, and ATS-6 was manoeuvred westward to a new geostationary location over the Pacific Ocean, out of sight of the UK, for further experiments with US terminals. Since I had been inspired by the ATS results, I was now eager to receive more satellite tv broadcasts. The USSR had a system known as Orbita which used Molniya satellites in 63° inclined orbits, but information was sparse. The Molniya-1 series used frequencies around 1000MHz, and the locus of pos-

sible apogees (Molniyas were activated for a six-hour period around apogee, when their orbital characteristics made them appear almost stationary in the northern sky) arced northwards to east and west of a point almost overhead. Signals were received, but they carried f.s.k. data at a low bit-rate. It appeared that the Orbita tv service had been transferred to the Molniya-2 and -3 series, with downlinks in the 4GHz band. At around this time there was news of Russian tv broadcasting tests from one of their first geostationary satellites, Skran, or Statsionar-T. The e.i.r.p. was quoted as 56.5dBW at 714MHz, but the satellite's longitude of 99°E put it well below the eastern horizon.

It became clear that the best results would be achieved in the microwave part of the spectrum and that 3.7 to



Fig. 1. Sheffield terminal's 8ft dish antenna with 4GHz feed in position. Fig. 2. 4GHz head unit. The GaAs f.e.t. stage is mounted near the top. Fig. 3. 11-12GHz feed system mounted at the prime focus point.

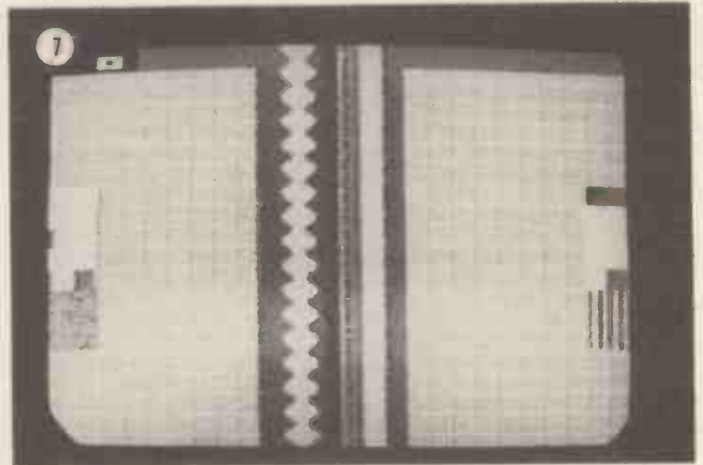


Fig. 4. India's instructional tv experiment received in 1975 from ATS-6 at 860MHz. Carrier/n noise density is about 70dB(Hz). Fig. 5. RTVE, received 1977. Relay to Canary Islands via Intelsat half-transponder, hemispheric beam. Frequency 3916MHz, e.i.r.p. 20-25 dBW, c/n density 65dB(Hz). Fig. 6. Sudan, received 1978. Internal distribution via leased half-transponder. Global beam, e.i.r.p. about 20dBW, c/n density 65dB(Hz). Fig. 7. Molniya-3 satellite serving Orbita system with Soviet Central tv. Orbita uses an analogue width-modulated audio pulse in line blanking, and 7.5MHz subcarrier audio. First pulse carries 1kHz tone, second pulse unmodulated. Frequency 3875MHz, e.i.r.p. about 29dBW, c/n density 75dB(Hz).

4.2GHz should be explored. The 5ft mesh dish used for ATS-6 was discarded, and I obtained a surplus 8ft solid-surface paraboloid, originally used for terrestrial radio links in the 7GHz region. To resolve pictures from the signals available on 4GHz, an overall system noise temperature of better than 400°K was required. The dish was fitted with a circular polarisation antenna feed, made from a piece of 2in. copper pipe, carrying the downconverter, a low-noise amplifier constructed from two HXTR-6101 devices on a microstrip, and 25dB of wideband u.h.f. i.f. amplification. The amplifier was included so that signals could be carried 50ft to the house without significant breakthrough of local u.h.f. tv broadcast stations. The second converter was installed in the house together with the remainder of the receiver. A modified Varicap u.h.f. tv tuner was used, as for ATS-6, but with facilities for re-inserting syncs., phase-locked to the output of an independently-tuned narrow-band sync. pulse demodulator.

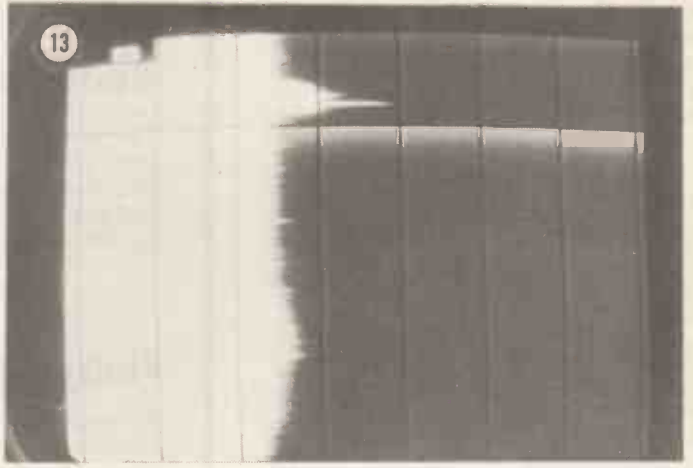
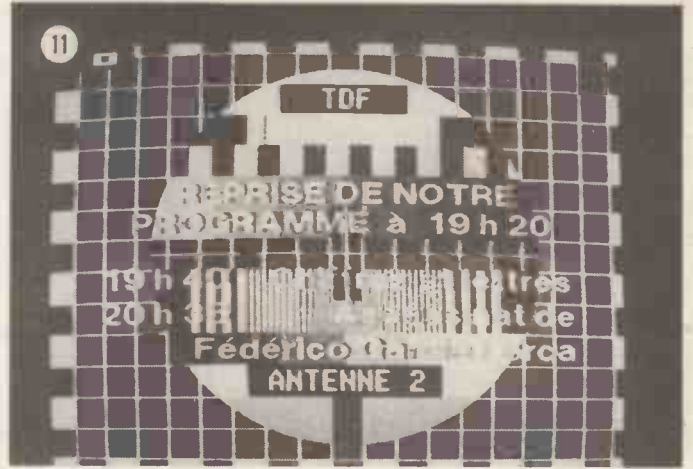
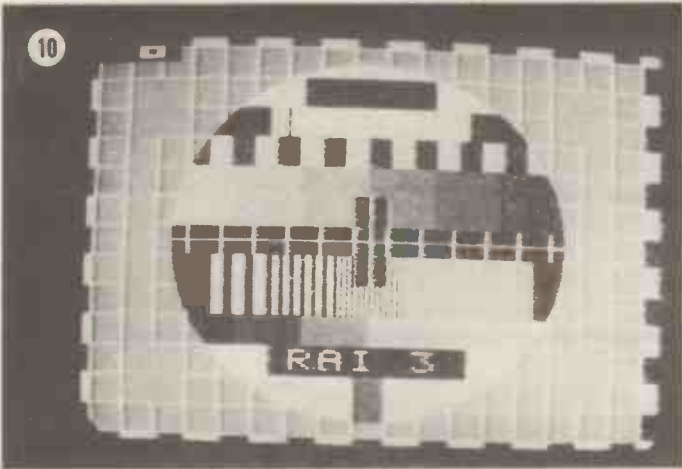
The receiver was aimed at the sun and aligned for maximum solar noise. A figure of 5.5dB above clear sky was achieved on the first day which, with an

assumed value for solar noise flux of $8 \times 10^{-21} \text{ W/m}^2/\text{Hz}$, translated to a G/T of 12.6dB/°K. This gave a predicted overall receiver noise figure of about 3.5dB, which was later confirmed by comparing ground noise with sky noise. When the antenna beam was lowered onto the geostationary orbit arc, my efforts were rewarded by the appearance of RTVE's (Spain) first chain programme via the leased half-transponder 6 of the new Intelsat-IVA (F2) at 29.5°W. This Canary Islands relay is at present carried on the Major Path 1 Intelsat at 34.5°W.

Since receiving RTVE, many other 4GHz satellite tv downlinks have been observed. In addition to carrying the world news and sports events, many nations lease capacity on the Intelsat system for their own use, such as internal tv distribution from studio centres to transmitters, and tv relay to their overseas territories. Because Intelsat's constitution precludes broadcasting activities, reception of their transmissions by private terminals can only be made for experimental purposes to prove equipment performance. However, a rather different situation exists in the USA where a private terminal

boom is taking place. Home use of the common carrier traffic on domestic communications satellites is permitted, provided the programme supplier's permission is obtained. For about 3000\$ a person can purchase the principal elements of a 10ft satellite terminal, and have access to around 36 full-time tv channels without the video and colour distortions which occur on long distance terrestrial distribution.

During the last three years the Soviet Union has begun to establish Inter-Sputnik, a rival system to Intelsat, with 4GHz downlink satellites in geostationary orbit over the three main ocean regions. To date, two types of satellite have been launched. The Raduga (Rainbow) class, which carry a single tv channel and appear to be similar to the Molniya-3 type, and the Gorizont (Horizon) class with 5 or 6 tv channels in the 3650 to 4000 MHz range. Their orbital stations are assigned Stationar numbers so the 14°W Atlantic slot for instance, called Statsionar-4, is currently occupied by spacecraft Gorizont-2. Two channels on this satellite use higher power or spot beams and radiate almost 10dB (in this direction) above the standard USSR 4GHz e.i.r.p.



of about 29dBW. Statsionar-4 is the most powerful satellite at this frequency, and can be received even with an indoor antenna.

As the accompanying photographs show, results have been improved since the early tests, due partly to the use of a Plessey gallium arsenide f.e.t., type GAT 5, which reduced the 4GHz system noise temperature to 185°K, a 3dB improvement in sensitivity.

Results have been further improved by the addition of another GaAs f.e.t. stage, a HFET-2202 device from Hewlett Packard. This half-micron gate length f.e.t has a noise figure only slightly above 1dB, and should produce a receiver noise temperature close to 100°K.

Fig. 8. Intersputnik. Coverage of non-aligned nations summit in Havana, received September 1979, Statsionar-4, channel 5, 3875 MHz, e.i.r.p. about 29dBW, c/n density 75dB(Hz).

Fig. 9. Soviet tv received November 1979. News and information programme "Vremya". Statsionar-4, channel 1, 3675 MHz, e.i.r.p. about 37dBW, c/n density 83dB(Hz), SECAM colour.

Fig. 10. Italian tv via USSR satellite, received 1980. RAI feed via Eurovision Brussels, converted to SECAM in Moscow and transmitted to Intersputnik over Statsionar-4, channel 5 at around 29dBW e.i.r.p. Frequency 3875 MHz, c/n density about 78dB(Hz).

Fig. 11. French tv on 11.64 GHz received February 1979. TDF-2 via OTS,

e.i.r.p. about 45dBW, c/n density about 85dB(Hz).

Fig. 12. Via Sirio received January 1980. Italian tv on 11.525 GHz, e.i.r.p. estimated at 28dBW, c/n density about 65dB(Hz).

Fig. 13. Video display switched to spectrum analyzer mode to show a portion of the 3.7-4.2GHz band while receiving a tv transmission from a Molniya (Lightning) spacecraft on 3895 MHz. Level increases from left to right, graticule lines are at 10dB intervals. Frequency increases from top to bottom, cursor line is set to 3915MHz. Carrier plus noise/noise ratio of this transmission was 15dB in the analyzer's noise bandwidth.

With the launch of the European Space Agency's OTS satellite in May 1978, I decided to explore a new satellite tv frequency band of 11-12GHz. The sub-bands in this region were destined to ease the congestion experienced by international and domestic systems in the 4GHz band, and provide the new regional (ECS) system for Europe as well as the allocations already made at WARC-77 for satellite tv broadcast downlinks. A new head unit was built around the feed horn, which was made capable of handling either linear (plane) or circular polarisation. The downconverter comprises a single unbalanced diode mixer in stripline, with a Gunn device in a coaxial cavity as the local oscillator. To improve performance, GaAs f.e.t. stages in microstrip construction were subsequently added. Mid-band noise temperature of the 11-12GHz system is around 400°K and, with an antenna gain of around 47dBi, this gives a G/T of 21dB/°K (clear sky) compared with the 4dB/°K being assumed for future direct-broadcast home terminals in this band. The same u.h.f. tunable i.f. is used as for 4GHz, which enables a 500MHz portion of the 11-12GHz band to be tuned for any setting of the Gunn source. High quality pictures have been received from OTS on the wide-deviation 120MHz wide spot-beam channels and on the standard-deviation 40MHz "Euro-beam" transponders. Television from various European broadcasters has been seen via OTS, often with the audio carried in digital "sound-in-synchs." form. However, the transmission schedule is a mystery, with long periods devoted to colour bars.

The Italian experimental satellite Sirio, also on 11-12GHz, has provided tv signals but, with an e.i.r.p. of only 28.5dBW compared with 37 to 45dBW for OTS, pictures are rather noisy as shown in Fig. 12.

The carrier/noise density figures in the captions are more meaningful than a carrier-to-noise ratio because the f.m. demodulator is a variable-bandwidth p.l.l. which can be narrowed at low c/n densities to optimise the trade-off between noise and video distortion over the picture portion of the video modulated signals. So, for a strong signal with a c/n density of 84dB(Hz), the noise bandwidth can be 25MHz and the signal may still exceed the f.m. threshold of about 10dB c/n ratio. But, with a signal of only 65dB(Hz) c/n density, reducing the bandwidth to 1MHz would only recover a 5dB c/n ratio. Therefore, bandwidth must be set to achieve the greatest possible c/n ratio over most of the deviation occupied by the l.f. luminance components of the pre-emphasised signal, perhaps 4MHz, which results in a picture similar to Fig. 12. The receiver can be switched to a 70dB logarithmic spectrum analyzer display, which is very useful when aligning to a satellite or looking for new signals. Fig. 13 shows

part of the 4GHz band between 3.85 and 4.20GHz while a Russian Molniya satellite was being received. The level reads from left to right and frequency from top to bottom of the screen.

Later this year the first Intelsat V should be launched for operation over the Atlantic with 4 and 11GHz downlink transponders. The first Soviet "Loutch" 11-12GHz spacecraft is also anticipated. Both satellites will have high e.i.r.p.s to allow for periods of high attenuation, caused by atmospheric water vapour in the downlink path, and should be easy to receive in clear weather. Within three or four years Europe may have direct tv broadcasting satellites, and the development of comparatively low-cost terminals for home use will take place.

Plessey and Mullard (Philips) are already working on monolithic low-noise downconverters on gallium arsenide chips. The Japanese already have 12GHz home terminals for the market following extensive tests with the Japanese "Broadcasting Satellite for Experimental Purposes". It is anticipated that the European broadcasting satellites will operate with an e.i.r.p. 15

or 20dB higher than OTS. This should allow reception at the Sheffield terminal, even though their beams will not be directed at the UK.

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IN OUR NEXT ISSUE

Acoustically small loudspeaker

To reduce colouration and cabinet resonances, the mid-range and high-frequency drivers of this active crossover design are mounted in an oblate cylinder, made of modelling clay. The enclosures are operated below lowest resonance, and the unusual shape gives an exceptionally 'solid' stereo image.

Floppy disc store

Because most home computers use audio cassettes for storing information, the location and transfer of data is very slow. Our floppy disc system comprises a controller and an 8in drive, which can store 400K bytes and transfer data at 500 bytes per second. The disc store has been designed by John Adams for the *Wireless World* scientific computer, but can be adapted for other systems bases on the Z80.

Frequency meter for radio receivers

A versatile digital frequency meter, usable from low frequencies to v.h.f. with a pre-scaler, and primarily intended for use in radio receivers to identify stations. John Linsley Hood has avoided the large-scale chips and, with the aim of achieving a more flexible design, has used c.m.o.s. logic, together with low-power Schottky elements.

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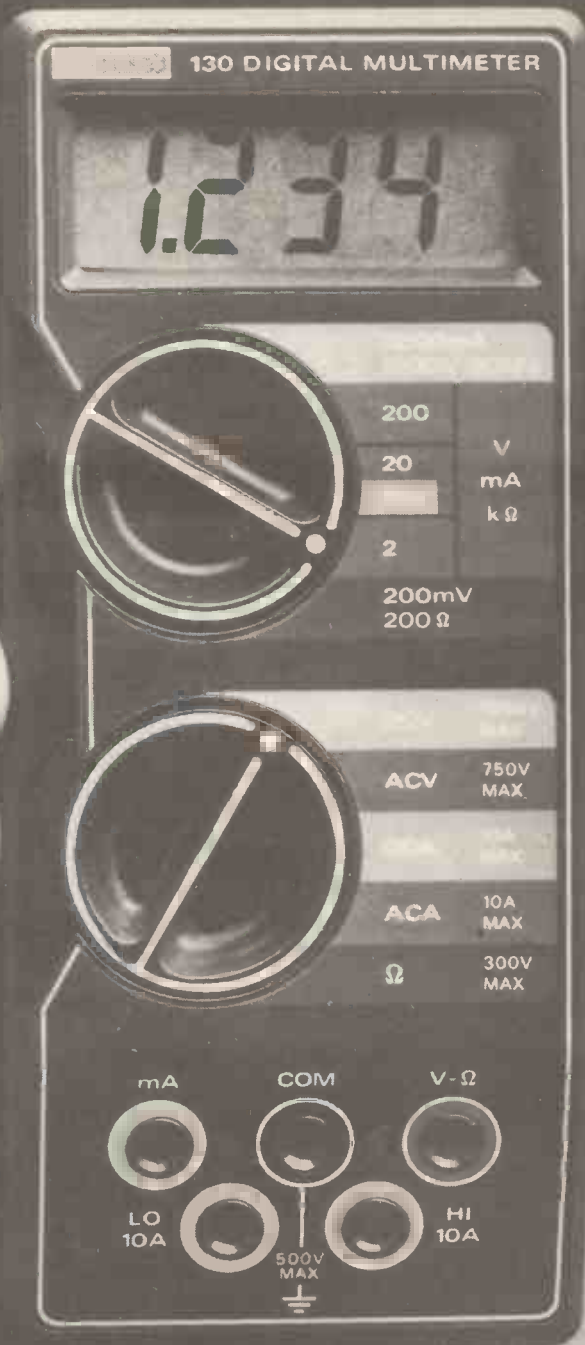
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WV9

Graphical communication with microcomputers — 2

Character generation and graphics

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

Dr Witten continues his article on interacting with a microcomputer. This final part goes on with the discussion of raster-scanned displays, finishing with a look at the light-pen and tablet method of input.

Cell-organized displays. To make a display system easily manageable by the programs that generate the pictures, it is necessary to impose a structure on them that allows the raw picture data to be compressed and stored. For example, we saw earlier how line-generating hardware in a point-plotting display processor permits a whole line to be specified by its two end points. The natural structure to impose on a raster-scanned display is a pattern of rectangular cells. Figure 15 shows a 256 × 256 bit-per-point screen, organized as a 32 × 32 array of cells, each one being 8 × 8 dots. There are 64 bits in each cell, so 2⁶⁴ possible patterns can occupy one cell alone. However, most of these patterns are unlikely to be used in a simple picture. Suppose we sacrifice flexibility for convenience and low cost by defining a small repertoire — say 256 — of patterns which may occupy each cell. Then to hold the complete set of patterns we need 256 × 8 × 8 bits — 2 Kbytes, and now a particular pattern can be indicated by an 8-bit pattern number. Since there are 32 × 32 cells on the screen, only 1024 of these numbers, or 1 Kbyte, are needed to hold the screen contents.

This certainly saves some storage. Previously, 8 Kbytes were needed to hold the screen contents on a bit-per-point basis. Now only 1 Kbyte specifies the screen contents, together with 2 Kbytes for the pattern dictionary. The price paid is heavy, though: only a tiny fraction of possible pictures can be displayed. (You may care to verify that the fraction is 1/2²²⁴, which is small indeed!) But the real advantage is one of convenience: now the computer need only wrestle with a 32 × 32 array of cells instead of a 256 × 256 array of dots. Since its storage and bus structure is in terms of bytes and not bits anyway, it is actually easier to handle cell pattern numbers than individual dots. (Recall the difficulty of generating straight lines on a bit-per-point display.)

Figure 17 shows the connexion of a memory-mapped, cell-organized dis-

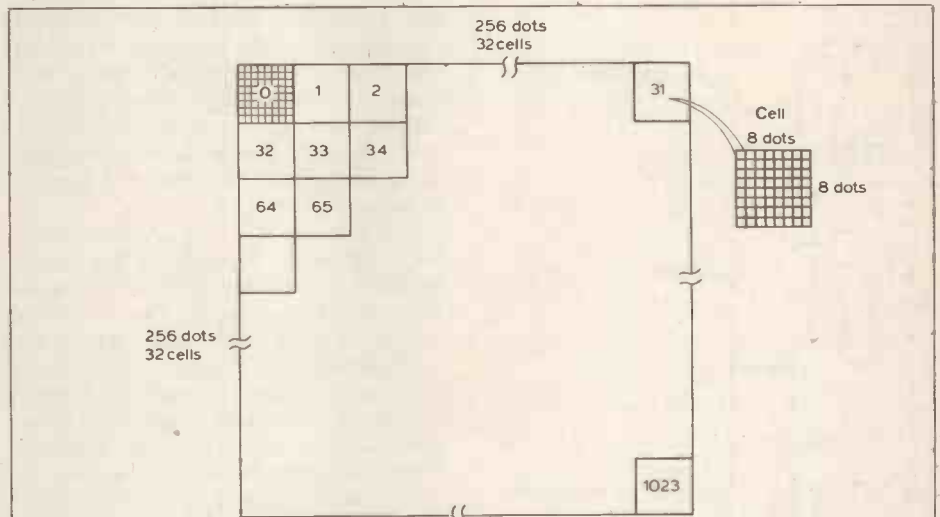


Fig. 15. Cell-organized display with 1024, 8X8 cells.

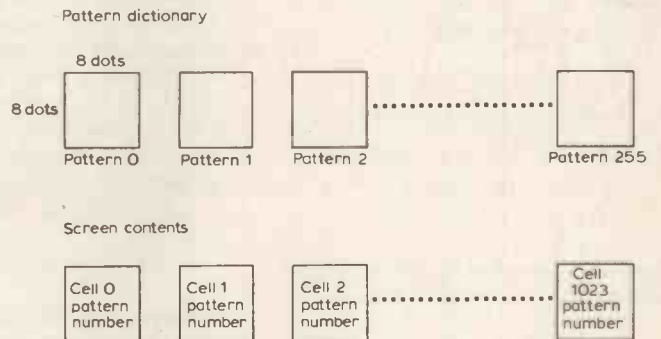


Fig. 16. Pattern dictionary and screen contents for cell-organized display.

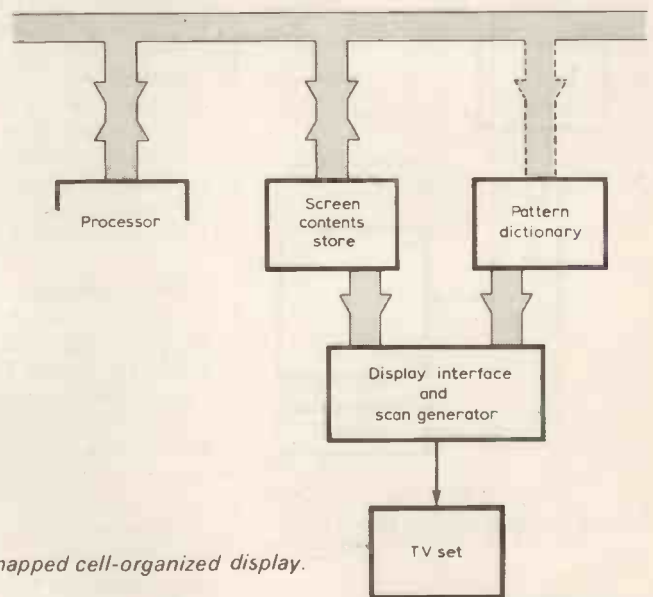


Fig. 17. Memory-mapped cell-organized display.

	64-character upper-case alphabet	ABCDEFGHIJKLMNOPQRSTUVWXYZ
	96-character alphabet	0123456789 !"#\$%&'()*+,-./:;<=>?@[]^_`space abcdefghijklmnopqrstuvwxyz { } rubout

Fig. 18. Standard 64-character and 96-character alphabets.

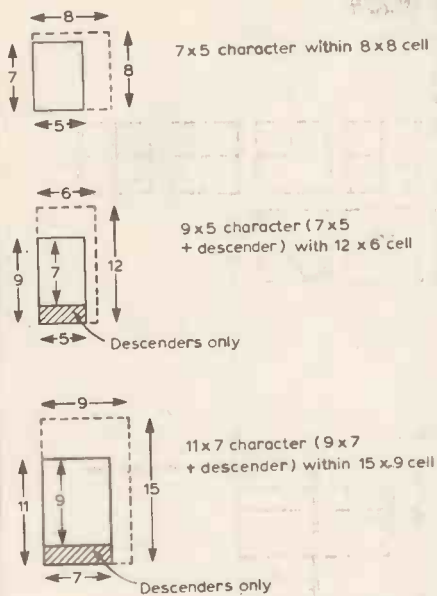


Fig. 19: Common character sizes.

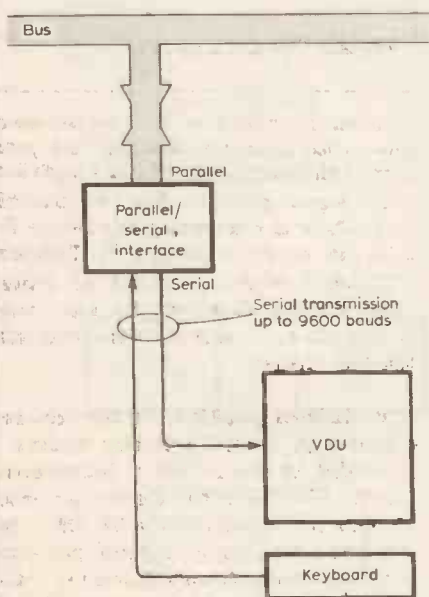


Fig. 20. Connecting a v.d.u. to the bus.

play to the computer bus. As with the bit-per-point system of Fig. 13, the display system is called *memory-mapped* because the screen contents appear to the processor as ordinary store. The connexion between the bus and the pattern dictionary is dashed because it is often not there at all: the patterns are fixed and cannot be changed by the processor.

The success of a cell-organized display in practice depends on the match between the patterns in the cells and the kind of pictures that are drawn on the screen. General cell displays which are intended for line drawings have been built, in which the cell repertoire naturally consists of line segments. However, the number of possible line segments through an 8×8 dot cell is unreasonably large, and rotational and axial symmetry is called into play to reduce the dictionary size. Then, the display interface must be able to perform rotation and symmetry transformations, and becomes a display processor which treats the screen contents store more as a program than as a list of pattern numbers. This parallels precisely the development of the display processor for point-plotting displays.

Let us instead examine some rather less ambitious pattern repertoires for cell-organized displays.

Character generation. One obvious use for a cell-organized display is to show text. Cell-organized character displays are called v.d.us (visual display units) — a rather unfortunate term because it gives no indication that only characters can be shown. The screen of Fig. 15 can accommodate 32 lines of 32 characters, each one being on an 8×8 grid. Of course, space must be left between neighbouring characters and between successive lines, so the actual character area is normally chosen as 7×5 dots.

Character storage. A 7×5 dot matrix is quite adequate for upper-case characters, digits, and some special symbols. The standard 64-character upper-case alphabet is shown in Fig. 18, along with the characters that augment it to the standard 96-character upper-and-lower-case alphabet. Although lower-case characters can be written satisfactorily on a 7×5 matrix, five of them — g, j, p, q, and y — have tails which should descend below the line if written properly. This needs a 9×5 dot matrix,

with any one character occupying either the upper or the lower 7×5 section; this works because there aren't any characters with both descenders and "risers". Higher-quality text can be obtained with an 11×7 matrix, with any given character occupying either the upper or the lower 9×7 section. The possibilities are summarized in Fig. 19, where a dotted outline shows the cell containing the character, including inter-character and inter-line space, and the solid line shows the actual size of the characters.

Read-only memory chips with the character patterns already in them are available from a variety of manufacturers. When addressed with the ASCII code of a character, the appropriate dot pattern appears on the output pins. The address of a particular row of dots is usually provided to the character generator and the dots comprising only that row appear at the output. Thus, with 64 characters of 7×5 dots each, 9 bits are required to address a particular row of a character and there are 5 output pins giving the dots in that row. This arrangement is especially suited to raster-scan displays, because one line of the raster is generated at a time. In some character generators, the action of "lowering" characters with descenders must be done externally to the chip, the user providing circuitry to detect these five characters and adjust the row address accordingly. The amount of storage required in a character generator is quite small. For our example, we need 512 words of 5 bits to provide the 64-character upper-case alphabet.

