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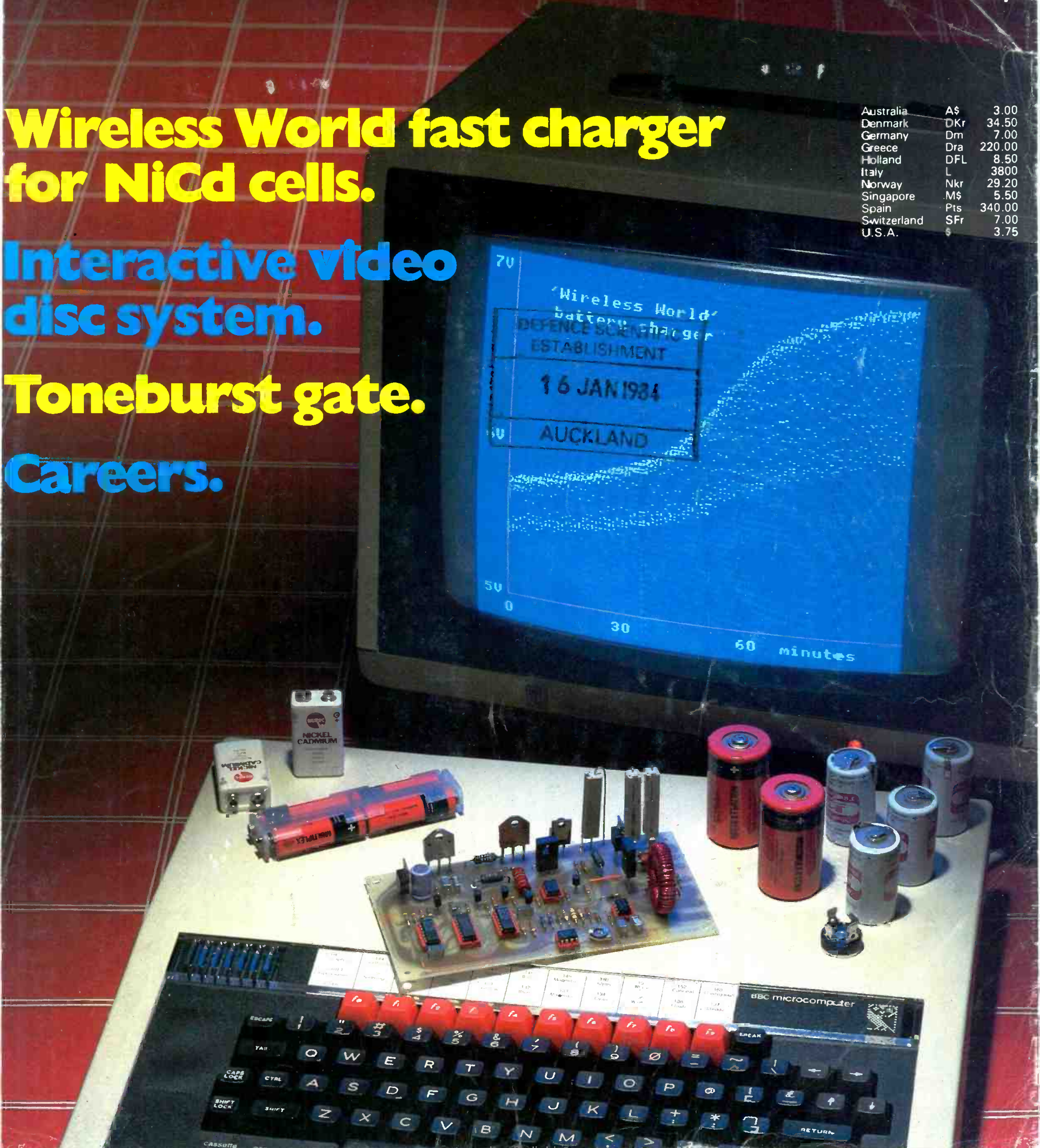

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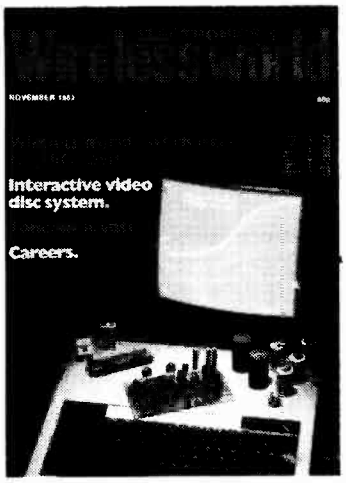

Front cover shows a prototype of the Wireless World *NiCd charger board. On the screen is the charging characteristic of a four-cell AA-size battery. The monitor was kindly provided by JLC Electronics. Photograph by Alan McFaden.*

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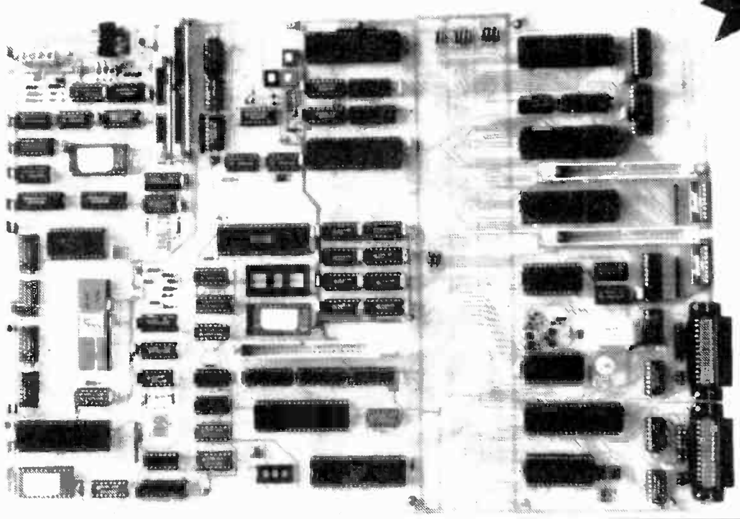

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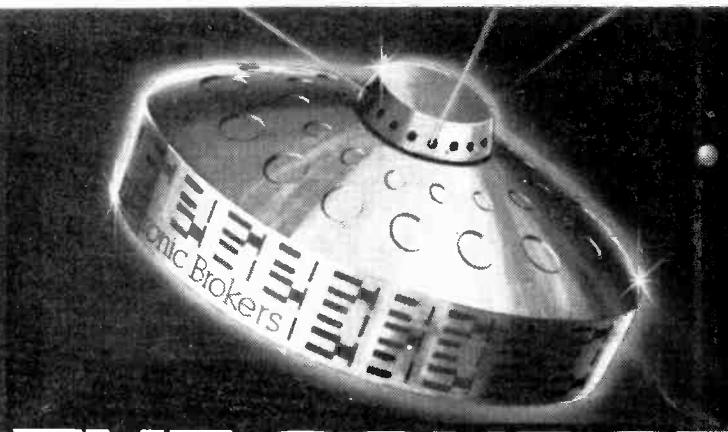

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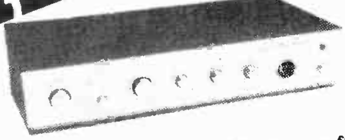

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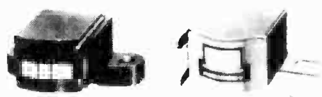

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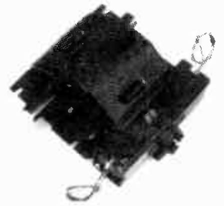

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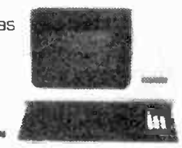