A 256×256 screen accommodates 32 lines of 32 characters if the character cell is 8×8 , 21 lines of 42 characters if it is 12×6 , and only 17 lines of 28 characters if it is 15×9 . All of these sizes are unrealistically small for text. A normal sheet of typed paper can comfortably hold about 57 lines of 80 characters. To achieve this with a 12×6 cell would require a 684×480 screen, which is not possible within the British 625-line standard. Many v.d.us compromise with about 24 full-length lines of 80 characters, requiring a 288×480 screen. There is currently a great deal of commercial interest in high-quality v.d.us, and special high-resolution screens are built for them, but they don't have the advantage of the mass tv market to bring down the price. However, it is worth noting that a 1125-line high-resolution tv system is under development in Japan, which should accommodate up to 75 lines of high-quality text, with a 11×7 character size (15×9 cell).

The v.d.u. V.d.us are not, in general, memory-mapped. It is far more convenient for the computer user to regard his text as a linear string, sending it one character at a time to the display device. Usually it is transmitted in serial form by a parallel-to-serial converter

attached to the bus, as shown in Fig. 20. The v.d.u. must provide store for the screen contents, but this only needs one byte per character displayed — say 2 Kbytes for 24 lines by 80 characters. In fact, local storage is sometimes provided for a good deal more than this, so that the v.d.u. can retain several screenfuls of text and you can look back to see what was presented a few moments ago.

The v.d.u. itself has to decide what to do when the screen fills up. A scrolling feature is almost universally provided, where the entire screen contents move up as necessary. Continual rapid jumping of the text is irritating and tiring for the reader, and so several lines are scrolled at a time. Smooth scrolling, where the contents move up a dot at a time rather than jumping whole lines is unfortunately rather rare at present, although it does not cause any particular technical problems. Other features which are often provided are blinking of the text on a selected area of screen, reverse video (black text on a white background), half-intensity or double-intensity display, and underlining of parts of the text. These options are switched on and off by control characters (ASCII codes 0000000-0011111) and sent down the line as part of the text, which can unfortunately alter all subsequent characters if a text character is corrupted by noise into a control character!

One really useful feature is the ability to move the current position for text to any point on the screen, so that characters in the middle of the text can be overwritten. A mark called the "cursor" is usually made on the screen at the current writing position, and any input typed on the keyboard appears at the cursor position (which is moved along with each successive character). Then, a questionnaire can be displayed and the cursor moved to the places where the user enters his answers, constraining him to write in the space provided. Cursor control is again dictated by a special character which signals the v.d.u. to interpret the next character as the cursor position. Notice that this reinstates the flexibility of a memory-mapped display where a character can be placed at any position on the screen.

Most v.d.us operate at speeds up to 9600 baud. Unlike printers, no extra effort is needed to make a v.d.u. go fast. 9600 baud allows a full screen of 24 x 80 characters to be sent in 2 seconds, which is certainly a high reading rate! However, people often scan text much faster than this — how quickly do you read a newspaper? Present v.d.u. technology leaves plenty of room for improvement.

Limited graphics

Pressure to provide limited graphics facilities based on inexpensive raster-scanned displays has come from two

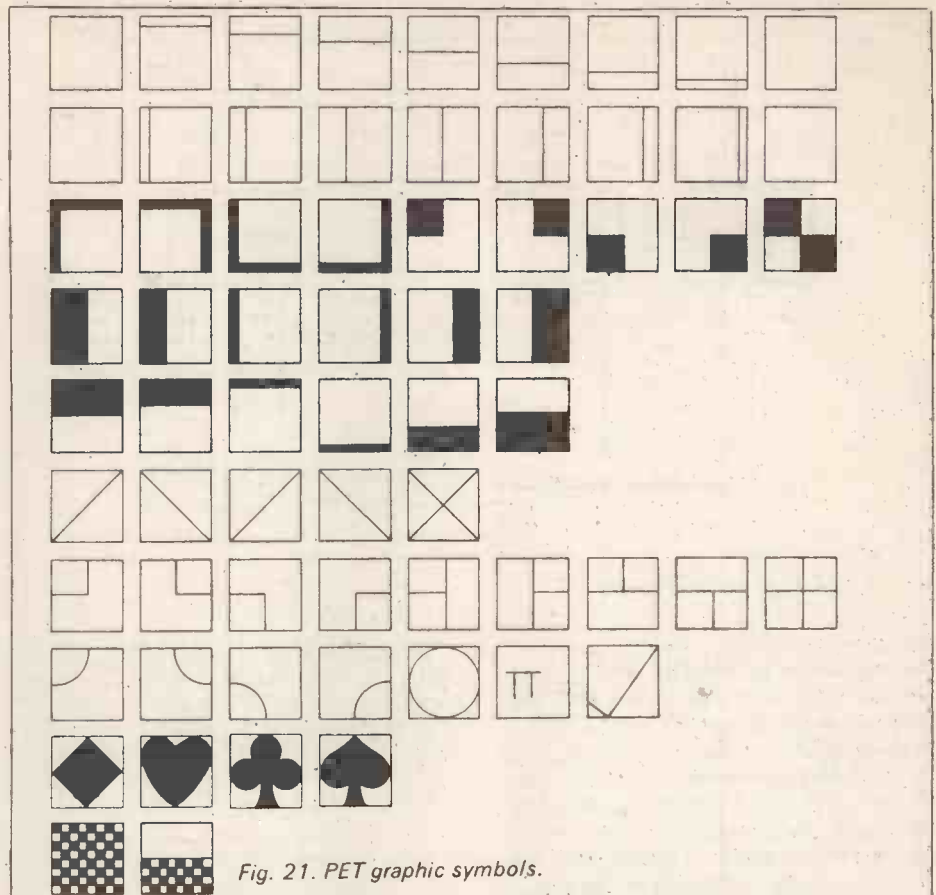


Fig. 21. PET graphic symbols.

directions: home computers and the teletext and viewdata information services. The character-generating read-only memories of most home computers contain an assortment of graphic symbols to draw primitive pictures. Figure 21, for example, shows the 64 symbols of PET, a typical low-priced domestic computer. In order that graphic symbols can abut to form pictures, the inter-word and inter-character spaces are stored explicitly in the character generator and not provided by external hardware as in most v.d.us. PET uses an 8 x 8 cell. The standard 64-character upper-case alphabet of Fig. 18 is provided, together with the 64 graphic symbols or the lower-case letters — software can select which of these latter groups is used. Some of the graphics reflect the game-playing orientation of PET; but the lack of coherent structure of the others makes constructing pictures or charts a rather tedious task. There is no standardization of graphics alphabets in the home computer industry.

Teletext. The teletext scheme for broadcast information defines a graphics standard, and it is possible that this might spread to the microcomputer industry. It uses 64 codes in a systematic way to provide a refinement of its basic 24 x 40 character grid. Each cell is split into the six regions shown in Fig. 22, and a 6-bit word specifies any combination of white and black ones. Thus, an effective 72 x 80 grid is available for graphics, and the picture of Fig. 6 gives an example of the resolution obtained. The teletext cell is not square but has 10

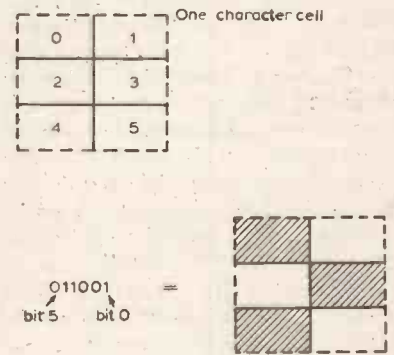


Fig. 22. Teletext graphics.

x 8 dots, with a 9 x 5 upper-and-lower-case character matrix. The problem of dividing a cell 10 rows high into three equal portions for the graphic symbols is a continuing challenge for teletext receiver designers! Teletext also has a defined protocol for coping with colour displays by inserting colour-change control characters into the text stream.

User-defined graphics: An unusual and interesting limited graphics facility is provided in the Sorcerer home computer. 256 character codes are used instead of the usual 64 or 96. Of these, 128 correspond to pre-defined patterns, which include the 96-character basic alphabet of Fig. 18 together with 32 extra graphics. For the others, the character-generating memory can be altered by the processor, so that the user can define his own graphic symbols. Since the character matrix is 8 x 8, 8 bytes serve to define one character,

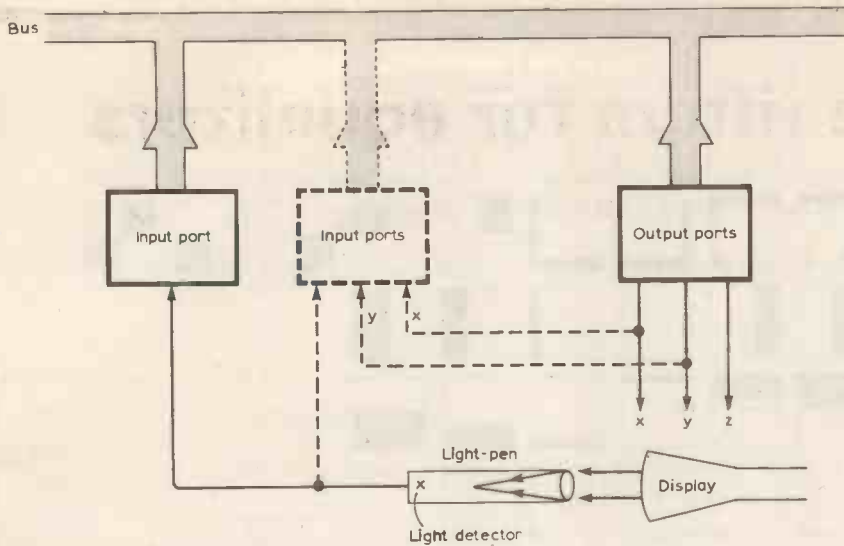


Fig. 23. Operation of a light-pen.

and the read-only and writeable parts of the character generator are each 1 Kbyte. The circuitry required to generate characters from a read/write memory is a little more complex than for read-only memories, because contention will occur when the display reads and the processor writes simultaneously. But the extra power provided is enormous, for the Sorcerer can simulate both PET and the teletext system, as well as others. For example, graphs can be displayed quite accurately by defining eight patterns each with one dot in the centre, at different heights. Or a character set can be defined for line drawings which includes all the line segments which are needed in a particular picture. Or a Cyrillic alphabet for text in Russian. This combines much of the flexibility of the memory-mapped bit-per-point display with a structure that can show text sensibly and simulate systems like PET and teletext.

The light-pen and tablet

Turning now to graphical input, a light-pen is a device that detects whether or not there is a spot of light on the screen at the place it is pointing. It can also signal the exact time the light appears. Recall that the picture is refreshed every 40 msec or so, so that if the pen points at a spot which is brightened up a signal will appear during every refresh cycle. The interrupt mechanism is ideally suited to advising the processor at the time a hit occurs.

The time-of-hit information provided naturally by a light-pen can easily be converted into the position of the hit by adding the hardware shown by dashed lines in Fig. 23. The x and y signals from the output port are routed back to an input port — in practice, this will be before they are converted from digital to analogue form — and loaded into two registers there whenever a hit occurs. Then the processor can examine these registers at leisure to ascertain the position of the last hit.

But which kind of information, time-of-hit or coordinates-of-point, is more useful? Suppose the house picture of Fig. 24 is stored as 28 lines:



Fig. 24. A house. Timing or coordinates?

and line-generating hardware drives the display. Then, although the x, y coordinates of a hit can in theory be used to determine which line was being drawn, the precise time when it occurred leads to the information much more easily because the processor only needs to examine its last request to the line-generator. In general, the *state of the display processor* at the time of the hit will provide most information about what was actually being drawn at the time, not the coordinates of the hit.

Tracking a light-pen. A light-pen only registers a hit if the spot it is pointing at is actually brightened up during the refresh cycle. If you point it at a blank part of the screen the processor cannot

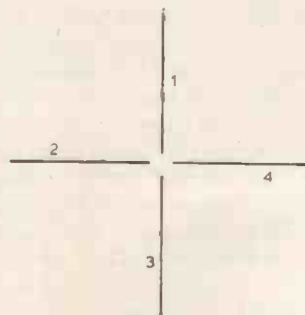


Fig. 25. Tracking cross.

tell where it is. A "tracking cross" is often drawn as part of the picture; this follows the pen around in an attempt to provide light for it to see. For the cross of Fig. 25, if a hit occurs on line 1 the cross should move up, for line 2 it should move to the left, and so on. The processor detects the hits and moves the cross as necessary. If the centre of the cross coincides with part of the picture, then a hit is registered whenever that component of the picture is refreshed, and so the processor can tell what part is being indicated.

Touch-tablet. Figure 26 illustrates another kind of graphical input device which is entirely independent of any display and provides the coordinates of the pen position.

Current is injected into a uniform resistive sheet through the pen tip, and is measured at one side of the tablet while the other is earthed. The resistive sheet acts as a potential divider, and the ratio of the output to the input current gives one coordinate. Then the connections are changed so that the other coordinate can be measured.

A particularly interesting feature of the tablet is that a finger can act as the pen, using high-frequency alternating current and capacitive coupling with the sheet instead of d.c. with direct coupling. Effectively, you sit on an electric chair and inject current with your finger. Then, no pen is needed and if the sheet is made transparent and fitted on to a display screen, you can indicate parts of the picture just by pointing at them with a finger.



Fig. 26. An x, y tablet.

This device provides coordinate information and not time-of-hit. However, it can easily be made into time-of-hit by comparing the x, y coordinates from the tablet with those being sent to the display. When they coincide (to within a specified tolerance), a bit interrupt is caused.

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Simple active filters for equalizers

Design examples using simulated inductors

by D. W. Protheroe, B.Sc.

Simple design rules allow construction of filters having any desired value of centre frequency, Q and gain, using simulated inductors. Examples illustrate provision of a symmetrical bandpass to band-stop characteristic, varied with a single control.

The majority of designs published as octave or graphic equalizers feature a number of independently controllable filters allowing boost or cut of specific frequencies within the audio band. These designs fall into two main categories.

● **RC bandpass/bandstop filters.** A typical system may have a number of active filters either enclosed in a negative feedback loop, Fig. 1 and refs 1, 9, 10, or having their outputs fed to a differential amplifier, Fig. 2 and ref. 8. Problems arise from both these configurations. In Fig. 1 noise generated within the active filters is coupled into the output amplifier, the signal-to-noise ratio decreasing as the number of filter sections is increased. This problem is avoided in Fig. 2, but the component values must be carefully calculated to give a symmetrical cut/boost characteristic. Many designs have been published giving only bandpass (presence) or bandstop (notch) characteristics.²

● **Series LCR filters.** This arrangement, Fig. 3, suffers from the disadvantages normally associated with discrete inductors, i.e. size, cost, distortion, refs 2, 3, 4. The present design overcomes this by synthesizing³ the necessary inductors, using the circuit of Fig. 4.

To duplicate the impedance versus frequency characteristic of an inductor, the input impedance of the circuit must be of the form $R + j\omega L$, and it can be seen in the Appendix that the circuit has an input impedance of $R_1 + R_2 + j\omega CR_1R_2$. Although many other methods of simulating inductance have been published (e.g. search under Gytrators), they have suffered from greater complexity or lower performance, often both.

Now add a series capacitor, C_x , to Fig. 4 to give a series LCR circuit, Fig. 5, which may be used in the circuit of Fig. 3 to realise the same function, though the parameters of the inductor are now easily controlled.

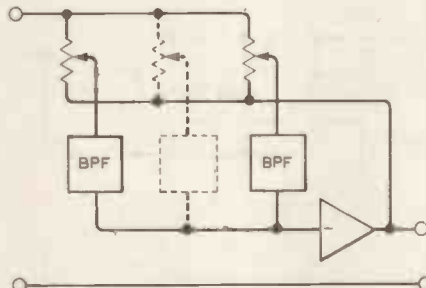


Fig. 1. With active filter enclosed in feedback loop, s/n ratio decreases as number of sections increases.

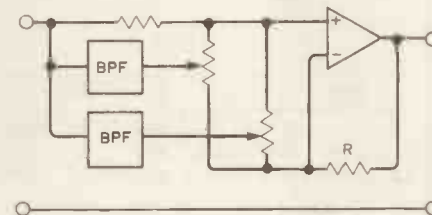


Fig. 2. Alternative circuit using differential amplifier avoids noise problem but component values as critical.

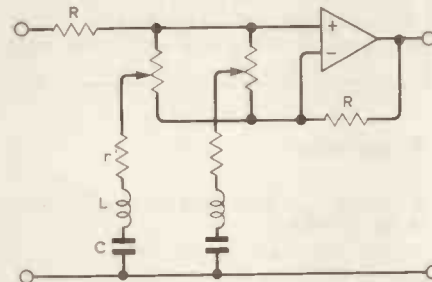


Fig. 3. Simple LCR network introduced symmetrically into forward or feedback paths by potentiometers.

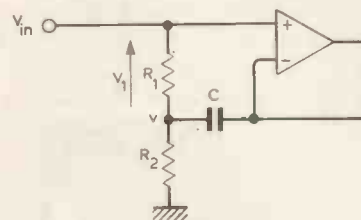


Fig. 4. Two-terminal RC network simulates inductance, value $L = CR_1R_2$

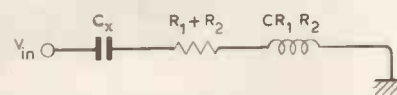


Fig. 5. Series capacitor C_x tunes simulated inductance for use in Fig. 3.

Design procedure

Making use of the standard formulae for series tuned circuits:

$$f_o = \frac{1}{2\pi\sqrt{C_x L}}$$

$$\text{and } Q = \frac{1}{r} \sqrt{\frac{L}{C_x}}$$

where the symbols have their usual significance, and r is the equivalent series resistance. Eliminate L thus

$$L = C_x r^2 Q^2$$

$$\text{and } C_x = \frac{1}{(2\pi f_o)^2 L}$$

$$C_x = \frac{1}{2\pi f_o r Q}$$

$$\text{Also, } L = C_x r^2 Q^2 = CR_1R_2$$

$$C = \frac{C_x r^2 Q^2}{R_1R_2}$$

Fig. 3 shows that maximum or minimum gain at f_o is

$$20\log\left(\frac{R + r}{r}\right) \text{ dB}$$

Armed with these equations, filter design becomes a matter of setting the design parameters, taking account of any required component values, and calculating the remaining component values.

Fig. 6 shows an example of a 50Hz notch filter, depth of null variable, $Q=50$ (say). Synthesized inductance has a value of $\sim 1400\text{H}$. To enable frequency to be trimmed to off-set the effect of component tolerances, R_1 and R_2 incorporate a potentiometer. Thus f_o and the notch depth are independently variable.

The value of the potentiometer used as the cut/boost control is non-critical, varying only the control law. The buffer amplifier used in Fig. 4 can be an emitter follower, a Darlington follower, or a 741 follower depending on the load to be driven (the values of C, R_1 , R_2) and the performance required. Signal-to-noise ratio and distortion level for the system depend mainly on the differential

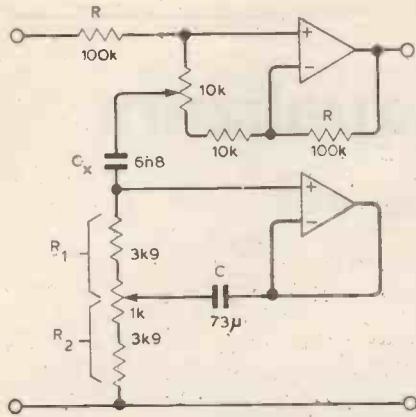


Fig. 6. 50Hz notch filter can be trimmed with lower potentiometer. 10k resistor modifies characteristic to attenuation only.

amplifier used; for most purposes the 741 is sufficient, though increased performance may be achieved with a more specialized amplifier.^{6,7}

Practical applications of this circuit have varied (in frequency) from l.f. variable filters for electrophysiological research, to a fine-section tone control for audio systems. Although developed for use at audio and sub-audio frequencies, high frequency operation is dependent only upon the characteristics of the amplifiers used. However, as the frequency of operation is increased, the value and size of a discrete inductor soon reach manageable proportions.

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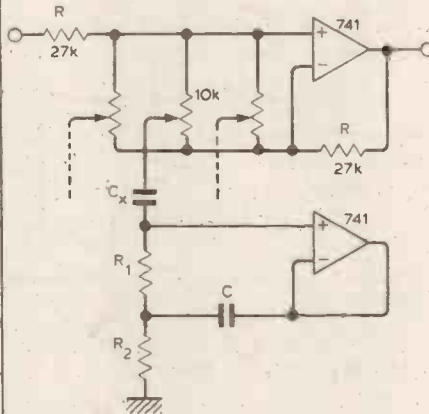
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Dave Protheroe was an electronics technician in the psychology department of the City of London Polytechnic, where he constructed prototypes of this filter. Since then he has graduated in electrical engineering and is now lecturing in electronics at Thames Polytechnic. Researching into digital systems design, recent work has centred around applications of digital devices, especially the hardware and software design of a Z80-based microcomputer system.

Practical designs

8-14Hz three-section filter

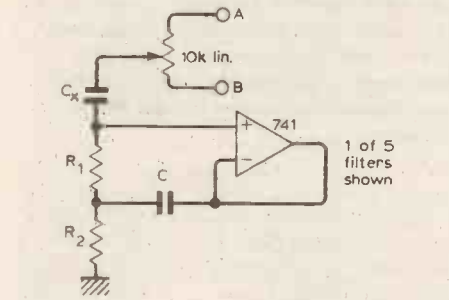
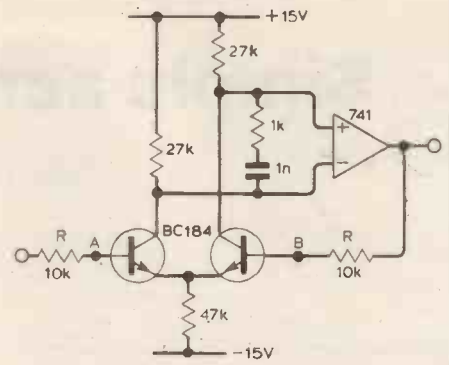
Application: vibration analysis, electromedical recording. Design criteria: constant bandwidth, control range ±20dB. Values of R₁, R, R₂ were chosen to give the required control range. Q value was then calculated from Q=f₀/bandwidth. The underlined equations give the required capacitor values, and the last equation gave the value of R.



f	BW	Q	C _x	C	R ₁ , R ₂	R
8	3	2.7	1.3µ	40µ	2.7k	27k
11	3	3.7	0.68µ	40µ	2.7k	27k
14	3	4.7	0.47µ	40µ	2.7k	27k

50Hz-2.8kHz five-section equalizer

Application: supplement to audio tone controls. Constant-Q characteristic is required to keep tonal effect of filters constant over the frequency range. In the interests of higher s/n ratio a more complex differential



amplifier was used.⁷ To avoid slew-rate limiting at high frequencies use faster op-amps e.g. 748, 741S, 531. Control range: ±12dB, consistent with commercial units. Component values chosen as above.

f	Q	C _x	C	R ₁ , R ₂	R
50	1	1µ	4.2µ	1.5k	10k
200	1	0.27µ	1µ	1.5k	10k
800	1	68n	0.27µ	1.5k	10k
3.2k	1	16.8n	68n	1.5k	10k
12.8k	1	4n	16.8n	1.5k	10k

Appendix

A voltage V_{in} is applied to the input terminal of Fig. 4. Then

$$V_1 = V_{in} - v$$

$$\text{where } v = V_{in} \left(\frac{R_2}{R_2 + \frac{R_1}{1 + j\omega CR_1}} \right)$$

$$V_1 = V_{in} \left(1 - \frac{R_2}{R_2 + \frac{R_1}{1 + j\omega CR_1}} \right)$$

Thus

$$i = \frac{V_1}{R_1} = V_{in} \left(1 - \frac{R_1}{R_2 + \frac{R_1}{1 + j\omega CR_1}} \right)$$

where i is the current flowing into the input terminal.

$$i = \frac{V_{in}}{R_1} \left(1 - \frac{R_2 (1 + j\omega CR_1)}{R_2 (1 + j\omega CR_1) + R_1} \right)$$

$$\text{or } i = \frac{V_{in}}{R_1} \left(1 - \frac{R_2 + j\omega CR_1 R_2}{R_1 + R_2 + j\omega CR_1 R_2} \right)$$

$$z = \frac{V_{in}}{i} = \frac{R_1}{1 - \frac{R_2 + j\omega CR_1 R_2}{R_1 + R_2 + j\omega CR_1 R_2}}$$

$$= \frac{R_1 (R_1 + R_2 + j\omega CR_1 R_2)}{R_1 + R_2 + j\omega CR_1 R_2 - R_2 - j\omega CR_1 R_2}$$

$$\text{i.e. } z = R_1 + R_2 + j\omega CR_1 R_2.$$

This is of the form required and assumes the amplifier has a gain of unity, a high input impedance, and a low output impedance - conditions easily satisfied. □

American letter

from George Tillet in Chicago

Attendance at the Chicago Summer CES was about 55,000, some 15% less than last year — although the advance bookings were at a record high. The reason, of course, had to do with the uncertain economic situation, but the growing popularity of the January Las Vegas Show might have had an effect too. If there is a recession, some of the exhibitors seemed unaware of it, judging from the number of high-priced luxury items on show. Infinity had a \$20,000 loudspeaker system and Lux were showing a \$3,000 turntable, while there were several phono cartridges costing over \$250. One was priced at \$550 and a precision tonearm could be had for a mere \$1300! If you are tired of ordinary tv, you can spend anything between \$16,500 and \$30,000 for a dish antenna so you can watch satellite transmissions.

Video

As at the last Show, video discs were again a centre of attraction and the Pioneer and Magnavox demonstrations were always crowded. Both these models use a laser system, but RCA were showing off their Selectavision player, which uses a stylus pick-up, at a hotel nearby. RCA state that recent modifications include random access and that the price will still be lower than its competitors. Since they have an agreement with CBS they also have access to a wider range of programme material. V.c.r.s are fast gaining in popularity and several new six-hour models were to be seen. In the long-playing mode, there is inevitably a loss in definition — particularly with models with reduced track width. The ordinary track width in VHS machines is 58 microns, but when the same heads are used to scan the 19.3 micron width employed in the six-hour mode, the tracks overlap, causing picture degradation, since adjacent tracks are out-of-phase. Now, JVC have come up with a simple — well, relatively simple — solution: two extra narrow-field heads are switched in for the long playing mode.

Sony's AG-300 features a cassette autochanger, permitting 20 hours of recording time, and the programme unit allows the user to record separate programmes on separate cassettes. Other Sony models use Beta-Scan, which lets the user search backwards or forwards

at any desired speed up to 20 times normal, with or without a remote control unit. Toshiba has a similar fast scan system, but theirs can flip the tape at 40 times the normal speed.

Sony's latest tv projection uses a ceiling-mounted projector to produce a picture measuring 11½ feet by 5, and a switch allows the size to be changed. Another company, Electron Systems Products, introduced a projection system capable of producing a 20ft picture. It is quite portable, measuring 20 by 28 by 9½ inches, and the extra brightness is achieved by using a liquid-coupled lens with liquid-cooled tubes to increase the light output.

Turning to "ordinary" tv sets, there seems to be a trend towards better audio quality and several models were seen with multi-speakers and separate amplifiers. One model even boasted simulated stereo, using a time-delay circuit.

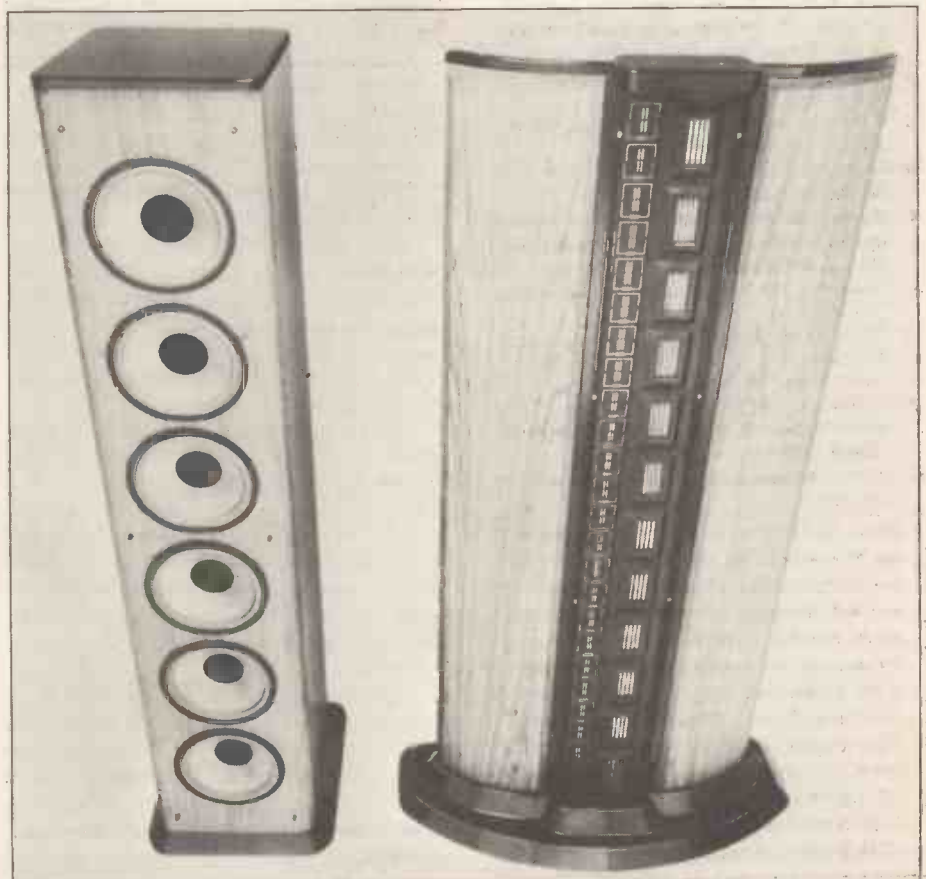
In spite of the relatively high prices, there appears to be a growing interest in dish antennas to receive satellite trans-

missions. One company quotes a basic price of \$16,500 for a single-channel system, plus \$5,000 for each additional channel. The leaflet I picked up also mentions concrete pads: "Try not to think about mounting the antenna on the roof. It weighs 2000 lbs, it is 16 feet in diameter and it makes a great sail." You might ask what programmes are available to justify all this hassle? Well, there are many transmissions intended for cable networks and they carry such intriguing titles as "Showtime", "Galavision", "Calliope" and the "Movie Channel". There is a small licence charge for hotel and apartment users.