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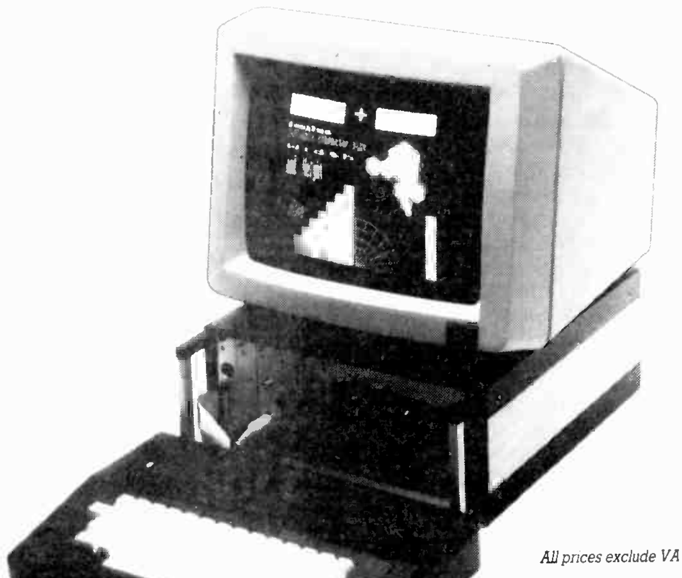

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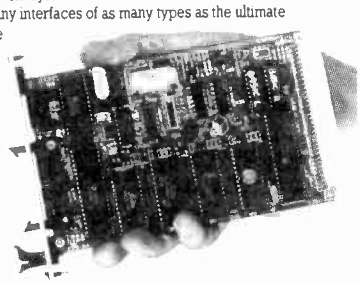

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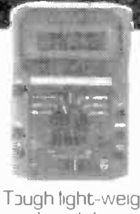

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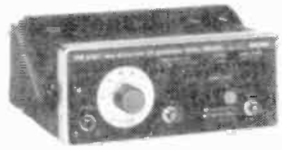

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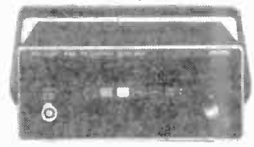

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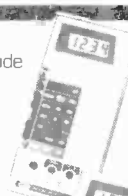

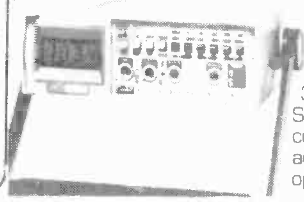

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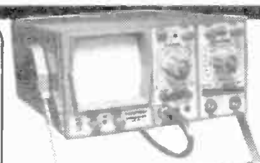

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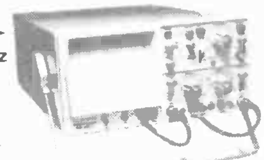

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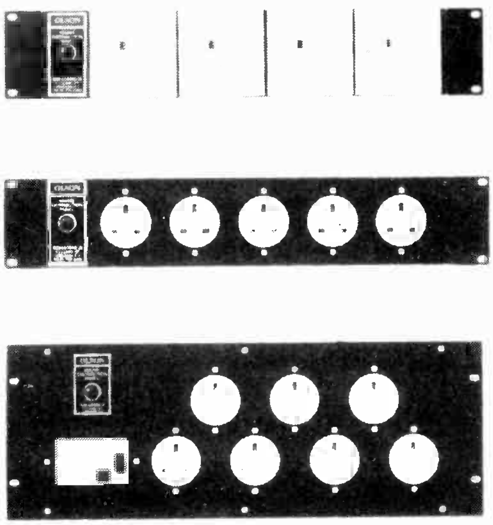

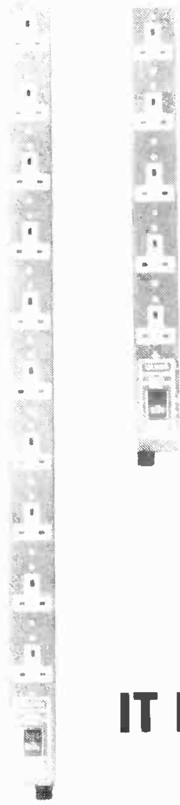

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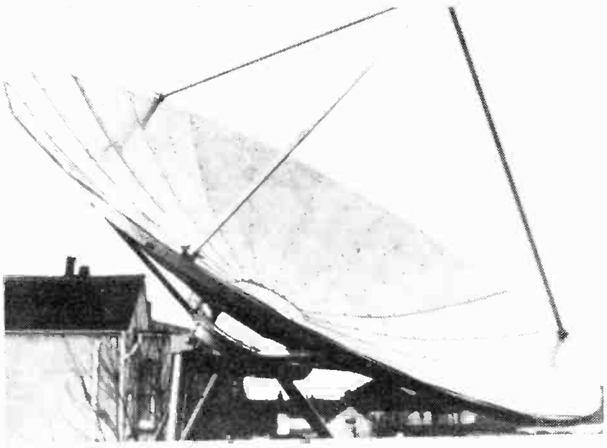