Audio

Two or three years ago, receiver makers were committed to a kind of 'power race' to see how many watts they could cram in, but not too many buyers were enthusiastic about the cumbersome 400 watts jobs. So these days the accent is, on features such as automatic scanning,

Infinity's Reference Standard.



preset station selection, bar-graphs and so on. Onkyo scooped its competitors with a receiver having a built-in "snap, crackle and pop" remover that works like the SAE and Garrard units, which reverse the phase of the signal before removing narrow-pulse transients. A few genuine Class A amplifiers and receivers were to be seen but there is a definite trend towards a modified Class A circuit where the output stage is biased by the signal. Efficiency is claimed to be comparable with Class B without the switching or crossover problems. Variations are known by several names: Kenwood use the term "Zero Switching" and JVC use the description "Super A", while Fisher prefer "Class-II" and Technics call their arrangement "Synchrobias".

All manufacturers are aware of the problems caused by too much negative feedback and designers have abandoned the use of "brute force" loops of 50 to 60 dB to get some impressive figures. In other words, amplifiers are designed for low distortion before the loop is closed, so that only 15 to 20 dB is necessary. Yet another approach will, I believe, become quite popular — at least for the more expensive models. This is the "feedforward" circuit which involves the use of a separate amplifier to balance out the inherent distortion in the main amplifier. Threshold were the first to use it in their Stasis model, but now Sansui have developed a similar circuit. They introduced the first model at the Show, the AU-DII rated at 120 watts per channel at a distortion less than 0.004%. Frequency response is within +0 and -3 dB from zero to 200 kHz.

Cassette decks now offer better value for money than ever and several models were to be seen priced at well below \$160 with metal tape capability, large VU meters, provision for four kinds of tape, a Dolby system and a good all-round performance. The more expensive decks featured such refinements as digital displays, automatic programme selection, end of tape indicators and mic-line mixing. At least 12 models boasted the new Dolby HX (Headroom Extender) circuit while among the dual-speed (3¼ and 1½ ips) models were entries from Marantz, BIC, and Fisher.

Turntables are also reasonably priced now and there is quite a selection of direct-drive models under \$180. Straight tonearms seem to have almost superseded the old familiar S-shaped designs, although Technics still use them in most of their range. Linear tracking or straight-line arms are becoming more common, and among those seen were models from Technics, Harman-Kardon, Mitsubishi, Yamaha, Phase-Linear and Dennesen. The last named turntable uses a tiny air pump to float the phono cartridge. Lux also have a turntable which employs a pump but this one creates a vacuum to hold down the record so it is really flat. It seems to be an expensive way of doing things, as

the price of this model is \$3000! Dual were using a special record to demonstrate the virtues of their Ultra Low Mass (ULM) arm and Ortofon phono cartridge. The record carries a 300 Hz signal, but it also has eight uniformly spaced warps. The eight-gram ULM combination plays it with no trouble, but the severe intermodulation produced by a standard 18 gram arm combination could easily be heard.

Once again, the Show was enlivened by a fascinating array of loudspeakers ranging from shoebox models to wardrobe sized behemoths. The most elaborate system was Infinity's new Reference Standard at a cool \$20,000. It consists of four modules, 7ft 6 inches high which house two 1.5 kilowatt bass amplifiers as well as the drive units. Each bass column contains six 12 inch drivers and servo feedback is obtained with an accelerometer. Crossover frequency is 70 Hz and the midrange section consists of a vertical stack of 12 planar electromagnetic induction units arranged as a dipole. High frequencies are handled by another stack of 36 planar units. The cabinets are 1 inch thick and some of the sections are sand-filled (remember the Wharfedale baffles?) and the total weight is 1200 lbs. How did it sound? Well, it was unquestionably very, very good and the low frequencies were particularly impressive. After all, a dozen 12 inch speakers can move a lot of air! Although the system is not a true line source, the stereo image was outstanding, but it must be said that the overall gain over a really good pair of \$1000 systems is quite small — at least at "normal" listening levels. It's the law of diminishing returns.

Cerwin-Vega were demonstrating a new model, designed to "meet the challenge of the new digital super-discs". It is a three-way system with an 18 inch bass driver and a 12 inch co-axial unit, which has a compression tweeter. An unusual feature of this model is the use of inert gas to effectively increase the volume of the bass compartment of the enclosure. No, the gas can't escape: it is contained in plastic bags. The system stands 52 inches high and it will handle 1000 (yes, one thousand) watts continuous power.

The Ionophone is back again: its new name is "Ionovac" and the one at the Show hailed from West Germany. Crossover point has been moved an octave up to 6 kHz. My old original used to radiate for a considerable distance on all tv bands, which caused some friction with the neighbours, but I'm told that this and other drawbacks have been overcome.

Sony had a large, floor-standing system using four drivers, all with flat diaphragms made from a honeycomb carbon fibre material. The bass speaker diaphragm is about 13 inches square and it is driven by four speech coils, positioned to "ensure a piston movement without flexing". Jumetite, a

Canadian manufacturer, were demonstrating the latest version of their system, which uses a horn-loaded ribbon transducer from 600 Hz up — some of the best sound heard at the Show.

The VSC company introduced several low-priced cassette players using a new i.c. with a "bucket-brigade" chip to provide high-speed, intelligible audio playback at speeds up to three times normal. According to the makers, there is a definite interest in the idea from manufacturers of v.c.r.s that can operate in the six-hour mode.

Crown introduced the unique PZM microphone at the January Show and again, it was attracting a lot of attention. It uses a new principle of sound detecting, using the pressure zone at an acoustic boundary to eliminate distortion problems common to other microphones — so say the inventors. The active element is a pressure-calibrated electret capsule and it is mounted on a plate measuring 5 × 5 inches. One of the advantages of the PZM is that the frequency response is independent of distance, but the gain in clarity is almost unbelievable. In one demonstration, it was compared with a very expensive German studio microphone in a recording session with a large orchestra. As soon as the PZMs were switched in, the feeling of strain simply vanished. Various models are available and they can be put inside a bass drum or piano, since inputs as high as 150 dB can be handled.

Garrulous gadgets

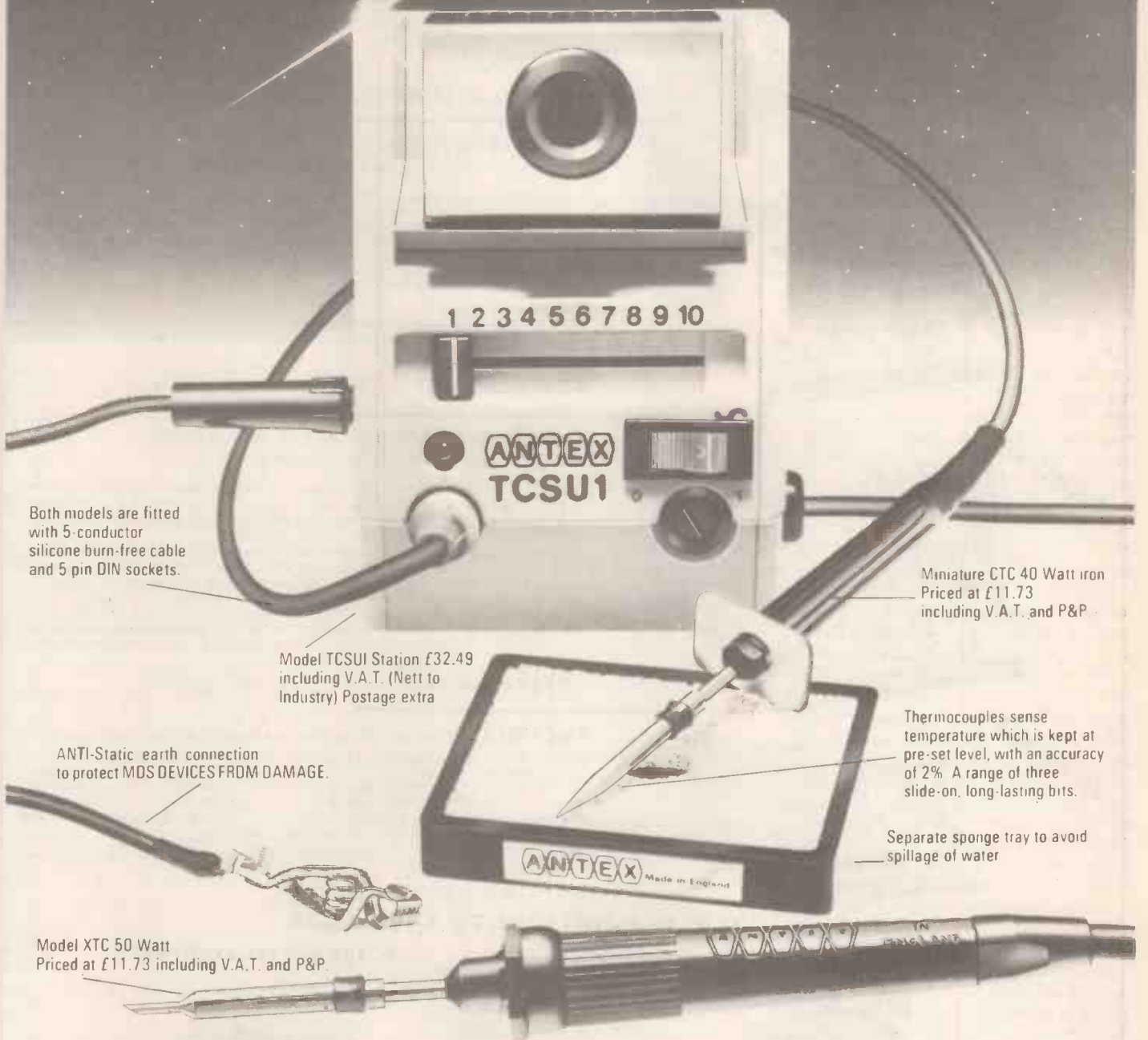
Talking clocks, calculators and microwave ovens are becoming commonplace and speech quality is improving. One reason is the use of new chips that can synthesize phonemes. It is said there are at least 45 uniquely different sounds needed to phonetically create words in the English language. These, plus 16 other durational alternatives are produced by a new l.s.i. chip made by Votrax. There are also three "pause" phonemes often necessary to separate phrases in continuous speech, so the result is a total of 64 phoneme selections. The duration of each phoneme is fixed, the slowest being 40ms and the fastest 250ms. Pitch variation varies automatically, or it can be controlled by an external "clock". Continuous electronic speech is created by sequencing sounds into recognisable words. For instance, 'phoneme' becomes F-01-N-EI-M.

Panasonic were showing a talking calculator which had a female voice with an impeccable British accent — Roedean, if I'm not mistaken. Casio had another which also contained a clock, date memories, a calendar and 12 recorded tunes. The user could program tunes for special occasions such as "Happy Birthday" or "The Wedding March", but one tune could not be changed. The thing plays "Jingle Bells" every Christmas. . . . □

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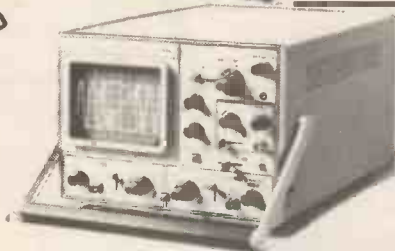
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Colour tv receiver design

3 — More on the colour decoder; also video outputs, sync processor and timebases

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

The previous article, in the August issue, ended with an outline of the three-chip colour decoder. The present article continues with further description of this decoder before passing on to other sections of the receiver.

Various sections of the circuit require a number of pulses for the purposes of gating, blanking and clamping. Fig. 10(b) shows the various pulses required and their relative timing and Fig. 10(a) shows how the signals are affected by them.

The "sandcastle" pulse is a convenient way of applying two pulses into one pin of an i.c. Level sensors in the i.c. sort out which width of pulse should go to which section of circuitry.

1. Sandcastle pulse on pin 7 of TDA 2560. The narrow top part of the pulse is used to clamp the luminance signal at black level during the back porch. The actual voltage of this black level is determined by the position of the brightness control. The wider lower part is used to gate the gain-controlled amplifiers which control the saturation and contrast (saturation tracking). During this time (the burst interval) these amplifiers are switched to maximum gain to prevent disturbance to the a.c.c. loop. This pulse must be wide enough to cater for tolerances in broadcast burst position.

2. Sandcastle pulse on pin 15 of TDA 2522. The narrow pulse gates in the burst for use in the subcarrier regenerator section of the i.c. This pulse must be as narrow as possible for optimum noise performance. However, due to the tolerances on broadcast burst position, some degree of adjustment is necessary to the leading edge of this pulse to ensure that all the burst is gated in. If part of the burst is lost, the pull-in range of the subcarrier regenerator a.p.c. loop will be impaired.

The wider part of the pulse is used for blanking the chrominance signal for the whole of the line and field flyback periods. This is needed because the process of gating the gain-controlled amplifiers to maximum gain inevitably produces coloured noise during these periods and this would show on the screen.

3. Luminance blanking. After the narrow part of the pulse 1 has clamped the black level to the voltage set by the customer brightness control, line and field pulses blank the signal during the whole of the line and field flyback periods. Thus these pulses must be derived from the line and field timebases. The luminance signal is blanked to a reinserted level of +1.5V. This luminance signal is then d.c. coupled throughout the remainder of the decoder.

4. Output clamp. A pulse wider than that of the chroma gain switch but narrower than the chroma blanking is required for clamping the colour difference signals before they are added to the luminance signal. The control for each of these clamps is derived from a sample of the video output signal, thus ensuring that the d.c. level of this output signal (and hence the black level on the c.r.t.) is closely controlled within a feedback loop.

The background controls, for presetting the black level of each colour, are also included in this loop.

Video outputs

Video output stages need to drive up to 90V p-p of video at a reasonable bandwidth into a load (the c.r.t. cathode) which has a substantial capacitance. The amplifier obviously needs to present a low output impedance to this load and a simple class A amplifier for this application would dissipate an appreciable number of watts. Consequently, several types of low-dissipation circuit have been developed to overcome this problem. The 70 series chassis uses a class A amplifier with an active load (Fig. 11).

In this circuit the drive is applied to a transistor operating as a high class A amplifier with a high-resistance load thus keeping the dissipation down. As long as this transistor is being turned on (i.e. the signal at its collector is going towards the 0V line) the output impedance is effectively low. However, if the drive to the class A transistor starts to go in a negative direction, trying to turn it off, then the output impedance would effectively be the high resistance collector load. Hence the reason for the second transistor, which acts as an emitter follower for positive going output signals and consequently presents a

low output impedance to the c.r.t. cathodes.

To ensure good linearity of the output waveform, feedback is applied over the whole stage, part of which is in the i.c. Here, a sample of the blanking level is also taken and the d.c. level of the output corrected as necessary. The c.r.t. background controls are d.c. potentiometers acting in this part of the circuit.

Sync processor

The purpose of the sync processor or "jungle" i.c. is to select the sync pulses from the video waveform, and use them to phase lock an oscillator running at the same frequency. By careful choice of time constants the phase locking process reduces the effect on the picture of noise and disturbances on the video waveform. The resulting line drive pulses can then be compared in another phase locked loop with flyback pulses derived from the line output stage and the resulting pulses amplified to drive the line output transistor. The sync processor i.c. may also separate out field sync pulses and may produce gating/clamping pulses for the colour decoder.

The TDA2571 used in the 70 series chassis does not contain the second phase-locked loop which compares the line oscillator output with the line flyback pulses. This loop, as we shall see, is contained in the power supply control i.c.

The TDA 2571 contains two major innovations, an adaptive sync separator, and a count-down field sync pulse system. Conventional sync separators are based on the d.c. restoring circuit shown in Fig. 12(a). Tr_1 is biased by R_1 so that it is just on the point of conducting. As each sync pulse comes along it drives Tr_1 hard on, producing the output pulses shown. The time constant $10R_1$ is chosen so that sufficient charge leaks away between pulses to enable each pulse to turn Tr_1 on. This type of circuit is particularly susceptible to noise on the sync pulses and also to "ghosts" or cross-modulation on the received signal. The principle of the adaptive sync separator used in the 70 series chassis is shown in Fig. 12(b).

The video signal is applied to a gain controlled amplifier which amplifies the sync pulse and sets the black level and sync tip level at the two levels shown. A level corrector takes a sample of each of

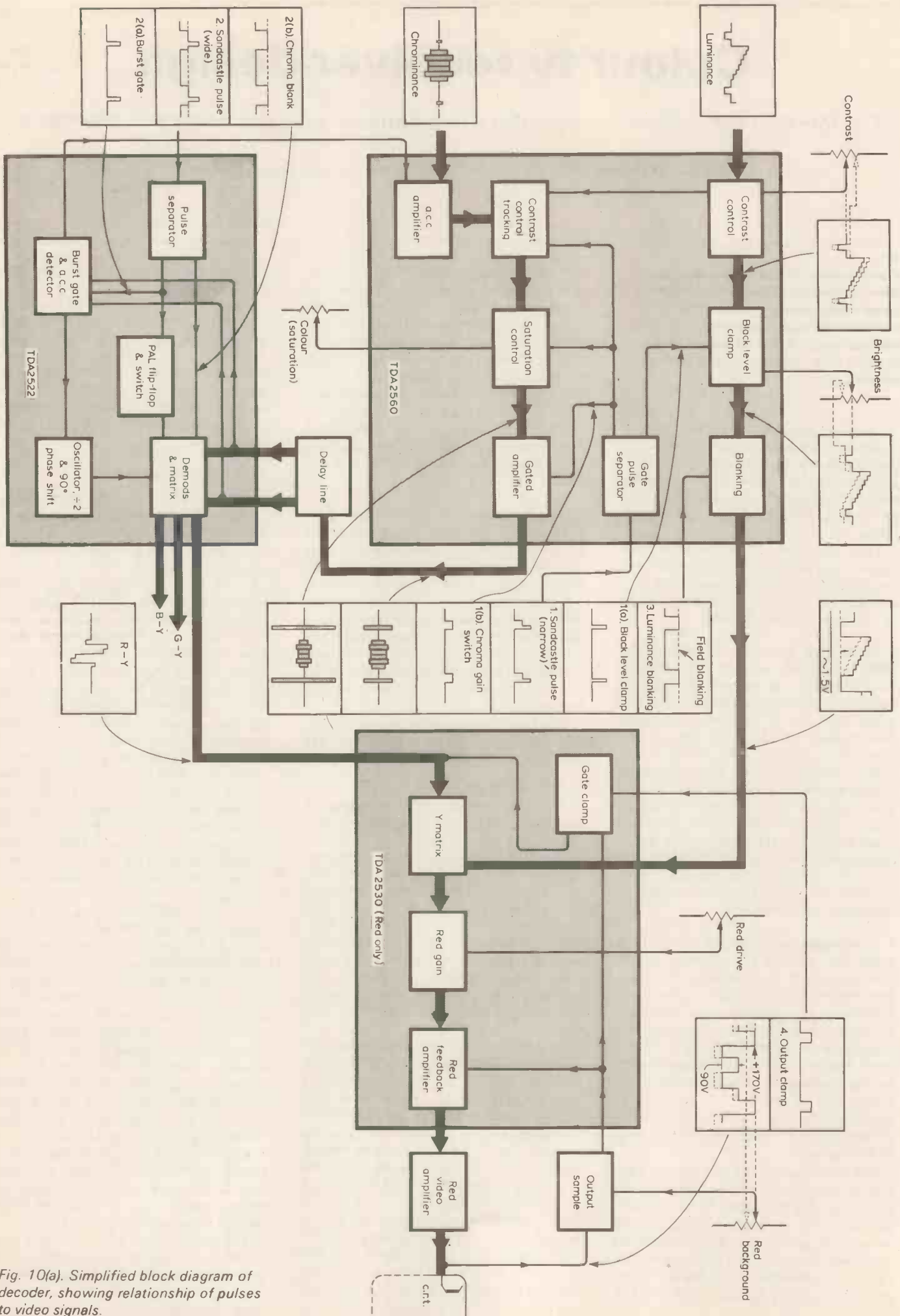


Fig. 10(a). Simplified block diagram of decoder, showing relationship of pulses to video signals.

these levels and corrects the gain of the amplifier as necessary. With the sync pulse having been closely defined, a small slice is taken out of the centre of it and amplified, thus producing a very stable, closely defined sync pulse. This type of circuit has been demonstrated to be markedly superior to the older type of circuit especially under noisy, "ghosty", or cross-modulated signal conditions.

Once the mixed sync pulses have been separated out, a further circuit separates out the field sync pulses. Often simple integration is sufficient, but again poor signals can result in poor or even no field pulses. Obviously the mixed sync pulses from the adaptive type of sync separator give improved field pulses but certain signals can be improved by the use of a field pulse count-down system.

A set of dividers counts down from the line oscillator frequency (in this case $2 \times$ line frequency = 31.25kHz) to the field frequency of 50Hz and produce an output pulse at this frequency. A normal integrating sync separator produces a field sync pulse directly from the mixed sync waveform and this is compared with the count-down pulse. If the two are completely in phase for a sequence of complete fields, the counted-down pulse is fed out to the

field timebase. If the pulses are not in phase, the integrated pulse is fed out. This procedure guards against incorrect processing of signals which do not have a defined count-down ratio between line and field sync pulses (e.g. some cctv cameras, video games, etc.).

The necessary delay in deciding which pulses to feed out causes a noticeable though not objectionable effect on the picture — on changing sync sources (e.g. changing channels) the picture locks momentarily with the field blanking interval in the centre of the screen before locking normally.

Direct frame sync

It was discovered, early on in the development of the 70 series chassis, that if the cctv camera or video game, or

whatever was the non-counted-down source, had a line/field frequency ratio close enough to the true counted-down one, then the i.c. sent out a proper indirect count down pulse. However, a few fields later it would "realise the error of its ways" when the direct pulse had drifted out of phase with the indirect pulse. It then momentarily supplied the direct field sync pulse while it "considered" the situation. Eventually for a few fields, the unlocked source would appear to have a locked line/field relationship and so the i.c. would revert to supplying the counted down pulse. This sequence would repeat itself ad infinitum and the picture would exhibit an irritating slow vertical jitter. For this reason a small sub-panel was fitted to the 70 series main panel to supply direct

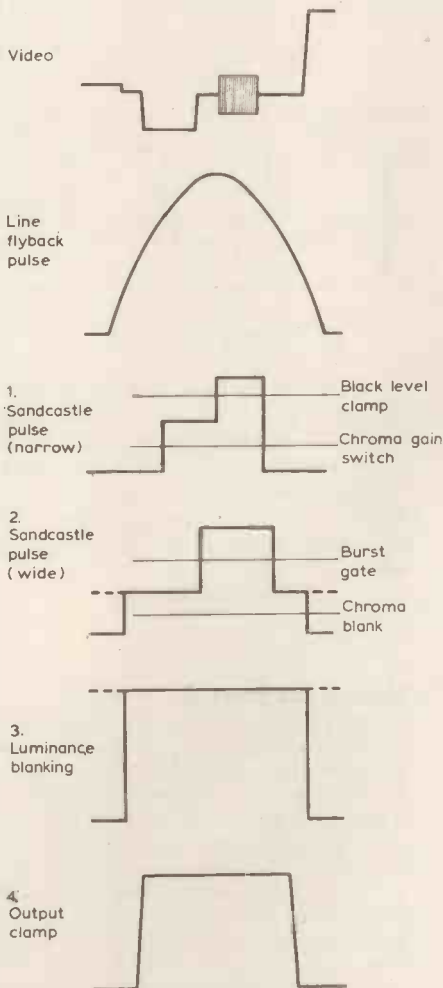


Fig. 10(b). Details of waveforms in decoder (Fig. 10(a)).

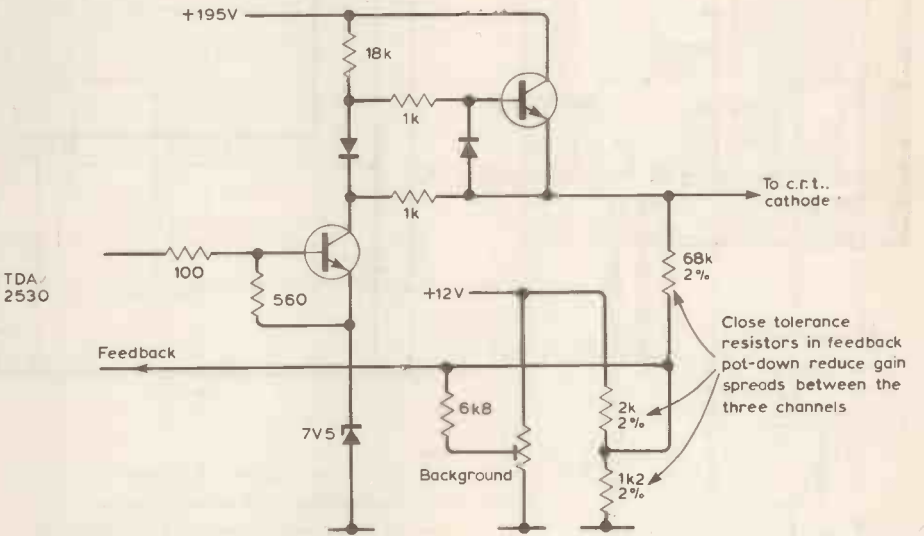


Fig. 11. Video output amplifier (simplified).

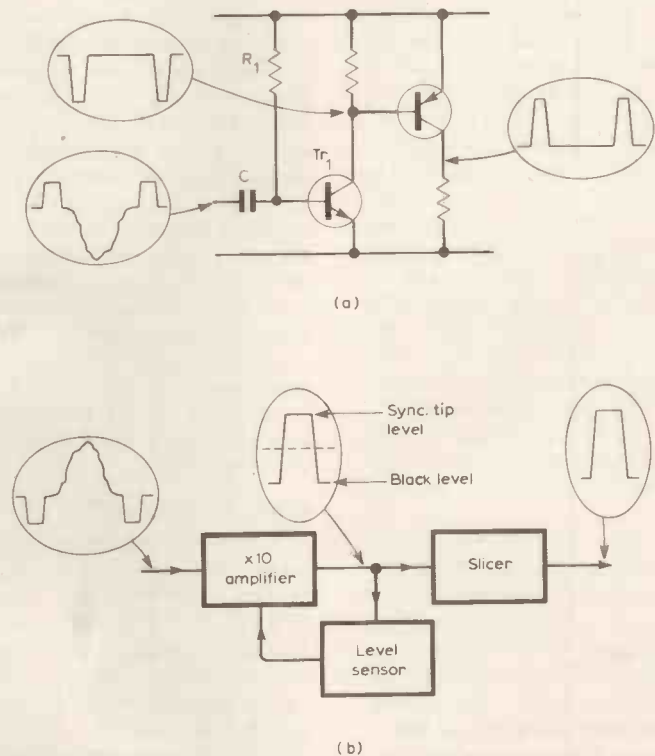


Fig. 12. (a) Conventional sync separator. (b) adaptive sync separator.

field sync when required. The customer channel-select switches are arranged to switch in this feature in conjunction with the a.v. time constant switching for v.c.rs etc.

Line timebase

The requirements of the main output of the power supply are largely governed by those of the line output stage. The least losses (and hence lowest dissipation and highest reliability) occur with low current, high voltage line output devices. The transformer is also simpler in this configuration, acting just as a high impedance supply choke as far as the line scan coils are concerned (Fig. 13). Hence the scan coils are switched

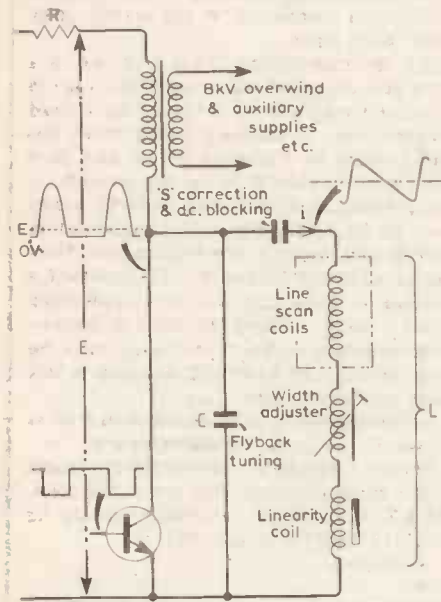


Fig. 13. Simplified diagram of line output stage.

directly across the supply and, consequently, their impedance (which, at 15625Hz, is largely composed of their inductance) and their sensitivity determine the supply voltage. The basic formula used is $E = -L(di/dt)$. The resistor R is required to limit the current in the transistor in the event of a c.r.t. flashover and extra volts must be allowed for the drop across this resistor.

The line output stage is often a secondary power supply itself, the overwind on the t.f. being the source of e.h.t. and focus voltage for the c.r.t. Sometimes tapped windings, scan rectified, are used to produce some supply voltages for the signal circuitry. All these sources add to the current through R and contribute to the volt drop across it.

In the 70 series chassis all the supply lines except one are taken from the s.m.p.s.u. transformer. This avoids any losses due to conversion efficiency in the line output stage. The field timebase h.t. is taken from the line output stage because of the need to "track" the height with the width during c.r.t. beam current variation. When the beam current increases, the supply current

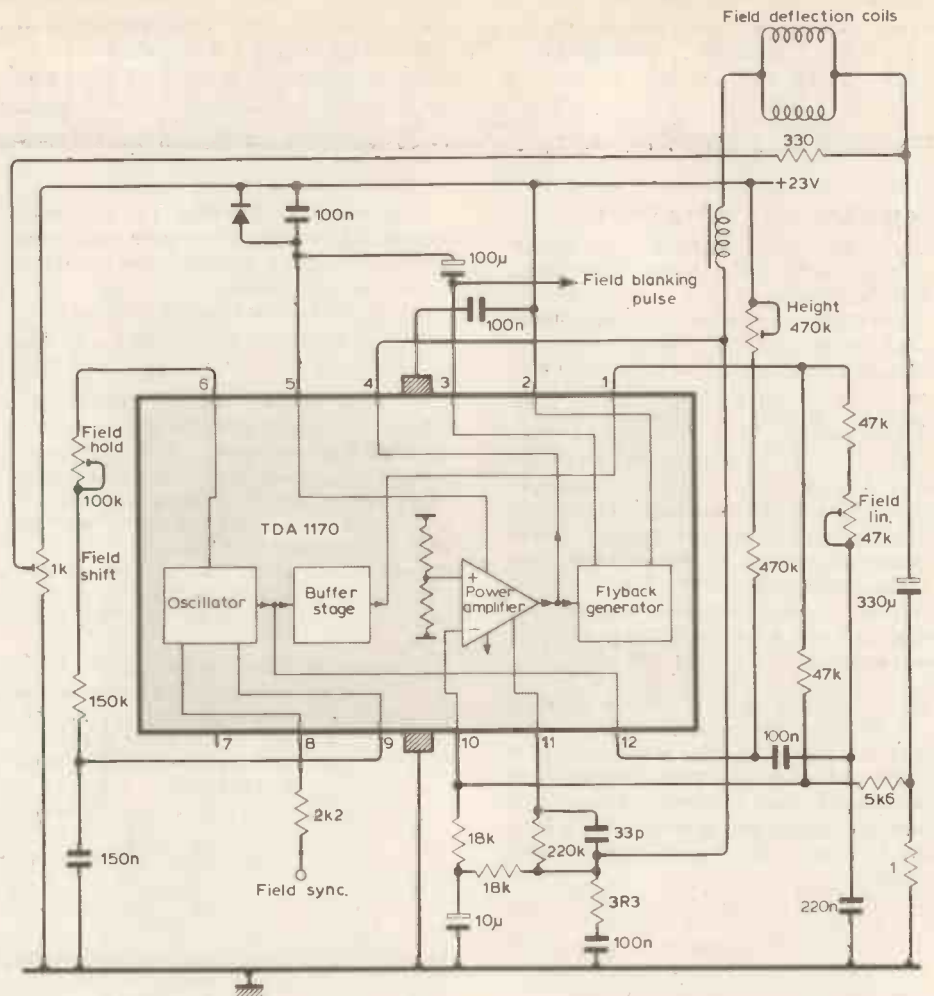
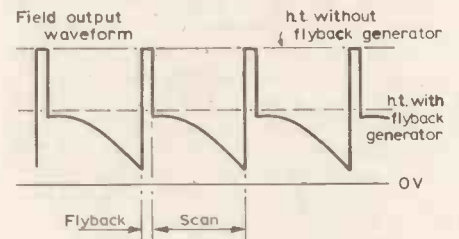


Fig. 14. Block schematic of the TDA 1170 field timebase i.c., including oscillator, sawtooth generator and output amplifier.

Fig. 15. Field output waveform with and without a flyback generator.



through R increases and so E falls, resulting in a drop in e.h.t. Now both line and field scan sensitivities are affected by variations in e.h.t. and, in general, when the e.h.t. falls the picture on the screen gets bigger. However, when E falls, so does the scan current ($E = -L(di/dt)$ again) and by careful choice of the value of R the "breathing" of the picture width can be reduced to a minimum. However, if nothing further were done, the height would apparently alter with beam current.

Since a scan rectified supply goes up and down in sympathy with E this is a convenient source for the field timebase, enabling the height to "track" with the width.

Field timebase

This uses the well-established TDA1170 which has operated successfully for several years in the 80 series chassis. The i.c. is a complete timebase with oscillator, sawtooth generator and output amplifier (Fig. 14). The output circuit incorporates a flyback generator which helps to reduce power consumption. In some circuits the field flyback is contained within the supply rails and

consequently a good deal of power is wasted (Fig. 15). In the TDA1170 the supply is only sufficient to contain the scan waveform. During flyback, the supply is switched to a value which is double that during scanning. Thus fast flyback is achieved with lower dissipation.

(To be continued)

Notes on Part 2

For space reasons we deleted a few lines from the text under the section "Sound i.f. and output" on page 64 of the August issue. As the author feels the matter is of importance to the design we are printing them here.

The 18V supply for the TDA1190Z is taken from the switched-mode power supply since the large current pulses which the audio output stage takes during bass transients would cause unacceptable picture movement if this supply were scan-derived.

Acknowledgements should have been included to Mullard Ltd for permission to publish Figs 4, 6, 7 and 8. - Ed.

LETTERS TO THE EDITOR

COMMUNITY RADIO

Norman Macleod could have strengthened his arguments about community radio (June/July issue) by reference to the experience of the surprisingly lively pirate broadcast radio in the nation's capital.

1. London has had a community radio station. For about fifteen months until it finally ceased transmitting in the summer of 1979, Radio AMY (Alternative Media for You) attempted a service for the six North London boroughs of Camden, Islington, Haringey, Enfield, Barnet, and Hackney. The rather idealistic collective that ran it had a vision of London divided into five manageable radio constituencies, three north of the river and two south. The six hours of programming included much local news and interviews, even locally produced music and dramatics.

It was the very scope of their ambitions which was their undoing – quite different from the usual deejay shows of the conventional pirate. In the end the collective was too exhausted to carry on – all that work with no possibility of a source of finance. Still, while it lasted and after I had written it up in *Time Out*, there is no doubt it had a substantial following.

2. A number of the spectrum 'holes' referred to in the Fred Wise report are actually used most Sundays by the present generation of pirates. In general, the medium-wave operators start around mid-day and close well before the dusk brings extended propagation and the v.h.f. stations tend to come on in the evening, though one well-established v.h.f. pirate who sometimes uses stereo prefers 12 mid-day to 3 p.m. Readers with the right sort of equipment may like to judge for themselves the extent to which these stations cause interference both within their nominated territory and beyond.

Lest this letter be misunderstood, I am not in favour of unregulated use of the radio spectrum, for all the obvious reasons. But, faced with the poor record of the Home Office Radio Regulatory Department in presenting honest information on the availability of r.f. spectrum space and the politician's lack of vision in restricting broadcast licences to only two bodies, the occasional carefully planned and well engineered demonstration seems entirely admirable.

Lennie Michaels
North London

IEEE BUS STANDARD

Some clarifications are required in the article by P. R. Ellefsen published in your June/July issue.

IEEE-Std. 488 (1978) defines with precision the General Purpose Interface Bus (GPIB), including its electrical and mechanical specifications, and the interface functions. IEC 625-2 will provide further guidance on the GPIB message content and formatting in byte-serial data streams.

In his discussion on the type of data driver required by IEEE-488 (1978) Mr Ellefsen is imprecise in his interpretation of the standard. He writes "... some means of allowing one device to control the state of a

bus line has to be provided. The available options are twofold: three-state logic, and wired-or. The more universal, and cheaper, wired-or system is used."

1. The GPIB uses binary logic. It is optional to use three-state output stages on gates driving the ATN, EO1, DAV, REN, and IFC lines.

2. By "wired-or" Mr Ellefsen means "open-collector". The RFD and DAC, messages are a "wired-and" combination of all the open-collector gates connected to the NRFD and NDAC, lines. The SRQ message is a "wired-or" combination of all the open-collector gates connected to the SRQ line.

3. The DIO1-DIO8 lines may be three-state or open-collector outputs. In the Parallel-Poll Active State these lines must be open-collector.

4. If three-state drivers are selected for DAV and DIO1-DIO8 then the GPIB data rate can be up to 1Mbyte/second. To say that "A tacitly agreed limit of 250 kbyte/second is therefore normally accepted" is a serious misinterpretation of IEEE-488.

The maximum data rate permissible on the GPIB is:

(a) 250kbyte/s using open collector data drivers.

(b) 500 kbyte/s using three-state drivers for DAV, DIO1-DIO8 and EO1.

(c) 1M byte/s using three-state drivers for DAV, DIO1-DIO8, EO1 and ATN, provided that (i) not more than 15m of cable is used (ii) there is at least one standard termination network per metre of cable, (iii) there are no powered-off instruments on the bus, and (iv) the device capacitance is less than 50pF.

In practice there are few GPIB instruments able to transfer data at even 250kbyte/s; however, this is not a limitation of the bus but of the instruments. In the future it is likely that test systems designers will require and obtain instruments operating at faster data rates.

The GPIB Parallel Poll function is a source of frequent confusion. In the Parallel Poll Enable message (PPE) the Controller instructs the current Listener how to respond to a subsequent Parallel Poll sequence. The interface function will give an affirmative Parallel Poll Response (PPR) in the Parallel Poll Active State (PPAS) only if the local "individual status" device message (ist) corresponds to DIO4 of the last received PPE message. For example, if DIO4 was a '1' the 'ist' must be '1' for an affirmative PPR to be sent. If DIO4 and 'ist' are in opposite states then there must be no PPR in PPAS.

Because DIO1-DIO8 are open-collector outputs and not three-state, the PPR received by the Controller is the wired-or function of all devices whose 'ist' message matches the DIO4 bit of the last PPE command received by each device.

Jonathan Summers
Fairchild Camera & Instrument (UK) Ltd
Bristol

The author replies:

My thanks to Mr Summers for his comments. Regarding drivers, it is quite true that three-state drivers may optionally be used on some lines, usually with the intent of increasing speed, and the end of the section which Mr

Summers quoted should read "... wired-or system is generally used".

I particularly tried to avoid confusion in the article by not referring to the RFD and DAC messages (which are the logical inverse of the state of the NRFD and NDAC lines). It is, however, clear that wired-and of RFD (for example) is equivalent to wired-or of NRFD. I note, incidentally, that Mr Summers occasionally refers to the bus lines by their "high=true" logical names (e.g. SRQ). This is a very useful way to refer to the lines when designing interfaces to the bus, but can lead to confusion when referring to the standard which, as I mentioned in the article, uses "low=true" logic.

My statement that 250 kbyte/sec is a generally accepted maximum data rate is based on paragraph 5.2 of the 1975 standard which states: "A standard performance bus will operate at distances up to 20m at a maximum of 250,000 bytes per second ... using 48mA open collector drivers". However, Mr Summer's explicitly detailed definition of data rates is totally accurate. Note that in paragraph 5.2.3 of the 1978 standard, a warning is given that if a speed-enhanced talker is used to achieve 1Mbyte/s data rates, with standard talkers, problems may be experienced even when the interface is not being used at that rate.

Mr Summers's section on Parallel Poll is extremely lucid, and I thank him for it.

Finally, I should like to correct a mistake which somehow crept into my manuscript. On p.77 the "untalk" message should be "1011111", and "unlisten" "0111111".

P. R. Ellefsen

MILITARY ELECTRONICS

Your News of the Month in the June/July issue reports that according to the Defence Estimates the defence equipment programme sustains about 200,000 job opportunities within the major defence industries and about the same number again indirectly in industry.

It seems to me to be illogical to work for wars in peace-time, even if they are only vaguely anticipated, i.e. by building up one's defences. It was, e.g., a very old Roman precept which said: 'if you desire peace, prepare for war', and, as the late Lord Mountbatten pointed out in a speech shortly before he died, that precept is now "absolute nuclear nonsense".

The defence programme therefore seems to me to be an illogical development of electronics, and also, perhaps, an increasingly dangerous one. Would this not seem to imply that the electronics engineers employed to maintain the defence equipment programme would therefore (a) be better off on the dole, since (b) their knowledge of electronics may even have serious gaps, inconsistencies, or failings?

This policy (to make these jobs redundant) could also help considerably to reduce inflationary pressure in the UK, as well as giving support to pacifism, which is surely the only sensible philosophy in Western Europe at the present time.

Peter G. M. Dawe
Oxford

WHAT'S SO NATURAL ABOUT e ?

Die ganzen zahlen hat Gott gemacht, Alles anderes ist menschenwerke

I do not understand why Dr Finlay (December, February, April) wishes to determine e using a ruler and two jam-jars. The mensch who made it was clearly not satisfied with integers. It has always been my wish, however, that these columns should bring light and sunshine into the lives of others, especially my bank manager.

Three jam-jars, I think, will be better, and nothing you can't find, if desperate enough, in the ordinary home. I do not possess a metre rule, but some quick hammering at a ceiling has provided a lath just over a metre long. A tape measure, some sand or sugar, or, if your grocer is old-fashioned, a mixture, and string.

The jam-jars are best replaced by those revolving plastic beakers, with string handles stapled on to make small buckets. The metre rule is drilled at its centre, and pivoted, or hung by string from a convenient support.

A supply of what the French call le Scotch, so described to help to break down the separation of the two cultures, will be useful, or, preferably, draughting tape. Most readers will have this in their homes (*Deuteronomy* Ch.25 v.4).

We now have our balance, the suspended metre rule. I propose to measure from the centre, 500mm. Set one empty bucket at +30 and another at -300 (200 and 530 on the scale).

Use a small coin to trim the balance, mark its position with the tape. Remove it.

Set buckets at +300 and -300. Fill to about one-quarter and then add salt/sand/sugar to get a balance. Remove one bucket and mark it as 'reference standard'. Set the other unit weight at +30 and an empty bucket at -300. Replace the trimmer. Add material to the -300 bucket to get a balance.

Empty the material from -300 into +30. Repeat ten times in all.

Set this bucket, now nearly $\frac{3}{4}$ full, at -100, and use the standard bucket to measure its weight. The scale reading will be about 260, or $e \times 100$.

The operation is based on the defining equation:

$$\frac{d}{dx}f(x) = f(x)$$

$$\text{and } f(0) = 1$$

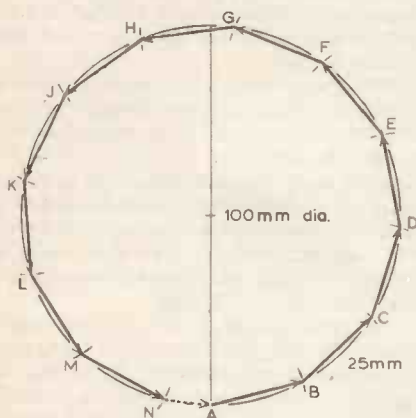


Fig. 1. Determination of π . Each chord, AB, BC etc. to MN is equal to $d/4$. Rather badly done, this gives $\pi = 3.1$.

The process corresponds to finding π by the construction of Fig. 1. As each chord is a short cut the value is always low, and I was surprised to find that on a diagram with 10cm diameter, hastily done, the total path A, B, ..., N, A came to 31cm.

We can draw another form, producing tangents. This gives a high value, again surprisingly close. The corresponding approach to e is to start with the standard buckets fairly full. Material is spooned out of the +30 bucket into the -300 bucket to get a balance, and is then discarded. Again ten steps are taken and the materials remaining weighed against the standard.

The basic experiment can be elaborated. The effect of taking fewer large steps, and more small steps, can be studied: the size of δc from $c(x)$, $x = 0$, through $x = 0.1, 0.2$ up to 0.9 can be recorded. With rather more stable equipment the explosive growth of e^x as it goes on can be shown.

Finally, there is one feature of this system which I find particularly attractive: you don't need the apparatus at all, or, to put it another way, you can repeat the operation on your adding machine:

$$f_0 = 1.00, + 0.1f_0 = 0.1 \rightarrow$$

$$f_{01} = 1.1 + 0.1f_{11} = 0.11 \rightarrow$$

$$f_{02} = 1.21 \dots 1.32, 1.45 \dots f_{10} = 2.56.$$

But my little adding machine, the back of an envelope, finds 3 significant figures the limit. A classier machine gave me 2.3579.

Thomas Roddam
London W8

SCIENTIFIC COMPUTER

I would like to thank John Adams and your selves for such an excellent and timely educational project as the Scientific Computer which appeared in your April to September, 1979, issues. Although I have modified the basic design to permit the use of dynamic random access memories and the use of an unmodified 525-lines 60-field/s television set for video display, Mr Adams's design presented me with the exposure and guidelines which were necessary to undertake such a project as an amateur.

Mr Adams's design utilizing the MM57109 number oriented microprocessor as a peripheral device of the Z80 main microprocessor to handle computations is indeed a novel one. This technique should be very attractive to those developers catering specifically for applications in science and engineering.

BURP Mk II has greatly enhanced the facilities of the computer but still lacks a few very vital functions like string variables, arrays and read/data statements. However, the branching of control to an address in r.a.m. for unrecognized commands, statements and functions allows additional facilities to be added fairly easily. In fact, I have added the use of REM for remarks, LINK N as a statement to link BURP and machine language programs and have changed the multi-statement line separator to the more familiar colon.

I should mention here that, instead of reprogramming my original r.o.m.s with the Mk II monitor/interpreter firmware, I have rewritten the Mk II so that it will load and run in r.a.m. at location 15A0 to 1D4F. This modified version of BURP Mk II is then saved on cassette tape and re-read into the computer when necessary. This exercise is done only as a temporary means of making use of

the added facilities of BURP Mk II and retain the use of my 5-unit code Baudot 50 baud teleprinter until I am satisfied that BURP firmware is sufficiently developed with enough facilities.

My system comprises 3K r.o.m. from 0000 to 0BFF, expandable to 0FFF (4K) and 12K dynamic r.a.m. from 1000 to 3FFF, expandable to 7FFF (28K). The video display remains memory-mapped from 8000 upwards but of necessity comprises half pages of 16 lines by 64 characters per half page, with each displayed half page automatically or manually selectable.

Since the computer makes use of r.a.m. area 1E00 to 1FFF without memory protection, I have transferred the commencement of BURP program loading to 2000. This position prevents long or sequenced BURP programs from extending into memory area used by the computer and also semi-reserves the area 1000 to 1DFF for machine language programs and any additional facility that may be added to the interpreter.

I invite comments from interested persons via P.O. Box 65, St John's, Antigua, West Indies.

Eustace N. Phillip, VP2AX
St John's
Antigua, W.I.

TECHNICAL AUTHORS

I was sorry to see that Mr Ronald C. Slater's otherwise comprehensive article on Careers in the Electronics Industry (May issue) should have overlooked so completely the engineers who produce the manuals and other technical publications upon which the success of a product can, and often does, finally depend. The work of the technical author surely deserves — together with that of engineers engaged in the parallel activity of technical training — to be ranked with "the main activities of a typical company". The provision of operating, maintenance and repair information is an essential support service for electronic equipment. It is generally a contractual requirement and a potential customer may be expected to defer the purchase of any new product, however meritorious, unless and until the necessary technical manuals are made available.

It takes an electronic engineer to generate a detailed technical manual for an electronic product, but his engineering attainments must be complemented by a willingness and an ability to communicate graphically and in writing. Unfortunately these are unfashionable attributes and such people are becoming increasingly rare. It is perhaps for this reason that competent technical authors are at long last beginning to be offered the sort of financial reward that their dual ability has always deserved.

The presentation of technical information offers a great deal of scope for expertise and can be highly satisfying. It is a much more creative activity than is commonly supposed. In explaining a circuit or a system in detail, the trained author constantly monitors his work through the eyes, so to speak, of a reader seeking enlightenment; the author thus subjects the design he is describing to a measure of independent critical analysis and this can result in his contributing to the development of a new product as well as to its eventual success in the field.

The growing scarcity of technical authors may well bring serious consequences for the industry. Those concerned with the education of engineers should make it their business to understand the importance of tech-

nical publications work and the possibilities it can offer as an engineering career.

*Claud Powell
Leatherhead
Surrey*

The author replies:

I would like to thank Mr Powell for his comments. While it was made clear that the article was not intended to be an exhaustive list of careers in electronics I would, nevertheless, agree that the technical author occupies an important place in the industry and that they are in short supply as, indeed, are good engineers and technicians of all persuasions. For the engineer, male or female, who has the ability and inclination it can certainly be a very satisfying task.

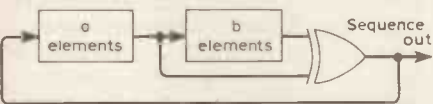
It is difficult to comment on technical communications without remarking on the notorious inability of the majority of engineers to communicate effectively. It is a point which has been made time and time again — but one which the educationalists seem reluctant to act upon.

Ronald C. Slater

FEEDBACK FOR P. R. B. S. GENERATORS

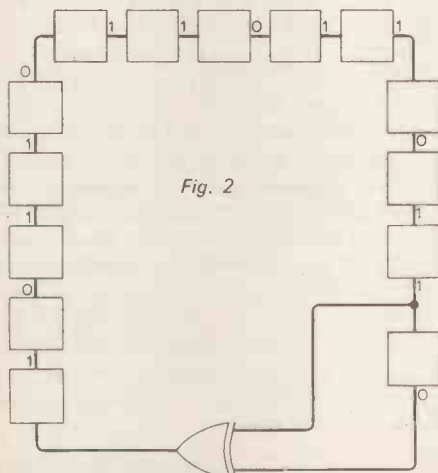
With reference to the article by the late Mr Butler in the February 1975 issue on Pseudo-Random Binary Sequence Generators, I think your readers may be interested in the full criteria for feedback selection. Careful choice must be made to ensure the full sequence length of $2^n - 1$ bits occurs.

If we consider the total shift register broken into two parts, with feedback around the system below, provided that $a \neq 1$ and



$b \neq 1$, if $xa = yb$ where x, y are integers then the system breaks down to being equivalent to two interlaced sequence generators (see later).

To illustrate the point, suppose that $a = 4$, $b = 2$. Logic state p at the output will be dependent on logic states $p - 4$ and $p - 6$ (four and six clock pulses ago, respectively). Thus even logic states are dependent only on preceding even states, and odd states depend only on odd states. This lack of interdependence causes the system to act as a pair of interlaced, independent, three element generators, so the total sequence length is only $2(2^3 - 1) = 14$ bits instead of $2^6 - 1 = 63$ bits.



A different kind of degenerate operation is possible under other conditions. As an example consider a p.r.b.s. generator where $a = 13$, $b = 1$. If the logic outputs should achieve the sequence in Fig. 2, or a shifted version of it (as it would normally do), then it will perpetuate the pattern in a closed loop of three states. This arises because the system described can be analysed as being equivalent to Fig. 3, which is a two-element

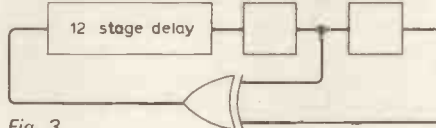


Fig. 3

p.r.b.s. generator with an extra delay, of suitable length to provide positive feedback (since 12 is a multiple of 3).

As a result of the above, rules can be drawn up which must be obeyed for non-degenerate p.r.b.s. operation:

- $a \neq (a + b)v/w$ except when $a = 1$ or $b = 1$
- $a - x \neq y(2^{(b-x)} - 1)$
- $b - x \neq y(2^{(a-x)} - 1)$
- where $w = 1, 2, \dots, (a + b - 1)$.
- $v = 1, 2, \dots, (w - 1)$.
- $x, y = 1, 2, \dots$, (smaller of a and b).

A feedback connexion table generated from these equations is given below. There are a few notable differences from Mr Butler's table.

a+b	Non-degenerate values for a
2	1
3	1, 2
4	1, 3
5	2, 3
6	1, 5
7	1, 2, 3, 4, 5, 6
8	3, 5
9	1, 2, 4, 5, 7, 8
10	3, 4, 6, 7
11	2, 3, 4, 5, 6, 7, 8, 9
12	1, 5, 7, 11
13	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
14	2, 3, 4, 5, 6, 8, 9, 10, 11, 12
15	1, 2, 3, 4, 6, 7, 8, 9, 11, 12, 13, 14

Note that it is simple to 'construct' these devices in microprocessor systems. I have written a Z80 routine for a 64-element generator in less than 32 bytes.

*K. Wood
Ipswich
Suffolk*

ILLICIT CB ON 27MHz

A number of people have urged the Government to move quickly on citizens' band radio before illicit use of 27MHz gets out of hand. I have a nasty suspicion that it's already too late. The authorities will never catch these users (they can't even be bothered to catch those who jam v.h.f. amateur radio repeaters continually, where they know the names and addresses of the offenders; how will they catch tens of thousands of illicit c.b.ers?), even with the current wave of indiscriminately stopping anyone and everyone with a non-broadcast antenna on the roof of their car (RSGB cards count for nothing and I now have to carry my licence at all times — not a legal requirement officially).

It's difficult to see what will entice these users on to another band. Certainly, rigs will have to be a good deal cheaper than the £50-£100 black-market price of an American 27MHz rig smuggled into the country, and I don't see that as being economically viable for British manufacturers as there will only be the home market and the chances of even the EEC adopting a system other than 27MHz a.m./s.s.b. must be pretty remote.

And there'll always be people who prefer the American mode and its UK illegality and just want to say '10-4' to each other: they'll never give up 27MHz. And there's something to be said for international compatibility. My 2-metre amateur rig is pretty useful anywhere in the world I care to go with a reciprocal licence. Would it not be a good thing to standardise c.b. equipment in a similar way? Then there would be a far greater market to encourage UK manufacturers (who already make the odd frequency synthesiser for Japan) and the possibility of cheaper rigs. Temporary import controls could establish the UK industry, which could then stand or fall on its ability to compete internationally.

What this all comes to is two points. First, 27MHz will never go away; the technical problems are easily sorted out and it really comes down to acknowledging that the present thousands are unlikely to leave the band. Either they are legalised or they aren't. Second, prices for v.h.f. rigs that are above the £50-£100 mark will ensure the continuation of 27MHz use and will equally ensure that the average 'citizen' won't be able to afford to use his 'band', leaving the way open for a future government to take the said band away 'because nobody's using it: it was never really necessary'. At best, such a c.b. would be little broader-based, socially speaking, than the amateur bands, which are almost exclusively middle-class. US and illicit UK 27MHz activities are totally classless, at least partially, because everyone can afford a rig.

After long consideration we may find that the technical arguments against 27MHz — which are very powerful and generally sensible — must be reconsidered in view of the social implications of a v.h.f. citizens' band or indeed any band which requires expensive equipment and isn't already — albeit illicit — in use.

*Richard Elen, G8RJK
Croydon*

ELECTRONIC IGNITION

I was most interested to read the letter from Mr D. J. Bruyns in the March issue since I have been building and using c-d systems for eight years. Last year I wrote to a well known manufacturer with some constructive criticisms of his design. A few days later I received the offer of a job! My own conclusions are:

1. The capacitor-discharge unit itself is not always to blame for spurious faults, although careful attention must be given to the choice of suitable components; in particular, the thyristor and the capacitor which must tolerate very fast risetimes, high voltage and high temperature.
2. The high output voltage from the coil attached to a c-d unit is susceptible to leakage and arcing caused by damp, dirty or cracked h.t. leads, faulty coil or suppressor caps.
3. C-d ignition does not appear to cope with a weak mixture any better than standard Kettering ignition, possibly because although the voltage can be higher, the duration of spark is much less than that of the standard system.
4. The c-d system does seem to cope with a rich mixture, perhaps because its fast risetime allows it to fire a fouled spark plug.

Note that points 2. and 3. can result in misfiring from a c-d driven system but apparently acceptable performance from standard ignition.

*M. T. Pickering
Stockton, Cleveland*

WORLD OF AMATEUR RADIO

Long-path and simple aerials

The ability of amateurs using only simple aerials to work long distances by taking advantage of the extremely reliable morning chordal-hop, long-path to Australia, via the dawn and dusk "tilts" in the ionosphere, rather than multi-hop paths, is underlined by the observations of Ron Fisher, VK3OM of Glen Waverley, Victoria. He reports working on 14MHz s.s.b. some 147 different British amateurs under "long-path" conditions during the past year. Of these, 55 of the British stations were using dipole-type aerials, 32 were using ground planes and vertical monopoles, four were using "mobile whips", representing a total of 91 with simple aerials, compared with 56 using beam arrays of various types. He writes: "It is interesting to note that some of the more consistent British stations heard in Australia at this time of day use dipoles; they are not necessarily the strongest signals but often the difference between them and the stronger signals heard at the same time is small, perhaps 1-1½ "S" points. (S-point calibration varies widely between different receivers but this probably represents about 4 to 5 dB).