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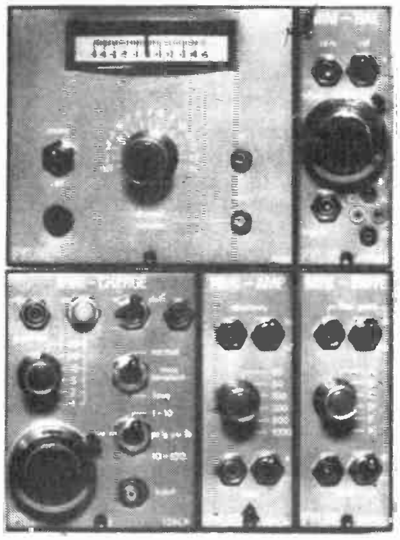

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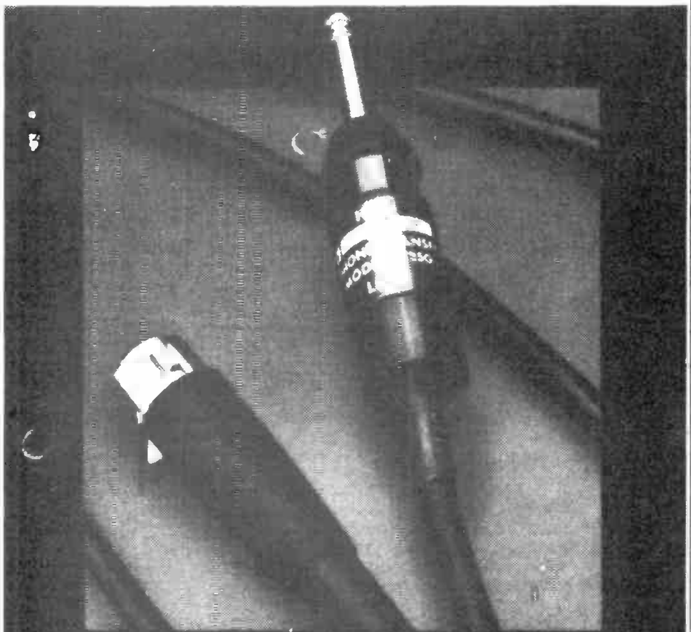

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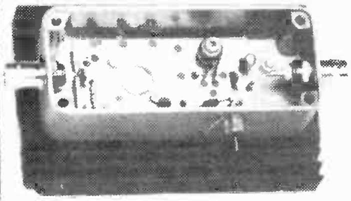

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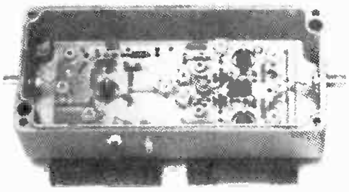

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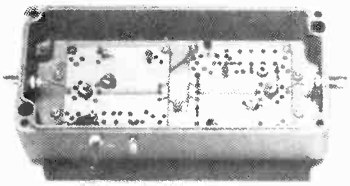

TYPE 9154

VMOS LINEAR POWER AMPLIFIERS

Tuned to your specified frequency in the range 1-250 MHz

TYPE 9154 200 mW.-2 watts input, 20 watts output. Gain adjustable 10-20 dB .... £180+£10 p&p
TYPE 9160 As above with integral mains power supply unit .... £240+£15 p&p
TYPE 9168 8 watts input, 80 watts output .... £240+£10 p&p
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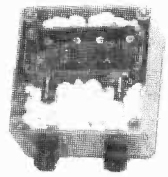
LOW NOISE GASFET PREAMPLIFIERS

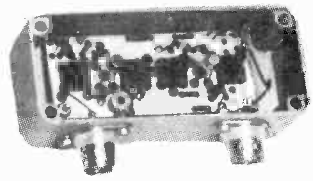


TYPE 9100 in 9010

THREE STAGE GASFET STRIPLINE PREAMPLIFIERS

Television bands IV or V.
Channel group 'A' 21-34, 'B' 39-51 or 'CD' 48-68.