US reply to the Pecker?

An American h.f. over-the-horizon radar system (Conus OTH-B) has recently begun a nine-months trial from a transmitter site near Moscow (sic), Maine with the receiving site for the backscatter signals about 100 miles away near Columbia Falls. The system is designed to detect moving targets at a range of up to about 1800 nautical miles, using complex digital data processing to isolate targets from the large amount of sea and land backscatter clutter. Twelve 100 kW transmitters are used on a 24-hour basis with any of four centre frequencies between 6.8 and 21.8MHz. The transmitting aerial array comprises 48 elements, 12 for each of the four bands: a ground screen stretches 750ft in front of the array to improve low-angle radiation. The USAF is said to have already spent some \$100-million on over-the-horizon radar development, although the American over-the-horizon radar at Orfordness in England was taken out of commission some years ago and the site turned over to BBC External Services.

Although it is stated that the OTH-B signals will cause much less interference to other services than the notorious Russian "Woodpecker", there are fears that the growth of such systems, if they prove successful, may become world-wide and will inevitably

affect low-power amateur transmissions. OTH-B signals will have a faster "knocking" rate than the Pecker, varying from about 20 to 60Hz and sounding rather like "mains hum". The system is being operated on a "non-interference" basis and one hopes that this will be achieved in practice. Amateur frequencies are to be avoided.

Local courses for RAE

Evening classes for those wishing to sit the Radio Amateur's Examination are again starting soon in many local adult education centres, with enrolment during early September. Among the towns where courses have been notified to the R.S.G.B. are: Bath, Belfast, Birkenhead, Birmingham, Bracknell, Gosforth, Turnford near Hoddesdon, Langley near Slough, Manchester, Melton Mowbray, Newport, Northampton, Orpington, Scunthorpe, Stockport, Walsall and Weybridge. As this list is probably incomplete, enquiries should be made at local adult education centres.

A second training course for electronics and amateur radio was held in Colombo, Sri Lanka recently with the co-operation of the German national amateur radio society, DARC. There were 29 participants, including students from India and Bangladesh (although amateur licences are not yet available in Bangladesh).

Around the bands

The IARU Region 1 Executive Committee has recommended that the new amateur band between 10,100 to 10,150 kHz (which is expected to become available about 1982) should be for c.w. operation only. This is to enable as many amateurs as possible to make effective use of this band which will be the narrowest of all amateur allocations. The IARU Conference in 1981 (to be held at Brighton from April 27 to May 1) is expected to set up a working group to consider band plans for the 18 and 24MHz bands, although these may not become available to amateurs for several years.

H. L. Wilson, E12W, one of the few European amateurs permitted to use the 50MHz band, has reported making 1552 transatlantic contacts with 600 different stations during the period October 20, 1979 to December 20, 1979, using a transmitter with an output of about 10 watts and a three-element beam aerial. On December 15 he reports that the m.u.f. was observed to rise to 62.75MHz.

According to *Ham Radio*, first news

of the initial volcanic eruption at Mount St Helens, Washington on March 27 came from an amateur radio station operated by a camper on the mountain slope. His dramatic transmission ended: "I'm getting the hell out of here" but he, and two other radio amateurs, were among the missing. Some 100 amateurs worked with rescue crews and another 100 at the communications centres: it is claimed that radio proved more effective than the telephone.

W. A. Scarr, G2WS, chairman of the Radio Amateur Invalid and Blind Club, has appealed for a wider understanding and appreciation of the club's aims and activities. RAIBC exists to help handicapped members to participate fully in amateur radio. The club has an RAE tuition course on tape cassettes for blind candidates and this has recently been revised; a number of Datong morse tutors have been donated by friends of the club and are proving successful. Some 50 copies of the club newsletter "Radial" are distributed on tape.

In brief

Kenya has introduced a "type approval" system for amateur radio equipment, charging a fee of \$150 which has to be paid again each time any alterations are made . . . Attendance at the RSGB National Amateur Radio Exhibition at Alexandra Palace last May was over 6,600 . . . Dates for the ARRA amateur radio exhibition at Leicester have been changed to November 6, 7 and 8 . . . Sixty years ago — summer 1920 — saw the issue of the first post World War I British amateur licences, including "2FZ" as the callsign of the Manchester Wireless Society . . . It was August 1920 when the weekly concerts for British listeners began from The Hague: PCGG on 1000 metres . . . The Queen's Birthday Honours List included the award of an MBE to Roy Stevens, G2BVN in recognition of his work for amateur radio . . . Basil O'Brien, G2AMV of Wirral, Cheshire is to be the 1981 President of the RSGB . . . Although the "Firewheel" scientific satellite on board the ill-fated Ariane launch last May has been recovered from the sea, the Oscar Phase 3A satellite seems unlikely to be salvaged . . . Forthcoming events include the Scottish Amateur Radio Convention on September 13 and the Welsh Amateur Radio Convention on September 28 . . . Charles Suckling, G3WDH in examining tape recordings of 432MHz "moonbounce" echoes has found that they include further "long delay" echoes.

PAT HAWKER G3VA

NEW PRODUCTS

Four-channel driver i.c.

The L293 is designed to drive inductive loads and can handle currents of up to 1A (2A repetitive peak) with supplies of up to 36V, enabling driving of relays, solenoids, d.c. motors and stepping motors.

The logic section of the device, which may be powered by a separate low-voltage supply, accepts normal logic levels and is provided with six inputs, one for each channel, and two inhibit inputs, each serving two channels.

The four centre pins of the 16 pin d.i.l. package provide thermal conduction for the L293, which has full thermal protection and a maximum power dissipation of 5W. SGS-ATES (U.K.) Ltd, Walton St, Aylesbury, Bucks.

WW301

Adjustable crystal oscillator

Precise frequency setting to within ± 0.001 p.p.m. is possible with this ovenized crystal oscillator by means of an integral multi-turn trimmer. The Ovenaire 85-1 series is available in a frequency range from 1 to 16MHz, each unit having a t.t.l. output circuit, with a fanout of three, the input of which fully buffers the oscillator circuit to provide load isolation.

Both oscillator and oven-control circuits have built-in voltage regulation and the glass-enclosed crystal has aging figures of $\pm 7 \times 10^{-8}$ /week at the time of shipping to $\pm 1 \times 10^{-6}$ /year after 90 days of operation. Dimensions of the 85-1 units are 44.45 x 31.75 x 26.50mm. Walmore Electronics Ltd, 11-15 Betterton St, Drury Lane, London WC2H 9BS.

WW302

Direct-to-wire connector kit

A new Direct-to-Wire Kit which offers 1000 connexions for £39.95, is introduced by Verospeed. The kit contains eight types of connector, interlinked with M100, 10-way ribbon cable, supplied on two reels, and a selection of pre-stripped ribbon cable in various lengths.

Gas-tight connexions, which obviate the use of noble metals to give cost reduction, are achieved by direct insertion of tinned, stranded or solid contacts into the contact assemblies. GTH



contacts, patented by BICC-Burndy, are the basis of the kit, which offers the Research and Development Engineer the ability to incorporate the same products that are used in production, thus eliminating the need for value engineering.

All individual replacement parts are available from Verospeed, and production quantities in excess of 1000 pieces will be quoted for by BICC-Burndy. Verospeed Ltd, Stansted Rd, Boyatt Wood, Eastleigh, Hampshire SO5 42Y.

WW303

Low-profile p.c. relay

With a weight of only 12.5g, this subminiature relay is described as being the lightest of its kind available. The Type SF series low-profile relays are distributed by Diamond H Ltd, and offer a choice of either double-pole, double-throw or four-pole, double-throw contact configurations, with contact ratings of 2A d.c. or 50W, at a maximum of 60V d.c. into resistive loads. Relays with activating coils for operation at either 5, 6, 12, 24 or 28V d.c. are available, each coil having a power consumption of 0.56W.

In addition to the standard basic relay, designated SFA, other more specialized versions are available, including non-polarity, self-latching types, designated SFL, and polarity self-

latching types, designated SFB. Further, a variety of alternative contact forms may be incorporated to meet individual user requirements. The terminals of the relays are in standard d.i.l. form and their bifurcated cross-bar contacts are of gold over silver palladium alloy. Diamond H Controls Ltd, Vulcan Road North, Norwich NR6 6AH.

WW304

P.t.f.e./woven glass laminate

Two new types of laminate have been introduced by the 3M (UK) Ltd., namely Cuclad 217, which has a dielectric constant of 2.17 ± 0.04 and a dissipation factor of 0.0009 at X-band, and Cuclad 233, which has a dielectric constant of 2.33 ± 0.04 and a dissipation factor of 0.0015 at X-band.

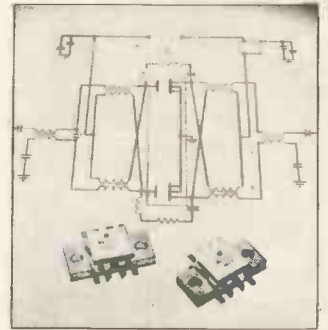
Primarily designed for use in microwave applications, such as computer systems working at sub-nanosecond bit processing times and microwave antennae, amplifiers, filters and couplers, the boards have mechanical strength and dimensional stability equal to similar woven glass products, and offer processing advantages as they do not require "double-etching".

The 217 type is available in thicknesses from 0.010in up to 0.125in, and the 233 type from 0.005in to 0.125in, both types having a standard size of 36 x 17in, a larger size of 36 x 34in being available on request. 3M (UK) Ltd, 3M House, PO Box 1, Bracknell, Berkshire RG12 1JU.

WW305

Push-pull r.f. power f.e.t.s

Claims of the first r.f. push-pull power f.e.t.s using the v.m.o.s technique, are made by Siliconix Ltd. These devices are intended for broadband applications from 2 to 200MHz, and offer the ad-



vantages of enabling reduced amplifier size, and minimizing the costs usually associated with the matching of transistor pairs by encapsulating two matched n-channel enhancement mode f.e.t.s in a single package.

The DV 28120D, DV 2880D and DV2840D can deliver up to 120, 80 and 40 watts respectively and give rated outputs of 28 volts with a minimum power gain of 10db at 175 MHz. The units can be used in either class A, B or C configuration. Siliconix Ltd, Morriston, Swansea SA6 6NE.

WW306

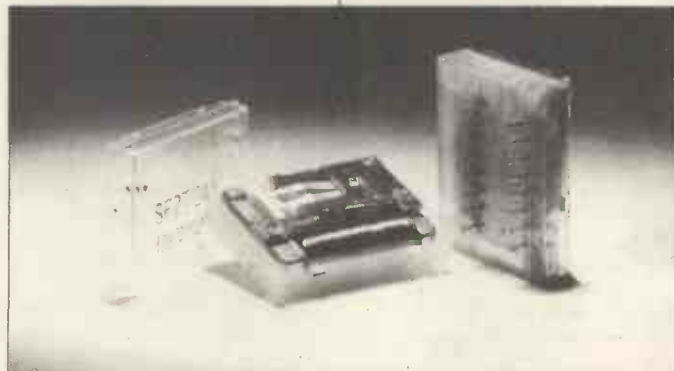
New microprocessor

All other single-chip microcomputers are out-performed by the 8051, claim GEC Semiconductors. It fits in at the top of the Intel MCS-48 family, and has an instruction set which includes multiply, divide, subtract with borrow, compare and non-paged jumps. Another of its features is a 'Boolean Processor' which allows very high speed implementation of logical or decision-making operations.

The 8051 is suitable for stand-alone, single-chip controller applications requiring up to 64K bytes of memory, and has itself 4K bytes of p.r.o.m. and 128 bytes of r.a.m. Unlike other processors in the MCS-48 range, the 8051 includes a full duplex u.a.r.t. for serial communication, complete with oscillator and clock circuits. For distributed systems, the serial I/O provides an inbuilt, high-speed multiprocessor protocol. Two 16-bit timer counters and four 8-bit I/O ports are also included.

The 8051 will be available in three versions: the 8051, which has a mask-programmed program memory; the 8571, which has a u.v.-erasable memory and the 8031 which has no internal program memory. GEC Semiconductors Ltd, East Lane, Wembley, Middlesex HA9 7PP.

WW307



Portable radio for the handicapped

A scanning portable radio, ideal for the blind, short-sighted or handicapped, has been developed by Sony (UK) Ltd. The ICF-M20L requires no visual control as raised dots on the touch buttons



allow touch-reading, and "pip-tones" are given to tell the user when the controls are operated correctly and when the radio is scanning. At each receivable station, the scanning stops automatically, and the radio has a memory in which up to seven stations on f.m. and seven stations on m.w./l.w. can be stored and recalled by one touch operation.

Dimensions of the ICF-M20L are 179 x 85 x 26mm, and its weight is 380g, including batteries. Sony (U.K.) Ltd, 134 Regent St, London W1.

WW308

Wide-range measuring amplifier

Comprehensive measurement of sound, vibration and voltage is possible with the new wide-range amplifier/voltmeter Type 2610, from B&K Laboratories Ltd, in which i.e.d. displays are incorporated for the gain/measuring range and overload indications, and accurate true r.m.s. and peak level detectors plus a max. hold facility enable its use as a precision voltmeter.

High-pass filter and 'A' weighting system for sound measurement, provisions to enable con-

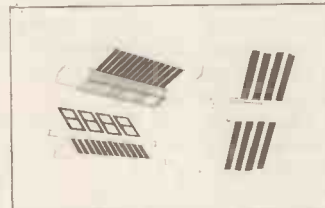
nexion of external filters for frequency analysis, and two versions providing either a.c. lin. or d.c. log. output are also featured. Various microphones, for which polarizing voltages are provided, and vibration transducers, can be used in conjunction with the low-noise amplifier/voltmeter, which complies with the IEC, ANSI and DIN standards for precision sound level meters. B&K Laboratories Ltd, Cross Lances Road, Hounslow, Middlesex TW3 2AE.

WW309

Conducting elastomer connectors

Connexion between elements which have contact pads as close as 0.010in is possible with the Stax Series 405/2 interconnexion system which uses alternate layers of conducting and insulating silicone-rubber, each 0.002in thick, that are bonded together to form a "block". Clamping of the block to the mating conductors is required to ensure good contact, the pressure required being that which causes the block to deflect by between 5 and 20%.

Elastomer connectors can be used to interconnect components such as displays, i.c. chip-carriers, p.c.bs, leadless hybrid-circuits and flat-cables, and as no soldering is required, and a greater tolerance to misalign-



ment is available than with conventional connectors, time savings can be made where large-scale production is concerned.

Stax 405/2 low-profile connectors are manufactured by Hulltronics Inc. (USA), and have a temperature range of -50 to +150°C. Symot Ltd, 22a Reading Rd, Henley on Thames, Oxon RG9 1AG.

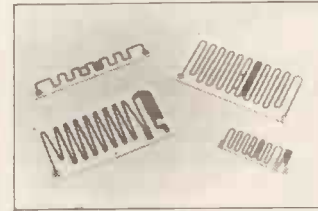
WW310

High-voltage networks

This new range of custom-built resistance networks is being launched by Welwyn Electric Ltd. Each network is capable of

withstanding up to 30kV, provided that the power dissipation of the device is not exceeded, making them particularly suitable for use as high-voltage dividers.

With power ratings of up to 4.5W, the networks can be obtained in a resistance range from 100Ω to 2GΩ, with a stability of 0.5% after 1000hrs of use, and a standard tolerance of ±5%, tighter tolerances being obtainable if required. Other applications in which the networks can be used to advantage are very low inductance and pulse systems, accurate feedback controls, measurement systems and bleeder chains.



Duplicate networks are identical in pattern, shape and electrical characteristics, offering a more consistent performance than can be obtained with discrete resistors. Substrate sizes range from 25 x 8.5mm to 25 x 50mm. Welwyn Electric Ltd, Bedlington, Northumberland NE22 7AA.

WW311

Universal vacuum-test fixture

Test heads which are interchangeable and a universal receiver, the section upon which the test heads are mounted, are the main components of this p.c.b. test fixture, the U3000, which holds the circuit under test in position and against the spring-loaded contacts using a vacuum. It is claimed that the "bed of nails" test-heads can be changed in a matter of seconds, an important feature where production costs are to be minimized in the testing of p.c.bs of varying nature and size.

The receiver, which is available for either 30 or 60° test head mounting, is either demountable, in which case a Cannon 156 way terminal connector is usually fitted, or semi-permanently installed into an a.t.e. system.

Each spring-loaded contact consists of a probe, which is made from beryllium copper, plated with either gold or rhodium, and a mating socket. Constant contact between probe and socket is ensured by using a patented "biasing-ball" construction which also precludes current passage through the pressure spring. The contacts are replaceable. The U3000 is made by Pylon and distributed in the U.K. by Teknis Ltd, Teknis House, Meadow, Godalming, Surrey GU7 3HQ.

WW312

Click-stop pots

Industry-standard potentiometers in either single or tandem-stereo forms, denominated Radiohm P20 and JP20 respectively, are manufactured by East Grinstead Electronic Components Ltd. They are produced in a choice of 12 different linear and non-linear law patterns ranging from 100Ω to 2.2MΩ, and are available in centre-indent, 11 and 21 position variations and with either ¼in or 6mm plastic spindles.

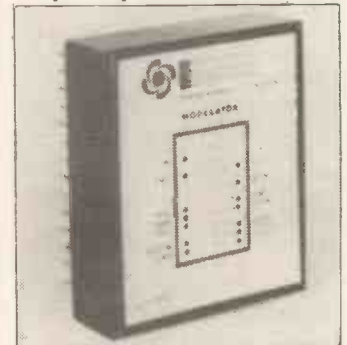
Standard track-dissipation ratings at 40°C are 0.4W and 0.2W for linear and non-linear versions respectively, with a minimum limiting element voltage of 500V d.c. and insulation breakdown voltage of 100V a.c. Normal operating torque over the full 300° rotation is 0.4Ncm, end stop maximum torque is between 60 and 80Ncm, dependent upon style, and maximum axial spindle load is 100N for 5sec.

Various p.c.b. and hard-wiring solder tag terminals are also available, as are integral support brackets, enabling robust assemblies to be achieved. East Grinstead Electronic Components Ltd, Imberhorn Industrial Estate, East Grinstead, Sussex RH19 1RJ.

WW313

High-accuracy modulator

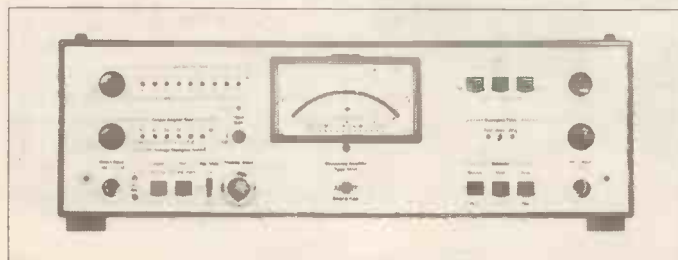
A series of low-cost, high-accuracy modulators with up to ±0.1% linearity has been introduced by Techmation Ltd. The Computer Conversions Corporation model 503 modulator converts d.c. input signals to linear, proportional a.c. output signals: it accepts ±10V d.c., or ±100V d.c. inputs and provides a.c. outputs of 0 to 7V r.m.s. It has an output impedance of 1Ω maxi-

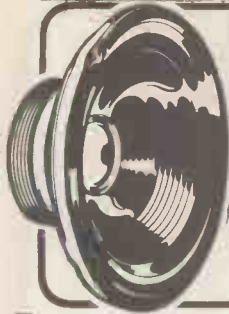


mum and is insensitive to ±10% reference line changes.

Any a.c. output voltage can be provided via internal or external transformers, and the output is short-circuit protected. Gain and zero adjustments are also standard features. Measuring 2.6 x 3.1 x 0.625in, the model 503 has an input impedance of 100kΩ and requires a 26V, 400Hz ±5% reference input and ±15V d.c. supply at 50mA maximum. Techmation Ltd, 58 Edgware Way, Edgware, Middlesex HA8 8JP.

WW314





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Castle Super 8 RS/DD	£14.95
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Coles 3000	£7.65
Celestion HF1300 II	£10.95
Celestion HF2000	£10.95
Dalesford ABR 10"	£10.25
Dalesford D30/110	£11.25
Dalesford D50/153	£12.25
Dalesford D70/200	£12.25
Dalesford D70/250	£25.50
Dalesford D100/310	£35.75
Dalesford D10 tweeter	£8.45
Decca London Horn	£81.95
Decca CO/1000/B	£10.25
Elac 6NC204 6 1/2"	£7.50
Elac 8NC298 8"	£7.95
EMI type 350, 13" x B", 4 ohm	£9.45
EMI 14A/770, 14" x 9", 8 ohm	£19.50
Isophon KK8/8	£8.15
Isophon KK10/8	£8.45
Jordan Watts Module	£24.95
Jordan Watts HF kit	£10.50
Jordan 50mm unit	£24.50
Jordan CB crossover	£24.50 pair
Jordan Mono crossover	£24.50 pair
Kef T27	£9.45
Kef B110	£12.25
Kef B200	£13.50
Kef B139	£27.75
Kef DN13	£6.75
Kef DN12	£9.40
Kef DN22	pair £42.00
Lowther PM6	£59.00
Lowther PM6 Mk I	£62.00
Lowther PM7	£94.50
Peerless KO10DT	£10.95
Peerless DT10HFC	£10.50
Peerless KO40MRF	£13.60
Radford BD25 Mk III	£36.95
Radford MD9	£14.85
Radford MD6	£25.50
Radford FN8/FN831	£22.50
Richard Allan CG8T	£13.50
Richard Allan CG12T Super	£29.50
Richard Allan HP8B	£20.75
Richard Allan LP8B	£14.50
Richard Allan HP12B	£33.50
Richard Allan DT20	£9.95
Richard Allan DT30	£10.75
SEAS H107	£8.95
Shackman Electrostatic with polar. network & crossover	£130.00 pair
Tannoy DC296 10"	£107.35
Tannoy DC316 12"	£148.50
Tannoy DC386 15"	£178.90

Celestion G12/50TC	£19.50
Celestion G12/80CE	£24.50
Celestion G12/80TC	£23.75
Celestion G12/125CE	£42.00
Celestion G15/100CE	£37.95
Celestion G15/100TC	£38.50
Celestion G18/200	£64.75
Celestion HF1300	£12.50
Celestion HF2000	£12.50
Celestion Powercell 12/150	£66.00
Celestion Powercell 15/250	£88.00
Celestion MH1000	£21.75
Fane Classic 45 12"	£13.95
Fane Classic 55 12"	£15.50
Fane Classic 80 12"	£19.75
Fane Classic B5 15"	£26.00
Fane Classic 150 15"	£37.95
Fane Classic 125 18"	£43.95
Fane Classic 175 18"	£47.95
Fane Guitar 80L 12"	£26.25
Fane Guitar 80B/2 12"	£27.25
Fane Disco 100 12"	£28.75
Fane PA85 12"	£26.25
Fane Bass 100 15"	£39.00
Fane Crescendo 12E	£57.50
Fane Crescendo 15E	£74.50
Fane Crescendo 18E	£94.75
Fane Colossus 15E	£99.95
Fane Colossus 18E	£107.00
Fane J44	£66.90
Fane J104	£15.95
Fane J73	£10.90
Fane HPX1/HPX2	£3.45
Fane HPX3A	£5.60
Fane HPX3B	£4.55
Goodmans 8PA	£5.05
Goodmans PP12	£22.50
Goodmans D112	£25.50
Goodmans GR12	£24.95
Goodmans 18P	£48.45
Goodmans Hifax 50HX	£21.85
McKenzie C1280GP	£24.45
McKenzie C1280TC	£24.45
McKenzie C1280 bass	£24.45
McKenzie GP15	£35.10
McKenzie TC15v	£35.10
McKenzie C15 bass	£59.60
Motorola Piezo horn 3 1/2" x 6"	£8.50
Motorola Piezo 2" x 6"	£12.25
Richard Allan HD8T	£20.25
Richard Allan HD10T	£21.75
Richard Allan HD12T	£29.75
Richard Allan HD15	£52.75
Richard Allan HD15P	£52.75
Richard Allan Atlas 15"	£77.00
Richard Allan Atlas 18"	£96.00

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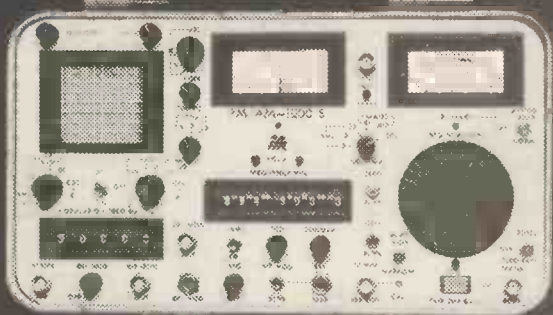
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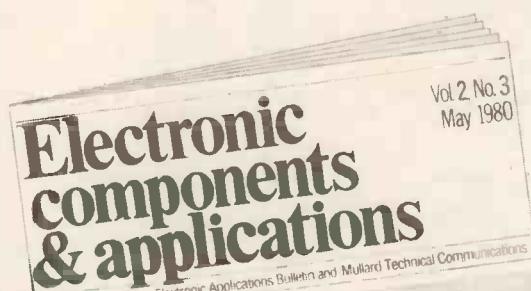
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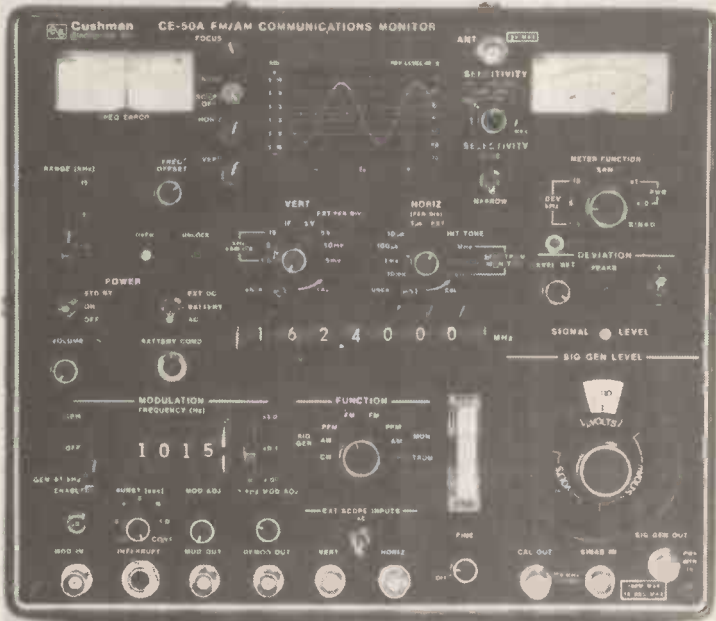
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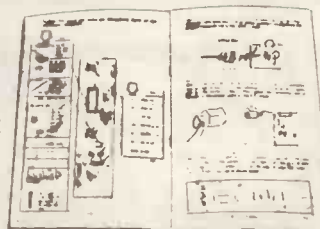
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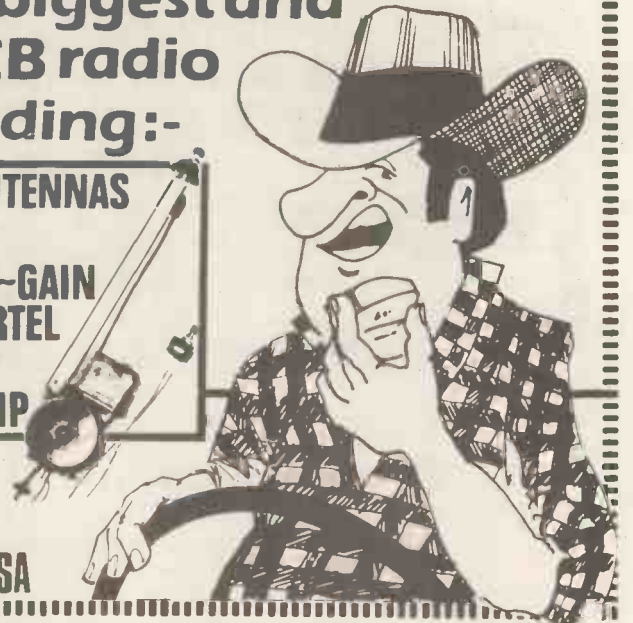


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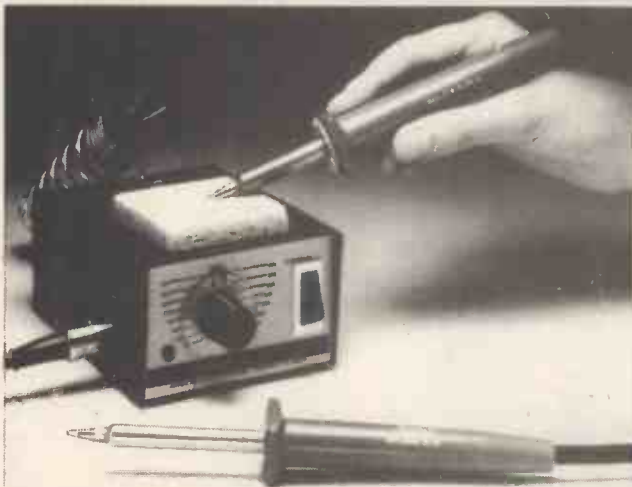
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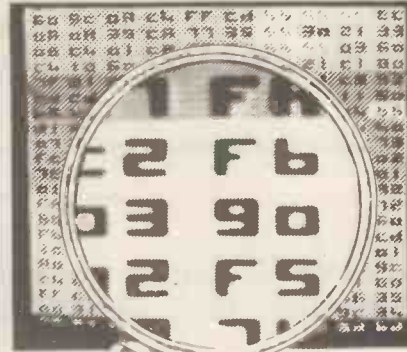
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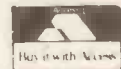
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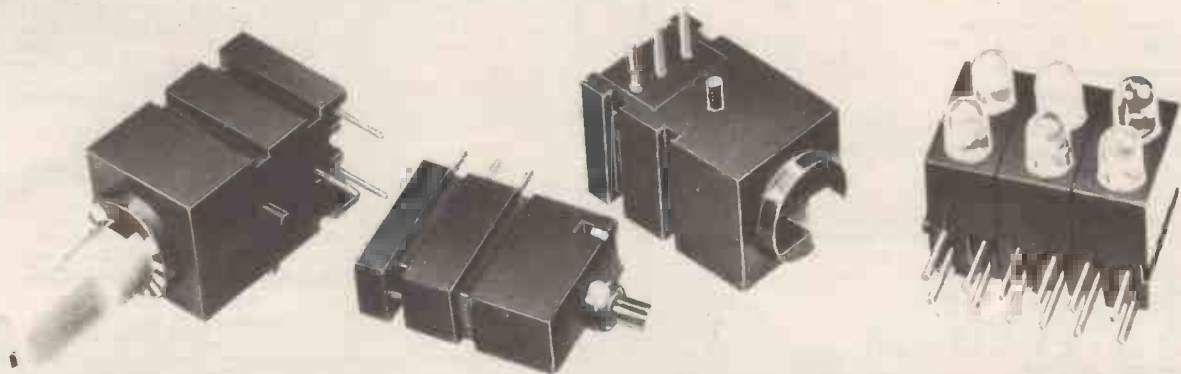


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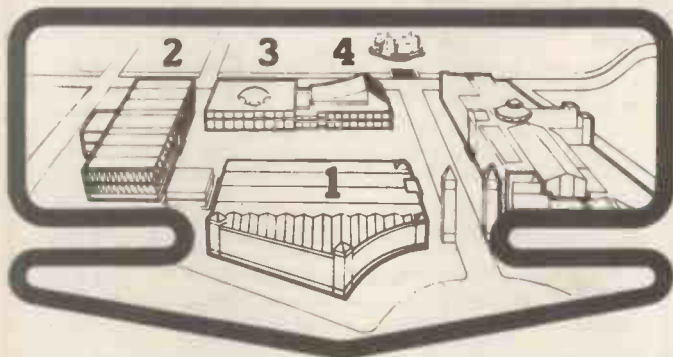


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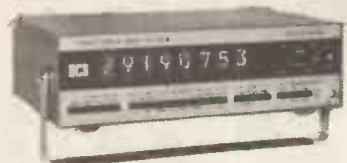
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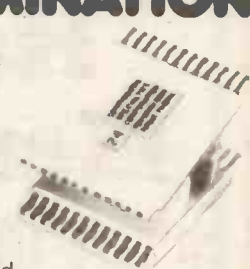
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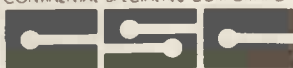
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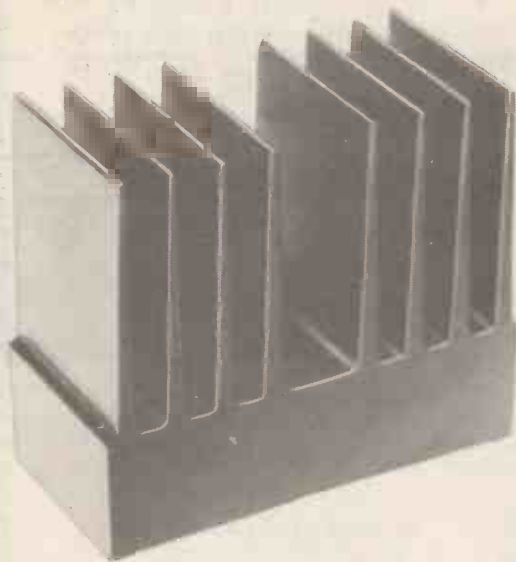
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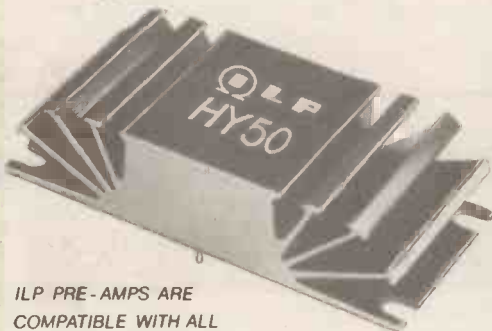
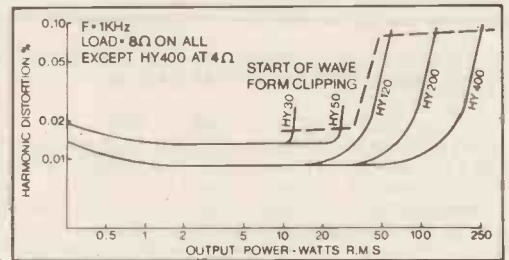
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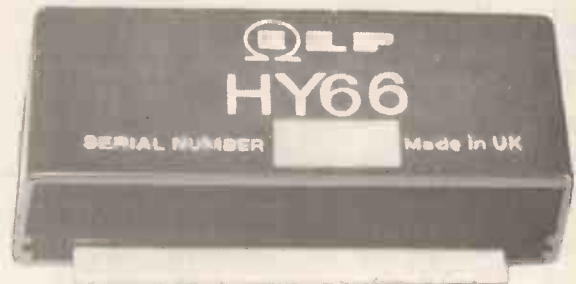
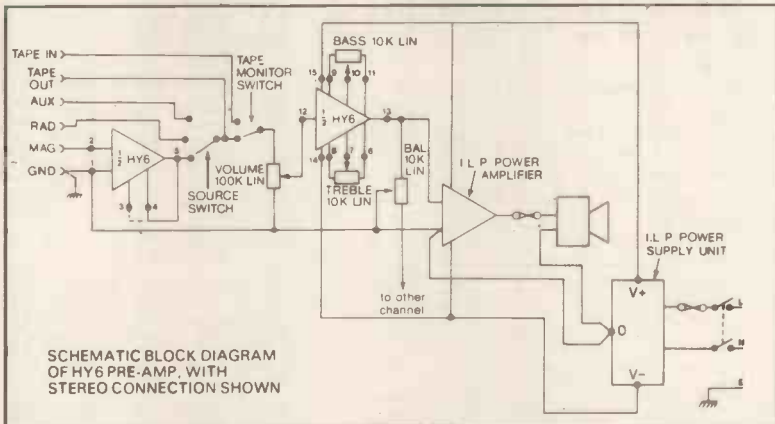
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AA190	0.12	ASZ16	1.44	BC173	0.14	BD132	0.44	BF258	0.30	GEX66	1.73	0A2206	1.15	OC206	2.88	ZTX503	0.20	2N1613	0.29	2N3772	2.30
AA191	0.12	ASZ17	1.44	BC177	0.17	BD133	0.49	BF259	0.37	GEX541	4.60	0A2207	1.15	OC207	2.02	ZTX504	0.23	2N1671	1.73	2N3773	3.45
AA192	0.12	ASZ18	1.44	BC178	0.16	BD134	0.39	BF336	0.35	GJ3M	0.86	OC16	2.30	OC208	2.88	ZTX505	0.23	2N1893	0.29	2N3819	0.41
AA193	0.12	ASZ19	1.44	BC179	0.18	BD135	0.49	BF337	0.35	GM0378A	2.02	OC20	2.88	OC209	2.88	ZTX550	0.18	2N2147	2.02	2N3820	0.52
AA194	0.12	ASZ20	1.44	BC182	0.13	BD140	0.51	BF528	2.56	MJE340	0.92	OC22	2.88	OC21	1.44	2N2148	0.06	2N2218	0.29	2N3823	0.63
AA195	0.12	ASZ21	1.44	BC183	0.12	BD144	2.30	BF561	0.23	MJE371	0.71	OC23	3.16	ORP12	1.15	2N2149	0.07	2N2219	0.29	2N3826	0.83
AA196	0.12	ASZ22	1.44	BC184	0.13	BD181	1.26	BF598	0.23	MJE520	0.60	OC24	3.45	2N2008B	2.02	2N2150	0.06	2N2220	0.29	2N3830	0.15
AA197	0.12	ASZ23	1.44	BC212	0.15	BD182	1.36	BF610	0.24	MJE521	0.63	OC25	1.04	2R009	2.99	2N2151	0.07	2N2221	0.21	2N3835	0.15
AA198	0.12	ASZ24	1.44	BC213	0.14	BD237	0.46	BF611	0.76	MJE522	0.63	OC26	1.04	2R009B	2.99	2N2152	0.08	2N2222	0.21	2N3836	0.15
AA199	0.12	ASZ25	1.44	BC238	0.10	BD238	0.63	BF634	0.25	MJE3055	1.44	OC28	2.30	2R009C	2.99	2N2153	0.08	2N2223	0.21	2N3837	0.15
AA200	0.12	ASZ26	1.44	BC239	0.10	BDX10	1.05	BF635	0.26	MPP102	0.35	OC29	2.30	2R009D	2.99	2N2154	0.09	2N2224	0.21	2N3838	0.15
AA201	0.12	ASZ27	1.44	BC239	0.10	BDX32	2.30	BF636	0.26	MPP103	0.35	OC31	3.45	2R009E	2.99	2N2155	0.09	2N2225	0.21	2N3839	0.15
AA202	0.12	ASZ28	1.44	BC301	0.38	BDY20	1.44	BF637	0.26	MPP104	0.35	OC32	3.45	2R009F	2.99	2N2156	0.09	2N2226	0.21	2N3840	0.15
AA203	0.12	ASZ29	1.44	BC303	0.38	BDY60	1.72	BF638	0.24	MPP105	0.35	OC34	0.92	2R009G	2.99	2N2157	0.07	2N2227	0.21	2N3841	0.15
AA204	0.12	ASZ30	1.44	BC307	0.12	BF150	0.20	BF639	0.30	MPP106	0.35	OC36	0.92	2R009H	2.99	2N2158	0.07	2N2228	0.21	2N3842	0.15
AA205	0.12	ASZ31	1.44	BC308	0.10	BF152	0.21	BF640	0.24	MPP107	0.35	OC38	0.92	2R009I	2.99	2N2159	0.07	2N2229	0.21	2N3843	0.15
AA206	0.12	ASZ32	1.44	BC327	0.23	BF153	0.23	BF641	0.30	MPP108	0.35	OC40	0.63	2R009J	2.99	2N2160	0.07	2N2230	0.21	2N3844	0.15
AA207	0.12	ASZ33	1.44	BC328	0.21	BF154	0.20	BF642	0.30	MPP109	0.35	OC42	0.63	2R009K	2.99	2N2161	0.07	2N2231	0.21	2N3845	0.15
AA208	0.12	ASZ34	1.44	BC330	0.38	BF159	0.26	BF643	0.24	MPP110	0.35	OC44	0.63	2R009L	2.99	2N2162	0.07	2N2232	0.21	2N3846	0.15
AA209	0.12	ASZ35	1.44	BC336	0.20	BF160	0.20	BF644	0.24	MPP111	0.35	OC46	0.63	2R009M	2.99	2N2163	0.07	2N2233	0.21	2N3847	0.15
AA210	0.12	ASZ36	1.44	BC337	0.15	BF167	0.23	BF645	0.30	MPP112	0.35	OC48	0.63	2R009N	2.99	2N2164	0.07	2N2234	0.21	2N3848	0.15
AA211	0.12	ASZ37	1.44	BC338	0.15	BF172	0.23	BF646	0.30	MPP113	0.35	OC50	0.63	2R009O	2.99	2N2165	0.07	2N2235	0.21	2N3849	0.15
AA212	0.12	ASZ38	1.44	BC339	0.15	BF175	0.23	BF647	0.30	MPP114	0.35	OC52	0.63	2R009P	2.99	2N2166	0.07	2N2236	0.21	2N3850	0.15
AA213	0.12	ASZ39	1.44	BC340	0.15	BF176	0.28	BF648	0.30	MPP115	0.35	OC54	0.63	2R009Q	2.99	2N2167	0.07	2N2237	0.21	2N3851	0.15
AA214	0.12	ASZ40	1.44	BC341	0.15	BF177	0.28	BF649	0.30	MPP116	0.35	OC56	0.63	2R009R	2.99	2N2168	0.07	2N2238	0.21	2N3852	0.15
AA215	0.12	ASZ41	1.44	BC342	0.15	BF178	0.28	BF650	0.30	MPP117	0.35	OC58	0.63	2R009S	2.99	2N2169	0.07	2N2239	0.21	2N3853	0.15
AA216	0.12	ASZ42	1.44	BC343	0.15	BF179	0.29	BF651	0.30	MPP118	0.35	OC60	0.63	2R009T	2.99	2N2170	0.07	2N2240	0.21	2N3854	0.15
AA217	0.12	ASZ43	1.44	BC344	0.15	BF180	0.29	BF652	0.30	MPP119	0.35	OC62	0.63	2R009U	2.99	2N2171	0.07	2N2241	0.21	2N3855	0.15
AA218	0.12	ASZ44	1.44	BC345	0.15	BF181	0.29	BF653	0.30	MPP120	0.35	OC64	0.63	2R009V	2.99	2N2172	0.07	2N2242	0.21	2N3856	0.15
AA219	0.12	ASZ45	1.44	BC346	0.15	BF182	0.35	BF654	0.30	MPP121	0.35	OC66	0.63	2R009W	2.99	2N2173	0.07	2N2243	0.21	2N3857	0.15
AA220	0.12	ASZ46	1.44	BC347	0.15	BF183	0.35	BF655	0.30	MPP122	0.35	OC68	0.63	2R009X	2.99	2N2174	0.07	2N2244	0.21	2N3858	0.15
AA221	0.12	ASZ47	1.44	BC348	0.15	BF184	0.29	BF656	0.30	MPP123	0.35	OC70	0.63	2R009Y	2.99	2N2175	0.07	2N2245	0.21	2N3859	0.15
AA222	0.12	ASZ48	1.44	BC349	0.15	BF185	0.29	BF657	0.30	MPP124	0.35	OC72	0.63	2R009Z	2.99	2N2176	0.07	2N2246	0.21	2N3860	0.15
AA223	0.12	ASZ49	1.44	BC350	0.15	BF186	0.10	BF658	0.30	MPP125	0.35	OC74	0.63	2R0100	2.99	2N2177	0.07	2N2247	0.21	2N3861	0.15
AA224	0.12	ASZ50	1.44	BC351	0.15	BF187	0.10	BF659	0.30	MPP126	0.35	OC76	0.63	2R0101	2.99	2N2178	0.07	2N2248	0.21	2N3862	0.15
AA225	0.12	ASZ51	1.44	BC352	0.15	BF188	0.10	BF660	0.30	MPP127	0.35	OC78	0.63	2R0102	2.99	2N2179	0.07	2N2249	0.21	2N3863	0.15
AA226	0.12	ASZ52	1.44	BC353	1.05	BF192	0.12	BF661	0.30	MPP128	0.35	OC80	0.63	2R0103	2.99	2N2180	0.07	2N2250	0.21	2N3864	0.15
AA227	0.12	ASZ53	1.44	BC354	1.05	BF193	0.12	BF662	0.30	MPP129	0.35	OC82	0.63	2R0104	2.99	2N2181	0.07	2N2251	0.21	2N3865	0.15
AA228	0.12	ASZ54	1.44	BC355	1.05	BF194	0.10	BF663	0.30	MPP130	0.35	OC84	0.63	2R0105	2.99	2N2182	0.07	2N2252	0.21	2N3866	0.15
AA229	0.12	ASZ55	1.44	BC356	1.05	BF195	0.10	BF664	0.30	MPP131	0.35	OC86	0.63	2R0106	2.99	2N2183	0.07	2N2253	0.21	2N3867	0.15
AA230	0.12	ASZ56	1.44	BC357	1.05	BF196	0.10	BF665	0.30	MPP132	0.35	OC88	0.63	2R0107	2.99	2N2184	0.07	2N2254	0.21	2N3868	0.15
AA231	0.12	ASZ57	1.44	BC358	1.05	BF197	0.14	BF666	0.30	MPP133	0.35	OC90	0.63	2R0108	2.99	2N2185	0.07	2N2255	0.21	2N3869	0.15
AA232	0.12	ASZ58	1.44	BC359	1.05	BF198	0.14	BF667	0.30	MPP134	0.35	OC92	0.63	2R0109	2.99	2N2186	0.07	2N2256	0.21	2N3870	0.15
AA233	0.12	ASZ59	1.44	BC360	1.05	BF199	0.14	BF668	0.30	MPP135	0.35	OC94	0.63	2R0110	2.99	2N2187	0.07	2N2257	0.21	2N3871	0.15
AA234	0.12	ASZ60	1.44	BC361	1.05	BF200	0.31	BF669	0.30	MPP136	0.35	OC96	0.63	2R0111	2.99	2N2188	0.07	2N2258	0.21	2N3872	0.15
AA235	0.12	ASZ61	1.44	BC362	1.05	BF201	0.31	BF670	0.30	MPP137	0.35	OC98	0.63	2R0112	2.99	2N2189	0.07	2N2259	0.21	2N3873	0.15
AA236	0.12	ASZ62	1.44	BC363	1.05	BF202	0.31	BF671	0.30	MPP138	0.35	OC100	0.63	2R0113	2.99	2N2190	0.07	2N2260	0.21	2N3874	0.15
AA237	0.12	ASZ63	1.44	BC364	1.05	BF203	0.31	BF672	0.30	MPP139	0.35	OC102	0.63	2R0114	2.99	2N2191	0.07	2N2261	0.21	2N3875	0.15
AA238	0.12	ASZ64	1.44	BC365	1.05	BF204	0.31	BF673	0.30	MPP140	0.35	OC104	0.63	2R0115	2.99	2N2192	0.07	2N2262	0.21	2N3876	0.15
AA239	0.12	ASZ65	1.44	BC366	1.05	BF205	0.31	BF674	0.30	MPP141	0.35	OC106	0.63	2R0116	2.99	2N2193	0.07	2N2263	0.21	2N3877	0.15
AA240	0.12	ASZ66	1.44	BC367	1.05	BF206	0.31	BF675	0.30	MPP142	0.35	OC108	0.63	2R0117	2.99	2N2194	0.07	2N2264	0.21	2N3878	0.15
AA241	0.12	ASZ67	1.44	BC368	1.05	BF207	0.31	BF676	0.30	MPP143	0.35	OC110	0.63	2R0118	2.99	2N2195	0.07	2N2265	0.21	2N3879	0.15
AA242	0.12	ASZ68	1.44	BC369	1.05	BF208	0.31	BF677	0.30	MPP144	0.35	OC112	0.63	2R0119	2.99	2N2196	0.07	2N2266	0.21	2N3880	0.15
AA243	0.12	ASZ69	1.44	BC370	1.05	BF209	0.31	BF678	0.30	MPP145	0.35	OC114	0.63	2R0120	2.99	2N2197	0.07	2N2267	0.21	2N3881	0.15
AA244	0.12	ASZ70	1.44	BC371	1.05	BF210	0.31	BF679	0.30	MPP146	0.35	OC116	0.63	2R0121	2.99	2N2198	0.07	2N2268	0.21	2N3882	0.15
AA245	0.12	ASZ71	1.44	BC372	1.05	BF211	0.31	BF680	0.30	MPP147	0.35	OC118	0.63	2R0122	2.99	2N2199	0.07	2N2269	0.21	2N3883	

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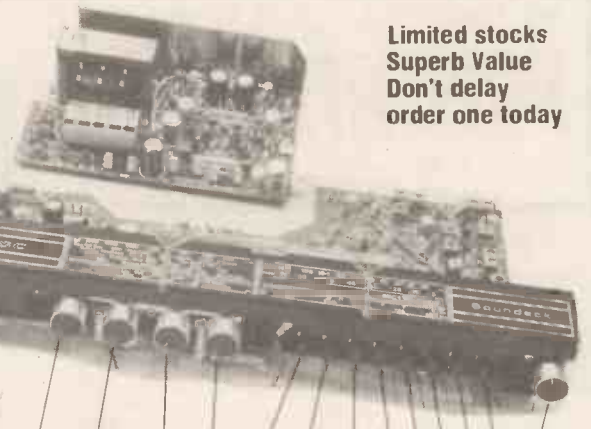
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TRANSCENDENT DPX

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)

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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"

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£49.90 + VAT!
MATCHES THE CHROMATHEQUE 5000 PERFECTLY!

CHROMATHEQUE 5000 5 CHANNEL LIGHTING EFFECTS SYSTEM

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



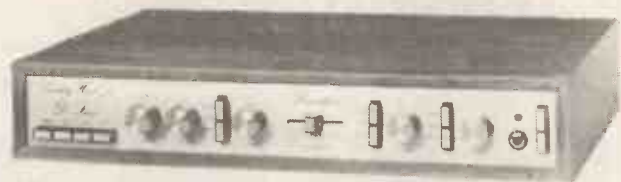
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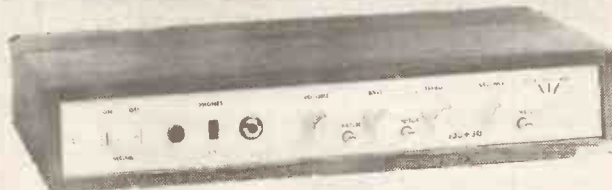
SYNTHESIZER KITS ON PAGE 103. MORE KITS AND ORDERING INFORMATION ON PAGE 101.

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!

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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)



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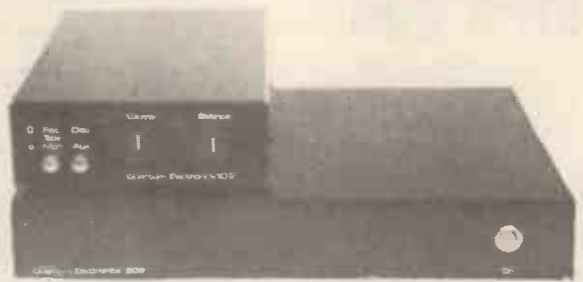
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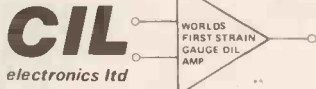
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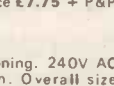
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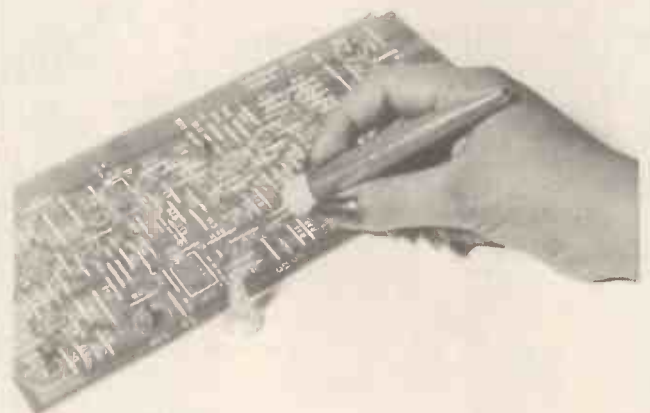
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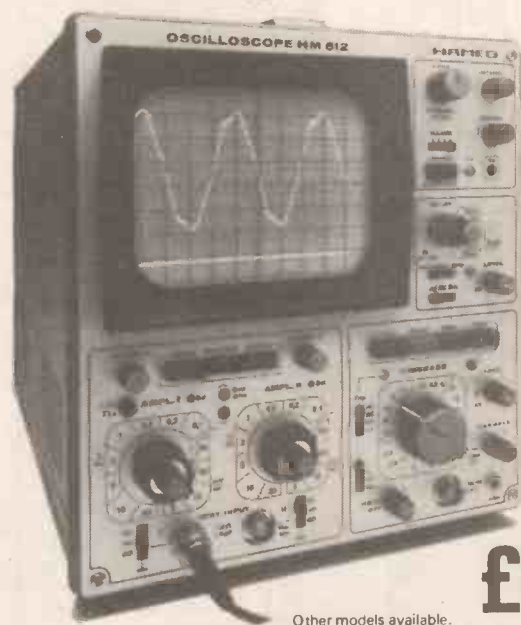
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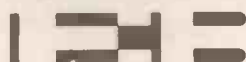
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3	2.0	6.35	1.10	
20	3.0	8.82	1.31	
21	4.0	8.79	1.31	
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1K	30.67	2.65	84W
2K	54.97	O.A.	95W

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Ref.	Amps	Price	P&P	
102	0.5	3.75	0.90	
103	1.0	4.57	1.10	
104	2.0	7.88	1.31	
105	3.0	9.42	1.52	
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Ref.	Amps	Price	P&P	
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126	1.0	6.50	1.10	
127	2.0	8.36	1.31	
125	3.0	12.10	1.31	
123	4.0	13.77	2.12	
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212 1A, 1A	0-6-0-6		3.14	0.90
19 100	9-0-9		2.35	0.44
235 330 330	0-9-0-9		2.19	0.44
207 500 500	0-8-9-0-8-9		3.05	0.85
208 1A, 1A	0-8-9-0-8-9		3.88	0.90
236 200 200	0-15-0-15		2.19	0.44
214 300 300	0-20-0-20		3.08	0.90
221 700 (DC)	20-12-0-12-20		3.75	0.90
206 1A 1A	0-15-20-0-15-20		5.09	1.10
203 5.5	0-15-27-0-15-27		4.39	1.10
204 1A 1A	0-15-27-0-15-27		6.64	1.10
239 50	12-0-12		2.88	0.37

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Ref.	VA	Price	P&P	
07	20	6.84	0.91	
149	60	7.37	1.10	
150	100	8.38	1.31	
151	200	12.28	1.31	
152	250	14.61	1.73	
153	350	18.07	2.12	
154	500	22.52	2.47	
155	750	32.03	O.A.	
156	1000	40.92	O.A.	
157	1500	56.52	O.A.	
158	2000	67.99	O.A.	
159	3000	95.33	O.A.	

*Pri 0-220-240V Sec 115 or 240V
State sec. volts required.

AUTO TRANSFORMERS				
Ref.	VA (Watts)	£	P&P	
113 15	0-115-210-240	2.79	0.61	
64 75	0-115-210-240	4.41	1.10	
4 150	0-115-200-220-240	5.89	1.10	
67 500	0-115-200-220-240	12.09	1.91	
84 1000	0-115-200-220-240	20.64	2.39	
93 1500	0-115-200-220-240	25.61	O.A.	
95 2000	0-115-200-220-240	36.31	O.A.	
73 3000	0-115-200-220-240	65.13	O.A.	
805 4000	0-10-115-200-220-240	84.55	O.A.	
575 5000	0-10-115-200-220-240	98.45	O.A.	

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930	55p
935	55p
937	55p
944	65p
946	55p
957	55p
962	55p
90989	90p

7400	
7400	11p
7401	12p
7402	12p
7403	13p
7404	17p
7409	18p
7410	16p
7412	18p
7413	28p
7420	16p
7430	18p
7432	25p
7440	16p
7442	68p
7448	75p
7473	32p
7474	32p
7475	40p
7476	40p
7490	35p
7492	50p
7493	50p
7496	45p
74121	35p
74123	45p
74154	90p
74157	55p
74122	45p
74125	50p
74195	100p
74196	100p
74283	140p
74290	120p
74365	90p
74361	90p

MEMORIES	
4040	99p
4041	75p
4042	73p
4043	86p
4044	88p
4045	160p
4047	99p
4048	56p
4049	38p
4050	40p
4051	69p
4052	75p
4053	73p
4054	111p
4055	121p
4056	121p
4059	580p
4060	112p
4063	112p
4066	56p
4067	422p
4068	19p
4069	19p
4070	28p
4071	25p
4072	25p
4075	20p
4076	88p
4077	29p
4078	29p
4081	23p
4082	25p
4085	86p
4086	68p
4087	68p
4093	68p
4094	225p
4095	99p
4096	325p
4098	110p
4099	180p
4501	25p
4502	112p
4503	68p
4507	52p
4508	258p
4510	76p
4511	125p
4512	75p
4514	250p
4515	290p
4516	109p
4517	99p
4520	99p
4521	230p
4526	105p
4527	130p
4528	99p
4529	130p
4531	150p
4532	125p
4538	150p
4543	160p
4546	170p
4550	225p
4559	240p
4572	46p
4584	79p
4585	125p

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6504	795p
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6532	895p
6551	1095p
6810	425p
6820	425p
6821	425p
6850	425p
6852	425p
8212	395p
8214	450p
8216	395p
8224	395p
8228	395p
8251	495p
8253	1125p
8255	495p
8257	1050p
8259	1325p
MC1489	90p
MC1489	90p
DM8123	125p
75150	125p
75154	125p
75182	195p
75322	250p
75324	325p
75325	325p
75361	350p
75365	295p
75451	50p
75491/2	75p
8T26	175p
8T28	175p
8T95	175p
8T97	175p

74LS	
74LS00	18p
74LS01	12p
74LS04	20p
74LS08	25p
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74LS49	99p
74LS73	30p
74LS74	30p
74LS75	39p
74LS86	39p
74LS90	40p
74LS107	40p
74LS123	69p
74LS125	69p
74LS132	79p
74LS138	69p
74LS151	75p
74LS153	75p
74LS155	65p
74LS161	78p
74LS163	90p
74LS164	90p
74LS168	99p
74LS174	99p
74LS175	99p
74LS195	87p
74LS221	110p
74LS244	175p
74LS245	325p
74LS251	120p
74LS257	110p
74LS290	95p
74LS293	120p
74LS366	75p
74LS373	170p
74LS374	170p
74LS375	170p
74LS377	180p
74LS393	135p
74LS490	140p
74LS570	260p

74C	
74C20	30p
74C76	60p
74C85	145p
74C97	125p
74C100	125p
74C107	100p
74C160	110p
74C161	145p
74C162	145p
74C163	145p
74C164	175p
74C193	175p
74C194	175p
74C195	175p
74C903	45p

74LS	
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74LS107	40p
74LS123	69p
74LS125	69p
74LS132	79p
74LS138	69p
74LS151	75p
74LS153	75p
74LS155	65p
74LS161	78p
74LS163	90p
74LS164	90p
74LS168	99p
74LS174	99p
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74LS174	99p
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74LS107	40p
74LS123	69p
74LS125	69p
74LS132	79p
74LS138	69p
74LS151	75p
74LS153	75p
74LS155	65p
74LS161	78p
74LS163	90p
74LS164	90p
74LS168	99p
74LS174	99p
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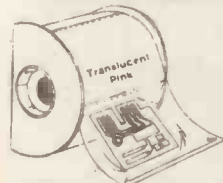
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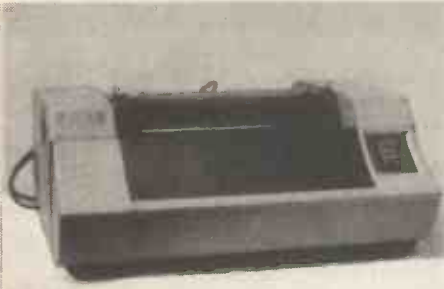
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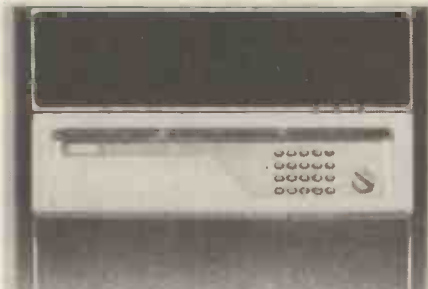
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Input/Output terminal incorporating paper tape punch and reader, 64 ASCII upper case character set, 110 baud operation, even parity keyboard, choice of RS232 or 20 mA interface. **NOW ONLY £595.00.**
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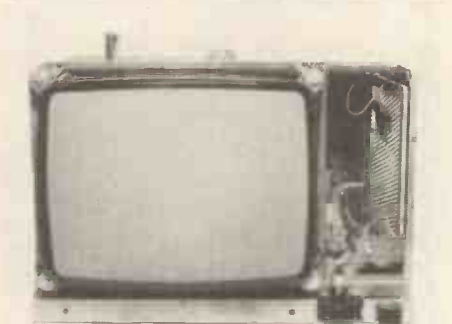
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Hazeltine H-1000

The low, low priced teletypewriter-compatible video display terminal, offering your choice of transmission speeds up to 9600 baud as well as parity generation and checking.

Specification

SCREEN SIZE — 12" diagonal.

SCREEN CAPACITY — 960 characters; 80 per line x 12 lines.

CHARACTERS — 5 x 7 Dot Matrix; 625-line raster.

CHARACTER SET — 64 ASCII alpha- numerics and symbols.

KEYBOARD — TTY format.

INDICATORS — Power On, Parity Error.

PARITY — Parity error indicated by Parity Light and question mark (?) displayed in character position.

TRANSMISSION — Asynchronous. Switch-selectable for any two standard rates up to 9600 baud.

OPERATING MODES — Full/Half Duplex.

MEMORY — High Speed MOS refresh.

STANDARD INTERFACE — CCITT V-24 (EIA RS-232 B/C).

REFRESH RATE — 50 fields per second.

When ordering please specify your choice of switch-selectable baud rates.

Standard: — Either A) 110/300 baud or B) 300/1200 baud

Optional: A combination of any 2 of the following transmission speeds can be provided at a surcharge of £25.00.

75, 110, 150, 200, 300, 600, 900, 1200, 1800, 2400, 4800, 9600, (N.B.: 900/1800 not compatible with 110/200 respectively).

Hazeltine H-2000

The world's largest-selling teletypewriter-compatible video display terminal. The Hazeltine 2000 sets the standard in features, performance, reliability and value in an ever-expanding list of applications in Universities, Hospitals, Business, Finance and Government.

Features include ★ Switch-selectable transmission rates to 9600 baud ★ Three switch-selectable operating modes — full duplex, half-duplex or batch ★ Direct cursor addressability ★ Dual-intensity video ★ Tabulation ★ Powerful editing capability ★ Remote keyboard ★ Selective or automatic roll-up ★ Teletype compatible ★ Parity select ★ Large screen capacity ★ Clear 5 x 7 matrix character image ★ Full remote command set ★ Format capability ★ Standard peripheral interfaces.

Specification

SCREEN — 12" diagonal; 1998 characters; 74 per line x 27 lines.

CHARACTERS — 5 x 7 Dot Matrix; 625 lines raster.

CHARACTER SET — 64 alphanumeric and symbols. 32 ASCII control codes.

KEYBOARD — Detachable, solid state. TTY design. 10-key numeric cluster plus editing and cursor control keys.

TRANSMISSION — Asynchronous.

Switch-selectable, for combinations of 5 standard rates, 110 to 9600 baud.

OPERATING MODES — Switch-selectable, full duplex, half-duplex or batch.

MEMORY TYPE — 2048 x 8 RAM.

EDITING FEATURES — Full Cursor Controls plus Insert/Delete Character, Insert/Delete Line, Clear Screen, Clear Foreground Data Only, Tab.

STANDARD INTERFACE — CCITT V-24 (EIA RS-232 B/C).

REMOTE COMMANDS — Insert/delete Line, Clear Screen, Clear Foreground Data Only, Home Cursor, Address Cursor, Set Background intensity, Set Foreground Intensity, Carriage Return, Backspace, Ring Bell, Transmit, Print.

AUXILIARY OUTPUT — Standard printer interfaces; Standard cassette interface.

Hazeltine MODULAR ONE

The Hazeltine Modular One terminal offers the full range of terminal performances — from simple teletypewriter compatibility to enhanced editing and polling capabilities.

The Modular one is supplied in two different versions. The BASIC MODEL provides the following features: ★ 1,920 character display (80x24) ★ 12-inch bonded ★ Incremental and absolute cursor positioning. ★ Dual video intensity ★ 11-key numeric pad ★ Movable keyboard ★ Choice of 8 transmission rates up to 9600 baud ★ Communication interfaces: EIA RS-232 and current loop ★ Choice of block or blinking underscore cursor ★ Choice of white-on-black or black-on-white display representation.

Optional:

Lower Case	£35.00
Printer Port (parallel)	£70.00
Printer Port (serial)	£70.00
EIA Data Cable	£15.00
Remote Edit	P.O.A.
Current Loop Interface	P.O.A.
Synchronous Interface	P.O.A.
External Baud & Parity	
Switch	P.O.A.
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ONLY
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TELETYPE ASR33 I/O TERMINALS



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Full fledged industry standard ASR33 data terminal. Many features including: ASCII keyboard and printer for data I/O, auto data detect circuitry, RS232 serial interface, 110 baud, 8 bit paper tape punch and ready for off line data preparation and ridiculously cheap and reliable data storage. Supplied in good condition and in working order. Options: Floor stand £12.50 + VAT. Sound proof enclosure £25.00 + VAT

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£325 + CAR
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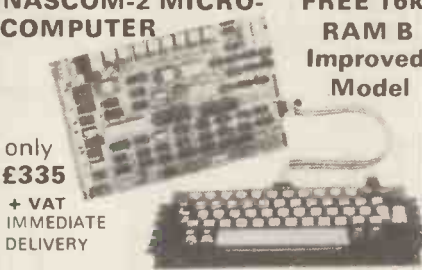


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UART + BAUD rate generator + crystal for I/O board	16.00
CTC — MK3882 multiple interrupt driven clock generator for I/O board	8.25
P/IO — MK3881 + interconnect for I/O board	8.50
P/IO interconnect only (for I/O board)	3.80
Econographics kit for additional 128 characters (N1 only)	30.00
2708/2716 Programmer for Nascom 1 and 2	20.95
NAS-SYS	
Nascom 19" rack mounting card frame for N1 and N2	32.50
Nas-OA disassembler 3 EPROM for Nas-sys	37.50
MK36271 8K BASIC in 8K x 8 ROM	40.00
Naspen VS in 2 EPROM	30.00
Nas-sys monitor in 2 EPROM	25.00
Nasbug T2 1 x EPROM	12.50
Nasbug T4 2 x EPROM	25.00
Tiny Basic 2 x EPROM	25.00
Super Tiny Basic 3 x EPROM	37.50
Super Tiny Basic upgrade 1 x EPROM	12.50
Tape Software	
ZEAP 1, 2 tape and documentation for N1	30.00
ZEAP 2 tape and documentation for Nas-sys	30.00
BK BASIC tape and documentation for N1	15.00
MEMORIES Discounts 10% for 4, 15% for 8, 20% for 16	
MK3880 (Z80) for N1	7.50
MK3880-N4 (Z80A) for N2	7.95
MK4116 16K x 1 dynamic RAM	7.50
MK4027 4K x 1 dynamic RAM	2.25
2102 1K x 1 static RAM	1.00
4118 1K x 8 static RAM	12.75
Unprogrammed 2708	7.50
Unprogrammed 2716	19.95
IM6402 UART	4.50
2114 1K x 4 Static RAM	3.95
8080A	5.25

NASCOM IMP



PLAIN PAPER PRINTER Fully built and housed in a stylish enclosure for just **£325** plus VAT. Interfaces with all micro computers

The Nascom IMP (Impact Matrix Printer) features are

- 60 lines per minute.
- 80 characters per line.
- Bi-directional printing.
- 10 line print buffer.
- Automatic CR/LF.
- 96 character ASCII set (including upper/lower case, \$, #, £).
- Accepts 8½" paper (pressure feed).
- Accepts 9½" paper (tractor feed).
- Tractor/pressure feed.
- Baud rate from 110 to 9600.
- External signal for optional synchronisation of baud rate.

IDEAL FOR WORD PROCESSING

COMPUTER KEYBOARDS




TASA 56 key touch sensitive keyboard. All ASCII characters including control keys. Parallel output with strobe. Shift lock. Keys coded in 3 colours to indicate function. 18 V DC at 35 mA. 15" x 6.25" x 0.385" thick. Black resin encapsulated. **£49.50 + VAT**

Star Devices Mk III 71 key touch sensitive keyboard. With numeric pad. All ASCII characters including control keys. Auto key repeat. Parallel output with strobe. Shift lock with indicator LED. Built in 'beeper' with level control. 5 V DC at 300 mA. 15" x 7" x 1.25". Grey case with white keys on blue. **£48.50 + VAT**

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FERRANTI — "SIZE 14 x 6 x 3" SLOPING FRONT
 55 Key ASCII Coded in steel case. Complete with Plug and Cable with circuit to convert to T.T.L. levels. In good condition at only **£25 + VAT, P/P £2.50**

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EXCLUSIVE TO HENRY'S 50% OFF MAKER'S PRICE

for **TANDY PET NASCOM**

- Software selectable 20, 40 and 80 column using 120mm aluminiumised paper. 1 roll supplied.
- 150 lines per minute.
- Centronics parallel data Interface for Nascom, Tandy, etc.
- 240 volt mains input. ASCII character set.
- Paper feed, and on/off select switches. 'BELL' signal. Weight 10lbs. Size: 13" x 10½" x 4¼". list price **£400.**
- New boxed and fully guaranteed.

POST PAID Price £195.00 + VAT
 See **COMPUTING TODAY** Recommendations March/May issues

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Ready cut Mounting Board £1 extra

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

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Cut out for most BSR or Garrard decks. Silver grey finish. Size 16 x 14 x 3in.

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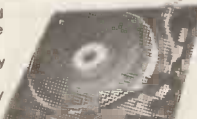
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BSR SINGLE PLAYER DECKS

BSR P182 3 speeds flared aluminium turntable "S" shape arm, cueing device, ceramic cartridge **£26**. Post only **£2**. Ready cut mounting board only **£1** extra.



BSR C142 RIM DRIVE QUALITY DECK

Manual or automatic play. Two speeds. Precision ultra slim arm. Cueing device. Bargain price

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

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

ELAC HI-FI SPEAKER 10in. TWIN CONE

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



POTENTIOMETERS Carbon Track

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

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With tweeter and crossover. 10 watt. 8 ohm. 15 watts. 3 or 8 ohm.

£9.95

Post 99p

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THE "INSTANT" BULK TAPE ERASER Suitable for cassettes and small sizes of tape reels. AC mains 200/250V. Hand held size with switch and lead.

Will also demagnetise small tools **Head Demagnetiser only £5** Post 50p

RELAYS. 12V DC 95p. 6V DC 85p. **BLANK ALUMINIUM CHASSIS.** 6 x 4—95p; 8 x 6—**£1.40**; 10 x 7—**£1.55**; 12 x 8—**£1.70**; 14 x 9—**£1.90**; 16 x 6—**£1.85**; 16 x 10—**£2.20**. **ANGLE ALI.** 6 x 1/4 x 1/4 in—25p.

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

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HIGH QUALITY



JVC DECK

£28.50

Post £2

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Detachable head, adjustable counter balance weight, hydraulic damped cueing platform, automatic pick-up arm return, 2 speeds, 33 and 45 rpm, suppression circuit to start stop switch, 240V AC motor, dynamic pendulous bias compensator. Teak veneered base, 19in. x 14 1/2 in. **£9**. Post **£2**. plastic cover **£6**, post **£2**. Suitable stereo magnetic cartridge **£6.50** extra.

RCS SOUND TO LIGHT KIT Mk. 2

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

"MINOR" 10 watt AMPLIFIER KIT £12.50

This kit is suitable for record players, guitars, tape playback, electronic instruments or small PA systems. Two versions available: Mono. **£12.50**; Stereo. **£20**. Post 45p. Specification 10W per channel; input 100mV; size 9 1/2 x 3 x 2 in. approx. SAE details. Full instructions supplied. AC mains powered. Input can be modified to suit guitar.

RCS STEREO PRE-AMP KIT. All parts to build this pre-amp. Inputs for high, medium or low imp per channel, with volume control and PC Board **£2.95**

Can be ganged to make multi-way stereo mixers **£2.95** Post 35p

MAINS TRANSFORMERS ALL POST 99p.

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

GENERAL PURPOSE LOW VOLTAGE.

Tapped outputs available
2 amp 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V **£6.00**
1 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£6.00**
2 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£9.50**
3 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£12.50**
5 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£16.00**
12V, 100mA **£1.30** 20V, 40V, 60V, 1 amp **£4.00**
12V, 750mA **£1.75** 12V, 3 amp **£3.50**
10-0-10V 2amp **£3.00** 10V, 30V, 40V, 2 amp **£3.50**
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OPUS COMPACT SPEAKERS

FLUTED WOOD FRONTS
TEAK VENEERED CABINET
11 x 8 1/2 x 7 in
50 to 14,000 cps, 15 watts 8 ohm
Post £2 **£20** pair

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1 mfd, 2 mfd, 4 mfd, 8 mfd, 10 mfd, 16 mfd, 25 mfd, 30 mfd, 50 mfd, 100 mfd, 250 mfd, All 15 vgs. 22 mfd/6V/10V; 25 mfd/6V/10V; 47 mfd/10V; 50 mfd/6V; 68 mfd/6V/10V/16V/25V; 100 mfd/10V; 150 mfd/6V/10V; 200 mfd/10V/16V; 220 mfd/4V/10V/16V; 330 mfd/4V/10V; 500 mfd/6V; 680 mfd/6V/10V/16V; 1000 mfd/2.5V/4V/10V; 1500 mfd/6V/10V/16V; 2200 mfd/6V/10V; 3330 mfd/6V; 4700 mfd/4V. ALL 10p.
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4500mF 64V £2. 4700mF 63V £1.20. 2700mF/76V £1.
5000mF 35V 85p.

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16/350V 45p 8+16/450V 75p 32+32/450V 90p
32/500V 75p 16+16/450V 75p 100+100/275V 65p
50/500V £1.20 32+32/350V 50p 150+200/275V 70p
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MODEL	SIZE INCHES	OHMS	POWER WATTS	TYPE	OUR PRICE
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DELUXE MK II	12	8-16	15	HI-FI	£14
SUPERB	12	8-16	30	HI-FI	£20
AUDITORIUM	12	8-16	45	HI-FI	£20
AUDITORIUM	15	8-16	60	HI-FI	£29
GROUP 35	12	4-8-16	40	PA	£12
GROUP 45	12	4-8-16	45	PA	£15
GROUP 50	12	4-8-16	60	PA	£20
GROUP 75	12	4-8-16	75	PA	£22
GROUP 100	12	8-16	100	PA	£26
GROUP 100	15	8-16	100	PA	£29
DISCO 100	12	8-16	100	DISCO	£26
DISCO 100	15	8-16	100	DISCO	£29

BAKER 50 WATT AMPLIFIER



£69 Post £2.00
Ideal for Halls/PA systems, Discos and Groups. Two inputs. Mixer, Volume Controls, Master Bass, Treble and Gain Controls. 50 watts r.m.s. Three loudspeaker outlets 4, 8, 16 ohms.

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Professional 4 inputs with volume controls. Will mix mics, decks, musical instruments, etc. **£89**
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MAKE	MODEL	SIZE	WATTS POWER	OHMS	DUR PRICE
SEAS	TWEETER	4in round	50	8	£7.50
GOODMANS	TWEETER	3 1/2 in square	25	8	£4.00
AUDAX	TWEETER	3 in square	60	8	£10.50
SEAS	MID-RANGE	4in	50	8	£7.50
SEAS	MID-RANGE	5in	80	8	£10.50
SEAS	MID-RANGE	4 1/2 in	100	8	£12.50
GOODMANS	FULL-RANGE	5 1/2 in	15	8	£6.50
GOODMANS	FULL-RANGE	8in	20	8	£5.50
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R.C.S.	GENERAL	10in	20	8	£8.50

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Stabilised output. 9 volt 400 m.a. Ready made in plastic case with screw terminals. Safety overload cut out. Size 5 x 3 1/4 x 2 1/2 in. Transformer Rectifier Unit. Double insulated. Suitable Radio Cassettes etc.

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For 13x8in. or 8in. speaker **£9.50** Post 99p
For 6 1/2 in. speaker and tweeter **£8.50** Post 99p
Many other cabinets in stock. Phone your requirements.
SPEAKER COVERING MATERIALS. Samples Large S.A.E.
LOUDSPEAKER CABINET WADDING 18in wide 25p ft.

GOODMANS TWIN AXIOM 8 inch dual cone loudspeaker. 8 ohm. 15 watt hi-fi unit **£10.50**. Post **£1**. Cabinet **£10**.

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SPECIAL OFFER: 64 ohm, 2 1/2 in., 35 ohm, 3 in., 25 ohm, 3 in., 5x3 in., 7x4 in., 8 ohm, 2 in., 2 1/2 in., 3 in., 3 1/2 in., 5 in., 15 ohm, 3 1/2 in. dia, 6x4 in., 7x4 in., 5x3 in., 3 ohm, 4 in., 5 in., 7x4 in., 120 ohm, 3 1/2 in. dia. **£1.50** each.

RICHARD ALLAN TWIN CONE LOUDSPEAKERS Bin. diameter 4W **£3.50**. 10in. diameter 5W **£3.50**; 12in. diameter 6W **£4.50**. 3/8 or 15 ohms, please state.
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Handles up to 100 watts. No crossover required.
BLACK PLASTIC CONSTRUCTION BOX with brushed aluminium fascia. Sturdy job. Size 6 1/4 x 4 1/4 x 2 in. **£1.50**

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Standard 12in. diameter fixing with cut sides 12" x 10". 14,000 Gauss magnet. 20 watts RMS 4 ohm imp. Bass resonance = 30 c.p.s. Frequency response 20-8000 c.p.s. **BARGAIN, £8.50**. Post **£2**

ALUMINIUM HEAT SINKS. FINNED TYPE.

Sizes 5" x 4" x 1" 95p. 6 1/2" x 2" x 2 1/4" 45p.
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JACK PLUGS Stereo Plastic 30p; Metal 35p.
JACK SOCKETS. Mono Open 20p; Closed 25p.
JACK SOCKETS Stereo Open 25p; Closed 30p.
FREE SOCKETS—Cable end 30p.
2.5mm and 3.5mm JACK SOCKETS 15p.
2.5mm and 3.5mm JACK PLUGS 15p.
DIN TYPE CONNECTORS
Sockets 3-pin, 5-pin 10p. Free Sockets 3-pin, 5-pin 25p.
Plugs 3-pin 20p; 5-pin 25p.
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TV CONVERGENCE POTS 15p each
Values = 5, 7, 10, 20, 50, 100, 200, 250, 470, 2000 ohms.

"VALVES" special offer subject to being unsold £1 ea. Post Free

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12V6GT	35Z4GT	PL81	PY83	ECL80	EY51
12K8M	PC884	PL82	EB91	ECL82	EY86
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4055 125p 7441 70p 74LS74 36p 4056 135p 7442A 60p 74LS75 45p 4060 115p 7443 112p 74LS76 45p 4063 120p 7444 112p 74LS83 70p 4066 55p 7445 100p 74LS84 70p 4066 55p 7446A 93p 74LS86 40p 4067 45p 7447A 75p 74LS90 50p 4068 27p 7448 80p 74LS92 70p 4070 20p 7450 17p 74LS93 60p 4071 25p 7451 17p 74LS96 110p 4072 25p 7453 17p 74LS107 45p 4073 25p 7454 17p 74LS109 80p 4073 25p 7460 17p 74LS112 40p 4075 25p 7470 36p 74LS113 90p 4081 27p 7472 30p 74LS114 45p 4082 27p 7473 34p 74LS122 80p 4086 72p 7474 30p 74LS123 70p 4087 72p 7475 38p 74LS124 180p 4093 138p 7476 32p 74LS125 50p 4093 138p 7480 50p 74LS126 50p 4095 95p 7481 100p 74LS132 60p 4096 95p 7482 84p 74LS133 30p 4097 340p 7483A 90p 74LS135 50p 4098 120p 7484 100p 74LS138 75p 4098 120p 7485 110p 74LS139 75p 4099 200p 7486 34p 74LS145 120p 40101 132p 7489 21p 74LS147 220p 40102 180p 7490A 80p 74LS148 175p 40103 180p 7491 80p 74LS151 80p 40104 99p 7492A 46p 74LS153 60p 40104 99p 7493A 36p 74LS154 200p 40105 99p 7494 84p 74LS155 80p 40107 60p 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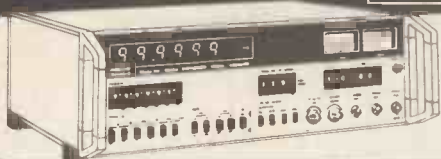
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The BBC's Engineering Training Department is situated in the Worcestershire countryside and includes well equipped Radio and Colour Television Studios. There are excellent welfare and club facilities.

Duties: Maintaining a full range of professional radio and television broadcasting equipment. This includes modifications to and commissioning of broadcast equipment, the repair and recalibration of sophisticated instruments. (Appropriate guidance will be given to candidates who are unfamiliar with BBC equipment).

Requirements: Recent experience of maintaining electronic equipment. A good technical knowledge of audio and/or video equipment. One of the following qualifications is essential:-

A degree from a British University in electronics or electrical engineering.

HNC or HND (Electrical Engineering or Applied Physics).

C & G Full Technological Certificate in Telecommunications.

Salary, depending upon experience, in the range of £6030-£6600 rising to £7455 plus 10% Shift Allowance.

Pensionable Post. Re-location expenses considered.

Further Details: If you would like to hear more and receive an application form, please send a stamped addressed envelope of at least 9" x 4" to Head of Technical Operations Training Section, Engineering Training Department, Wood Norton, Evesham, Worcs. WR11 4TF. quoting reference number 80.E.2305/WW. Closing date for return of application forms, 14 days after publication.

BBC

(617)

Trainee Radio Officers

First-class, secure career opportunities

A number of vacancies will be available in 1980/81 for suitably qualified candidates to be appointed as Trainee Radio Officers.

If your trade or training involves Radio Operating, you qualify to be considered for a Radio Officer post with the Composite Signals Organisation.

Candidates must have had at least two years' radio operating experience or hold a PMG, MPT or MRGC certificate, or expect to obtain this shortly.

On successful completion of 40 weeks' specialist training, promotion will occur to the Radio Officer grade.

Registered disabled people may be considered.

Salary & Prospects:

TRAINEE RADIO OFFICER: £3859 at 19 to £4549 at 25 and over. On promotion to RADIO OFFICER: £5288 at 19 to £6884 at 25 and over. Then by four annual increments to £9339 inclusive of shift working and Saturday and Sunday elements.

For full details please contact Robby Robinson, our Recruitment Officer, on Cheltenham (0242) 21491, Ext. 2269, or write to him at:

Recruitment Office, Government Communications Headquarters, Oakley, Priors Road, Cheltenham, Gloucestershire GL52 5AJ.

GCHQ

(576)

Aerial Engineers

(Broadcasting Systems)

Our current demanding programme of work includes the expansion of Independent Local Radio and the introduction of the fourth Television Channel. This provides excellent opportunities for Aerial Specialists at all levels – to strengthen our existing expertise and to provide for the future by training those keen on entering this challenging field.

We are small enough for you to be able to make your mark in a professional and friendly environment but at the same time large enough to provide career prospects.

Senior Aerial Systems Engineers

(up to £9600 p.a. under review)

Aerial Systems Engineers

(up to £8350 p.a. under review)

To be responsible for the design and specification – acceptance and commissioning of aerial systems, high and low power filters, channel combining and separating equipment for UHF, VHF and MF services.

Aerial Maintenance Engineers

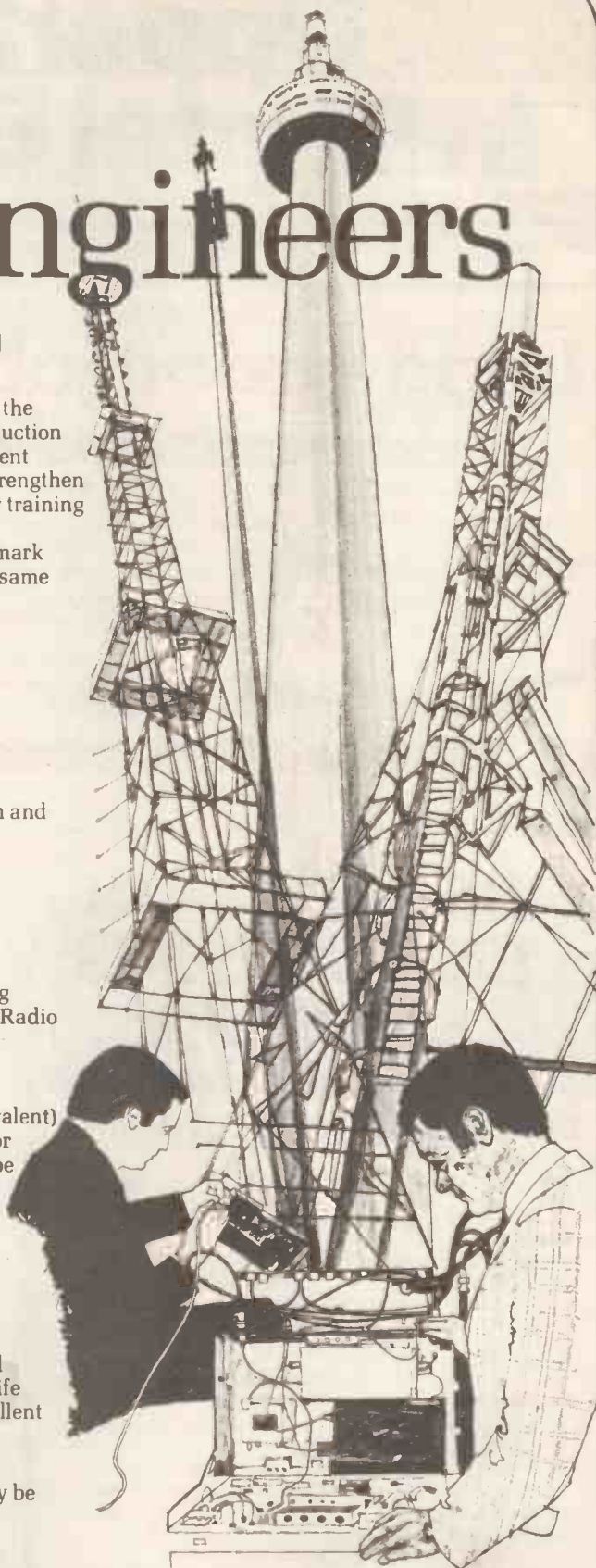
(up to £8350 p.a. under review)

To be responsible for implementing a programme of preventive maintenance for transmitting and receiving aerials, feeders, combining units and RF filters at TV, Radio and Link Stations. To provide a specialist corrective maintenance service, as necessary.

You should be qualified to degree/HNC level (or equivalent) and have substantial relevant experience (at the senior level supervisory ability is essential). We would also be happy to consider new graduates or those with little experience with a genuine interest in broadcast engineering to start at a trainee level.

You must be fit and able to climb tall structures; you must also hold a current driving licence and be prepared to travel within the U.K. Starting salaries will be according to experience – the figures quoted above are under review. Generous re-location, car and travelling allowances are payable together with free life assurance and personal accident scheme and an excellent contributory pension scheme.

Most of these posts will be based at our Engineering Headquarters, here in Hampshire, although there may be opportunities for appointments at our Regional Engineering bases.



IBA

INDEPENDENT
BROADCASTING
AUTHORITY

Applicants (male or female) should send full details of qualifications and experience as soon as possible to Glynis Powell, IBA, Crawley Court, Winchester, Hampshire, SO21 2QA.

Opportunities in Digital Electronics

Datek Systems Ltd., a subsidiary of the Mergenthaler-Linotype Group, are leading manufacturers of advanced intelligent terminals for the printing industry. We are a small, friendly company, based in Wembley, and we need the following key people:

Software Development Engineer

Here is a unique chance to be in at the beginning of an exciting new project, as our design team commences work on a new-generation machine. Candidates should have a minimum of two years' experience in applications software. Salary will be up to £9000 p.a.

Senior Test Engineer

This post affords an opportunity for an

engineer to further his/her career and extend his/her technical skills, by becoming head of a small team of engineers testing highly sophisticated systems. Several years' experience in testing digital equipment is essential, together with the ability to direct and motivate others. The salary will be around £7,500 p.a.

Both the above posts are open to men and women and offer generous terms and conditions of employment. Relocation expenses may also be available for the right candidates, if appropriate.

For further information and an application form, please contact: Miss Linda Bux, Datek Systems Ltd, 849 Harrow Road, Wembley, Middlesex. Tel (01) 904 0061.

DATEK (603)
SYSTEMS LIMITED

Electronics Engineers

Submarine Cables

QATAR circa £10,000 + bonus

The Ministry of Communications and Transport, Qatar, are seeking 2 Electronic Engineers with at least 10 years specialist communications experience. 5 of which have been in the operation and maintenance of submarine cables.

Applicants should preferably hold an engineering degree and be aged between 28-45 years old.

These are responsible and secure positions based in a pleasant and stable part of the Arabian Gulf. The successful candidates will be offered three year (renewable) contracts, free furnished accommodation and services, 4 weeks gratuity and 60 days U.K. leave per annum, family airfares, interest free car loan and free medical treatment.

Write or telephone for an application form, quoting Ref: G.1303 to:— Gordon Newton, Lansdowne Recruitment Limited, Design House, The Mall, London, W5 5LS. Tel: 01-579 6665/7610.

Lansdowne

Offices throughout the Middle East, Asia, North America and Australasia

Middle East

(587)

£25 REWARD

for anyone who can re-christen our hard-working computer. "Einstein" isn't quite right. Our scientific researcher has suggested "Lovelace," confident that all readers of this magazine will immediately think of Charles Babbage's assistant, the Hon. Ada Augusta — not the dreaded Linda. Our Einstein is indispensable, but what a prima donna — gets the vapours in hot weather! Further details of his performance are very wittily reviewed by David Tebbutt in the June issue of Personal Computer World.

Current vacancies include:

SENIOR SEMI-CONDUCTOR PROCESS ENGINEERS, to £14,000.
SEMI-CONDUCTOR QUALITY ENGINEERS, to £11,000. L.S.I. DESIGNERS, to £12,000 (Scotland).

DIGITAL DESIGN / RESEARCH ENGINEERS, to work on a new generation of data acquisition/recording instruments and special-purpose displays. Equipment based on 8048/8085 and 6800/6802. To £10,000 (South Coast).

P.D.S. ENGINEER for mobile radio. To £8,000 (West Country).
SOFTWARE ENGINEERS for a wide range of device, i.e. PROM programmers, mpu programmers, programmable array units and mpu test equipment. To £8,000 (Herts.).

TEST ENGINEERS for a wide range of RF and microwave navigational beacons. Very progressive firm with lots of chance to progress. To £7,000 (West Country).

MICROWAVE ENGINEERS for test equipment design and application of special-purpose components to standard range of test equipment. To £7,000 (West Country).

JUNIOR ENGINEERS to join a team working on the application of mpu's including 16-Bit devices to aircraft data recording systems and environmental control systems. Salary confidential (West Country).

P.D.S. ENGINEER for mobile radio. To £8,000 (West Country).
SOFTWARE ENGINEERS for a wide range of device i.e. RPOM programmers, mpu programmers, programmable array units and mpu test equipment. To £8,000 (Herts.).

TEST ENGINEERS for a wide range of RF and microwave navigational beacons. Very progressive firm with lots of chance to progress. To £7,500 (West Country).

MICROWAVE ENGINEERS for test equipment design and application of special purpose components to standard range of test equipment. To £7,000 (West Country).

For further details of these and other vacancies, please ring:

(532)

Charles Airey Associates

4 Hammersmith Grove, London W6 0NA Tel 01 741 4011

"PROBABLY THE BEST KNOWN SUPPLIER OF ELECTRONIC ENGINEERS IN THE COUNTRY" - Financial Times.

**INNER LONDON EDUCATION AUTHORITY
LEARNING MATERIALS SERVICE TELEVISION CENTRE
Thackeray Road, Battersea SW8**

VIDEOTAPE ENGINEER (ST3)

The Learning Materials Service produces teaching programmes in colour for ILEA schools and colleges, many of which are marketed throughout the U.K. and abroad. There is a Television Studio and mobile unit and a film unit. The programmes are recorded in the master control section on broadcast standard videotape (CCIR formats A and C). This section carries out all editing and post-production work, and provides large scale duplication on a variety of helical videocassette formats.

A vacancy has arisen in this section, which consists of four senior engineers. Applicants will be expected to have good operational experience of videotape, with a thorough understanding of the technical features, and to have appropriate technical qualifications. A general grounding in colour television theory is essential. The successful candidate will be expected to undertake maintenance of the tape machines and associated equipment, as well as the operational functions. Some overtime is required.

Salary within the scale £7904 to £8498.

Application forms from EO/Estab, 1C Room 365, The County Hall, SE1 Telephone No: 633 7456/8848.

(621)

MANAGEMENT & EXECUTIVE SELECTION

telephone
01-637 9611

COMPUTER & DIGITAL ELECTRONICS ENGINEERS

Our specialist consultants have knowledge and experience that could be *vital* to your career progression. Jobs, Companies (UK & International), Interview and Progression techniques - information and advice for each applicant.

Call Peter Gorton or Howard Wynne *today*.

Suite 201 6 Albany House
324 Regent Street London W1

**MANAGEMENT &
EXECUTIVE SELECTION**

FIELD ENGINEER

Electronic Test and Control Equipment

WEMBLEY

Technicians and Engineers with experience of system assembly, installation or commissioning of electronic equipment are invited to apply for an unusually interesting job, based at Johnson Matthey Services Limited, Wembley, with visits to other Johnson Matthey premises. Good basic training in electronics, backed up by a practical understanding of things electrical and mechanical is essential.

For an application form please write or telephone:

Miss L. Tarbox, Staff Office
JOHNSON, MATTHEY & CO. LIMITED
100 High Street, Southgate, London, N14 6ET
Tel: 01-882 6111

(584)

ARAMCO



The COMPANY WITH A FUTURE ... for ENGINEERS & TECHNICIANS

ENGINEERS £11,450 to £19,200

TECHNICIANS £10,100 to £14,500 per contract year after tax.

Aramco are involved in many varied projects in Saudi Arabia that will last for many years.

The COMMUNICATIONS PROJECTS MANAGEMENT DEPARTMENT

is responsible for the communications networks throughout the Eastern Province of Saudi Arabia and need skilled Engineers and Field Technicians in the following fields:-

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 distributions 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 low-cost 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 day 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/20/8 to:

(606)



INTERNATIONAL RECRUITMENT
5 EAST PARADE,
HARROGATE,
NORTH YORKSHIRE. HG1 5LF

UNIVERSITY OF ABERDEEN

ELECTRONICS WORKSHOP SUPERVISOR

(Technician Grade 6)

required for the Department of Psychology. Duties include the design, development, construction and modification of electronic instruments used in research and teaching laboratories — as well as the repair and maintenance of electronic equipment, including video recorders, biological amplifiers and computer peripherals. The work requires a thorough understanding of modern analogue and digital techniques and circuitry.

Applicants should hold an H.N.C. or equivalent qualification and have had 9-10 years' relevant experience.

For suitably-qualified candidate, salary on scale £4884-£5832 with pay award awaited from Pay Comparability Commission, but for candidates with less than the requisite qualifications an appointment on a lower scale would be considered.

Applications by letter, giving date of birth, and details of qualifications and experience, should reach the Secretary, University Office, Regent Walk, Aberdeen, AB9 1FX, by September 15, and quote Ref. No. 124/80.

(583)

REHABILITATION ENGINEERING UNIT

Chailey Heritage

ELECTRONICS TECHNICIAN

(Medical Physics
Technician II)

This post offers opportunity for initiative in design and construction of special equipment for disabled children with particular emphasis on research and development.

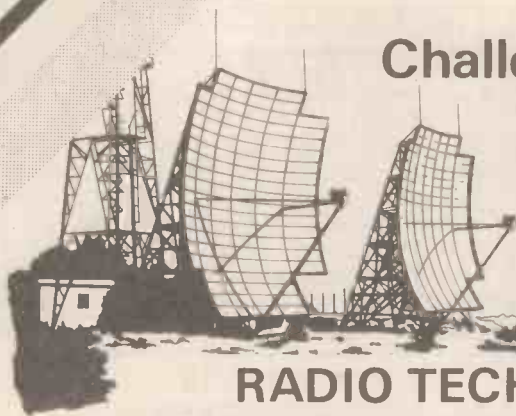
Applicants should be experienced in current electronics and be prepared to work with clinical staff and patients.

Salary scale £5547-£6918 p.a. (increase pending).

Further details from Technical Director, Chailey Heritage, Lewes, Sussex. Tel: 082 572 2112, Ext. 38.

(610)

Challenging positions at home and abroad



RADIO TECHNICIANS COMMUNICATIONS ENGINEERS

Plessey EAE design, install and maintain communications systems for the oil industry, at home and abroad.

Due to rapid and continuing expansion in our activities, we constantly require Radio Technicians, with experience of HF, MF, VHF and UHF, and Engineers (preferably qualified to HNC level or above) in the fields of Microwave, Multiplex and Tropospheric Scatter.

In the North Sea, earnings are in the range £9,000 to £12,000 p.a. Overseas earnings could be up to £20,000 – plus tax concessions and generous home leave.

The work is demanding, but rewarding, offering you the chance to use your skills and your initiative to the full.

The company is based in Great Yarmouth, with offices in Aberdeen and Lerwick – but where relocation is necessary, we will give generous assistance with removal, legal and temporary accommodation expenses.

Please apply, with details of your career to date, to: Personnel Manager, Plessey EAE Limited, Dept WW, Offshore House, 284/285 Southtown Road, Gt. Yarmouth, Norfolk NR31 0JB Telephone 0493 58541

(530)



PLESSEY EAE



Experimental Officer (Electronics)

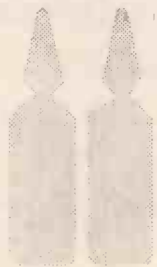
Greenford Middx.

Our Research Central Services Unit is undertaking an increasing amount of design and constructional electronics work. The application of microprocessor technology to the scientific effort is particularly important. Whilst routine construction work is undertaken elsewhere there is a great need for a technical officer to help in constructing prototype equipment during the development phase.

Applicants qualified ONC/HNC or equivalent should have previous experience in electronic construction. Some experience with printed circuit boards and an ability to translate circuit diagrams into practice is essential. An interest in the construction of experimental equipment, making use of microprocessors and needing some degree of innovation is required.

Starting salary within the range £4270 to £6450 according to qualifications and experience. Bonus and non-contributory pension scheme.

Please apply to: Miss E. M. Butler, Personnel Department, Glaxo Group Research Ltd., Greenford Road, Greenford, Middlesex UB6 0HE. Tel: 01-422 3434, ext. 180, quoting ref. ZH.334.



Glaxo Group Research Ltd.

(604)

Department of Physics
B.Sc.(Hons.) and B.Sc.
Combined Science

Available as five-year day-release modular courses offering a wide choice of units in science subjects.

M.Sc. The Physical Basis of Electronics

Available as two-year day-release, and two-year and three-year evenings-only courses. For graduates in Physics, Electrical Engineering and allied subjects.

Suitable graduates applying to enter one of these part-time M.Sc. courses in September 1980 are invited to apply also for one of ten Science Research Council bursaries. Students must meet normal S.R.C. requirements for residential and academic qualifications. If the demand for the bursaries exceeds the number available, selection will be competitive. Please ask for further details if required.

H.N.C. Applied Physics

A two-year day-release course, including electronics, vacuum physics, computing and spectroscopy. For technicians and others with suitable O.N.C., A levels or equivalent.

The Physics Department also offers full-time courses leading to B.Sc.(Hons.) in Physics and Physical Electronics, B.Sc.(Hons.) in Combined Science, and M.Sc. in the Physical Basis of Electronics.

Further details of all courses may be obtained from:

The Secretary, Physics Department (Ref. WW6), THE POLYTECHNIC OF NORTH LONDON, Holloway, London, N7 8DB (Tel: 01-607 2789, Ext. 2180).

The Polytechnic of North London

(580)

UNIVERSITY OF NOTTINGHAM
Department of Psychology

A vacancy exists in the Psychology Department for a Grade 6

COMPUTER TECHNICIAN

(male or female). Duties include the design/development of sophisticated on-line equipment for laboratory control plus routine maintenance of the Department's computer laboratory complex. The laboratory is based on a PDP 11-34 master computer with DEC GT40 and LSI 11 slave machines. Expansion of the system, including microprocessor-based developments, is in progress.

Design experience with CMOS/TTL devices is essential and previous computer experience desirable.

Suitable qualifications include HNC (or equivalent) in a relevant subject or ONC with appropriate computer experience.

Salary is in the range £4,884-£5,832 per annum.

Application forms can be obtained from the Establishment Office, University of Nottingham, University Park, Nottingham, NG7 2RD. Telephone Nottingham 56101, ext 2093 Ref. No. PSY4/80 (674)

Radio Technicians Work in Communications R&D and add to your skills

At the Government Communications Headquarters we carry out research and development in radio communications and their security, including related computer applications. Practically every type of system is under investigation, including long-range radio, satellite, microwave and telephony.

Your job as a Radio Technician will concern you in developing, constructing, installing, commissioning, testing, and maintaining our equipment. In performing these tasks you will become familiar with a wide range of processing equipment in the audio to microwave range, involving modern logic techniques, microprocessors, and computer systems. Such work will take you to the frontiers of technology on a broad front and widen your area of expertise — positive career assets whatever the future brings. In the rapidly expanding field of digital communications, valuable experience in modern logic and software techniques will be gained.

Training is comprehensive: special courses, both in-house and with manufacturers, will develop particular aspects of your knowledge and you will be encouraged to take advantage of appropriate day release facilities.

You could travel — we are based in Cheltenham, but we have other centres in the UK, most of which, like Cheltenham, are situated in environmentally attractive locations. All our centres require resident Radio Technicians and can call for others to make working visits. There will also be some opportunities for short trips abroad, or for longer periods of service overseas.

You should be at least 19 years of age, hold or expect to obtain shortly the City and Guilds Telecommunications Technician Certificate Part I (Intermediate), or its equivalent, and have a sound knowledge of the principles of telecommunications and radio, together with experience of maintenance and the use of test equipment. If you are, or have been in HM Forces your Service trade may allow us to dispense with the need for formal qualifications.

Registered disabled people may be considered.

Pay scales for Radio technicians start at £4640 per annum, rising to £6525, and promotion will put you on the road to posts carrying substantially more; there are also opportunities for overtime and on-call work, paying good rates.

Get full details from our **Recruitment Officer, Robby Robinson, on Cheltenham (0242) 21491, Ext 2269**, or write to him at **GCHQ, Oakley, Priors Road, Cheltenham, Glos GL52 5AJ**. We will invite suitable applicants (expenses paid) for interview at Cheltenham.



GCHQ

Recruitment Office

Government Communications Headquarters

Oakley, Priors Road, Cheltenham GL52 5AJ

(9483)

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)

Nene College Northampton

Applications are invited for the post of

Lecturer I/II in Electrical Engineering

Candidates should be graduates or Chartered Engineers with recent industrial experience.

The successful applicant will be able to lecture in the fields of electronics and instrumentation.

Salary Scales:

Lecturer Grade I £3,777-£6,498

Lecturer Grade II £4,851-£7,794

point of entry depending on previous experience.

Application forms and further particulars are available from The Dean, School of Technology, Nene College, St. George's Avenue, Northampton, to be returned within fourteen days of the date of appearance of this notice.

(572)

Electronic Engineers – What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £4000 to £8000 p.a.

If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you. All applications are treated in strict confidence and there is no danger of your present employer (or other companies you specify) being made aware of your application.

TJB ELECTROTECHNICAL
PERSONNEL SERVICES,

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

Tel: 0892 39388



Please send me a TJB Appointments Registration form:

Name

Address

(9238)

ELECTRONICS WORKSHOPS ENGINEER

(INSTRUMENT MAKING)

We are looking for an energetic and technically sound man or woman to join us in this specialist/assistant management post.

You should have proven skills in the fabrication and wiring of control panels and in the making of scientific instruments. You must have the ability to carry out development work without supervision and will preferably have a knowledge of solid state technology and microprocessors.

We see you as holding an appropriate ONC/HNC but would be prepared to offer day release facilities if you are still in the process of gaining your qualification.

We offer a progressive salary, pension and life assurance, flexible working hours and assistance with relocation expenses in an appropriate case.

INTERESTED?

Then write or phone for an application form to the Recruitment Officer, Unilever Research Port Sunlight Laboratory, Quarry Road East, Bebington, Wirral, Merseyside, L63 3JW. Tel: 051-645 2000, ext. 8408. Please quote ref. PS715AC.



(609)

TOP JOBS IN ELECTRONICS

Posts in Computers, Medical, Comms, etc. ONC to Ph.D. Free service.

Phone or write: BUREAUTECH,
AGY, 46 SELVAGE LANE,
LONDON, NW7. 01-906
0251.

(8994)

UNIVERSITY COLLEGE, CARDIFF

Applications are invited for the post of

TECHNICIAN (Grade 5)

in the FACULTY OF SCIENCE ELECTRONICS WORKSHOP. Applicants should possess an HNC or equivalent and have a good knowledge of analog and digital techniques; experience with microprocessor-controlled instruments and interface would be an advantage. Salary range: £4257-£4974 p.a. Duties to commence as soon as possible.

Applications, together with the names and addresses of two referees, should be forwarded to the Vice-Principal (Administration) and Registrar, University College, P.O. Box 78, Cardiff, CF1 1XL. Closing date: September 30, 1980. Reference 2067.

(573)

COMMISSION AGENTS REQUIRED

To sell Electronic Instrumentation Equipment and Components.

Areas to include: N.E. and N.W. ENGLAND, SCOTLAND, THE MIDLANDS AND WALES.

Send details to: DEPT. CTI, P.O.: BOX NO. 1, BILLINGSHURST, WEST SUSSEX, RH14 9SD.

(571)

TESTERS, TEST TECHNICIANS, TEST ENGINEERS. Earn what you're really worth in London working for a World Leader in Radio & Telecommunications. Phone Len Porter on 01-874 7281, or write: REDIFON TELECOMMUNICATIONS Ltd., Broomhill Road, Wandsworth, London, SW18. (9850)

ROYAL COLLEGE OF ART School of Film and Television Two additional ELECTRONICS ENGINEERS

required for the operation and maintenance of its broadcast standard television facility. The Studio is equipped with Philips plumbicon cameras and an RCA TR60 quadraplex VTR. In addition to the studio, 2 editing suites are planned, one equipped with Ampex VPRI and a second IVC 871P.

Experience of closed circuit or broadcast television is essential and a qualification such as ONC or C & G is desirable.

Starting salary will be in the range £5037-£7164 depending on age and experience.

Please write, giving full details of age and experience, to: Assistant Registrar (Staff), Royal College of Art, Kensington Gore, London, SW7 2EU. (577)

FOREIGN AND COMMONWEALTH OFFICE TELECOM- MUNICATIONS

We have vacancies for

TECHNICIANS

on duties involving the testing, maintenance and repair of machine telegraph and associated electronic equipment in London, and also on the installation of PABX telephone systems in British Government offices overseas. Staff employed on the latter duties are based at Hanslope, near Milton Keynes in Buckinghamshire. Applicants should possess a sound knowledge of basic principles and preferably have some experience with the appropriate equipment. Some knowledge of Radio would be an advantage. The vacancies are in the grade of Radio Technician; opportunities exist for transfer to other types of duty in due course, and the grade is the main source of recruitment, on promotion (subject to the possession of the necessary qualification and satisfactory performance) for our resident overseas maintenance staff.

QUALIFICATIONS REQUIRED:

A City and Guilds Intermediate Certificate in Telecommunications or an equivalent or higher qualification.

An Ordinary National Certificate in Electrical Engineering.

SALARY: is on a scale £4,640-£6,525.

An additional allowance of £780 is paid for working in London. The appointments attract four weeks' paid annual holiday and there are prospects of pensionable employment.

For an application form apply to:

Recruitment Section
FOREIGN AND COMMONWEALTH OFFICE
Hanslope Park, Hanslope, Milton Keynes MK 19 7BH

(579)

Professional Careers in Electronics



All the others are measured by us...

At Marconi Instruments we ensure that the very best of innovative design is used on our range of communications test instruments and A.T.E. We have a number of interesting opportunities in our Design, Production and Service Departments and we can offer attractive salaries, productivity bonus, pension and sick pay schemes together with help over relocation. If you are interested to hear more, please fill in the following details:-

Name _____	Age _____
Address _____ _____	
Telephone Work/Home (if convenient) _____	
Years of experience	0-1 1-3 3-6 Over 6
	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Present salary	£3,500- £4,500- £5,500- over
	£4,500 £5,500 £6,500 £6,500
	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Qualifications	None C & G HNC Degree
	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Present job _____ _____	

PE.1

Return this coupon to John Prodger, Marconi Instruments Limited, FREEPOST, St. Albans, Herts, AL4 0BR. Tel: St Albans 59292

marconi
instruments

(619)

A GEC MARCONI ELECTRONICS COMPANY

Link Electronics is a successful British Company active in the international sales of Broadcast television and radio equipment. We manufacture a range of studio products from colour cameras to simple D.A.s. We are also one of the largest suppliers of Outside Broadcast vehicles, television and radio studios, all designed and built in Andover for a worldwide market.

TECHNICAL SALES ENGINEER

To be involved in the active selling of television broadcast equipment.

The successful applicant should have a sound technical electronic background, preferably with at least three years' experience within the Broadcast Industry, but not necessarily in Sales.

TV SYSTEMS ENGINEERS

Experienced senior engineers to work on the design and project management of Outside Broadcast vehicles and television studios. This is an opportunity for engineers to become involved in projects from their initial design concept through manufacture to delivery and installation.

Our custom-built systems require a high degree of customer contact at engineering level from the initial design, to customer training after completion of the contract, both within the U.K. and overseas.

Applications are invited from engineers with a knowledge of T.V. studio engineering gained from experience in this type of work or from experience in the operation side of television.

Employment benefits include excellent salary, generous holidays, free life and health insurance, pension scheme, subsidised meals and relocation expenses.

Please apply for further details and application forms to Jean Smith at the address given below.



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(589)

ITN

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Telephone the Personnel Office on 01-637 3144, quoting ref. no. 40763.

(588)

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There is a vacancy in the Technology Unit at the Royal Observatory, Edinburgh, 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 Observatory provides Technological support to several major national astronomical facilities in the UK and overseas.

Initially the successful candidate will work with Officers at PTO II, III and IV levels designing, developing and commissioning acquisition and guidance systems and other instruments for use on the 3.8 metre Infrared telescope situated in Hawaii.

These systems incorporate a variety of detectors including cooled SIT TV cameras, and microprocessor controlled digital image storage and display. Special techniques are being developed to present complex information in a simplified form to assist astronomers working in a difficult environment.

The successful candidate may be required to work abroad on short term detached duty or on postings of up to three years. It is a pre-requisite of working in Hawaii that a special high-altitude medical examination be taken and passed.

Applicants are expected to have qualifications at degree level in the appropriate subjects leading to corporate membership of an appropriate professional body.

Experience in one or more of the following fields would be an advantage: Detectors, Detector Arrays, CCDs and associated amplifiers, low light level TV Systems, Integration and digital image storage techniques, application of microprocessor hardware and software.

Salary will be in the range £8600-£10200 per annum. There is a non-contributory superannuation scheme.

Application forms from The Personnel Officer, Royal Observatory, Blackford Hill, Edinburgh EH9 3HJ. Application forms should be returned by 1 September, 1980.

(605)

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Candidates must have served an apprenticeship or have had equivalent training. They should normally have 3 years' relevant experience, and hold ONC in Engineering (with pass in Electrical Engineering 'A') or Applied Physics or TEC/SCOTEC certificate or equivalent qualification in a relevant subject. **Ex-Service personnel** who have had suitable training and at least 3 years' appropriate service (as Staff Sergeant or equivalent) will also be considered.

Salary: £5310-£7170; London £780 more. Starting salary may be above the minimum for those with additional relevant experience. Promotion prospects. Non-contributory pension scheme.

For further details and an application form (to be returned by September 12, 1980) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). **Please quote T/5424.**

FOREIGN AND COMMONWEALTH OFFICE

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Applicants should have a sufficient combination from a degree or equivalent qualification, teaching experience in similar technology and three to four years' practical experience of professional radio communications systems. For all posts commencing salary up to £7,500 plus benefits.

Applications to Frank Braybrook, GEC-Marconi Electronics Limited, Marconi House, New Street, Chelmsford, Essex CM1 1PL. Telephone Chelmsford (0245) 353221 Extension 478.

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(629)

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(607)

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The successful candidate will be required to have considerable experience of work in the National Health Service Physics Department and will be expected to have a good knowledge of present day digital analogue electronic techniques and equipment.

Salary: £7082-£8207 inclusive.

For further information contact the Department of Medical Physics on ext 2350. Application form and job description obtainable from Sector Administration, King's College Hospital, Denmark Hill, London SE5 9RS or telephone 01-274 6222 ext 2408, quoting reference number SA/202.

Closing date: Sept. 12th, 1980.

(612)

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Please apply by letter, giving age, qualifications, experience and names of 2 referees, to The Secretary (W.W.), Queen Mary College, Mile End Road, London, E1 4NS. (670)



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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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For a job description and application form, please contact the Area Personnel Officer, Bromley Area Health Authority, "Bassetts," Startis Hill Road, Farnborough, Kent, BR6 7AR. Tel. Farnborough (0689) 53333, Ext. 339. (590)

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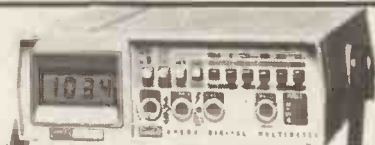


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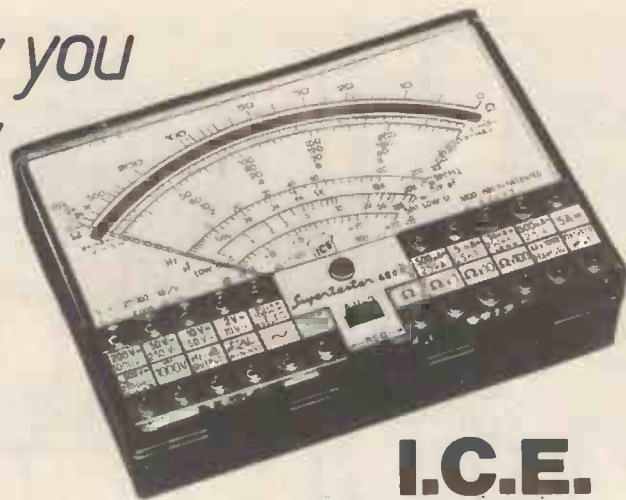
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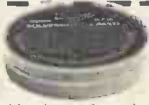


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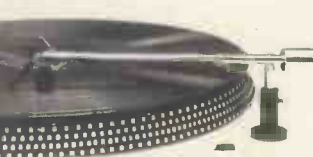
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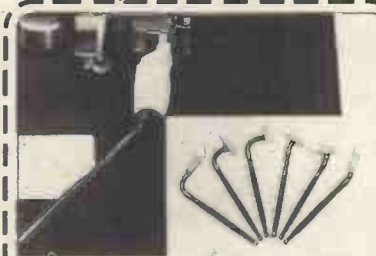
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