TYPE 9100 Three stage Gasfet preamplifier. N.F. 0.7 dB. Gain 25 dB. High Q filter. 12V + DC .... £95+£2 p&p
TYPE 9102 UHF three stage Gasfet preamplifier. N.F. 0.6 dB. Gain 25 dB. Aligned to your specified frequency in the range 250-500 MHz. High Q filter. 12V. + DC .... £95+£2 p&p
TYPE 9012 Gasfet preamplifier mains power supply unit .... £24.50+£3 p&p
TYPE 9010 Masthead weatherproof unit .... £6.50+£2 p&p



TYPE 9026

GASFET/MOSFET RF PREAMPLIFIERS

Aligned to your specified frequency in the range 1-250 MHz.
Masthead/local use.

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TF 2002B

TF 2170B

MARCONI TF 2002B SIGNAL GENERATOR 10 KHz.-88 MHz. 2V. RF output. AM/FM modulation. Fitted with MARCONI TF 2170B DIGITAL SYNCHRONISER frequency stability 1 part in 106. Digital setting of frequency in 10 Hz. increments £995
TYPE 9113 TELEVISION FREQUENCY CONVERTOR. Changes channels in the range 40-1000 MHz .... £242+£5 p&p
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TYPE 8034 PHASE LOCKED SIGNAL SOURCE using low frequency reference crystal. Specify output in the range 1-600 MHz. Output 10 mW. + 10 dBm .... £79.50+£2 p&p

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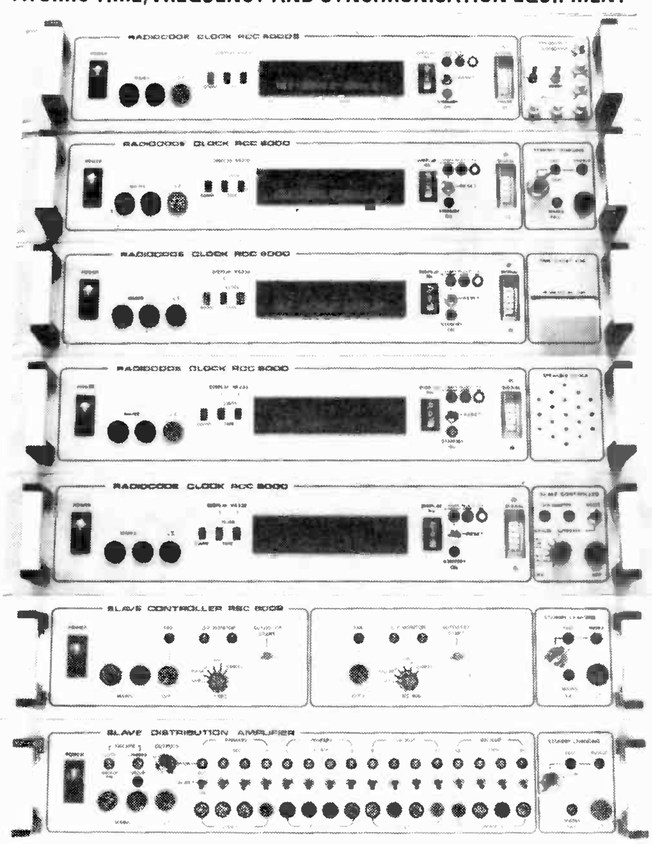
ATOMIC TIME, FREQUENCY AND SYNCHRONISATION EQUIPMENT



NEW PHASE-MODULATION SYSTEMS

Until recently, atomic time and date information was only available on v.l.f. transmissions using amplitude modulation. The RCC 8000AM series of equipment uses these transmissions to offer high noise immunity and high accuracy, particularly at very long range.

The new RCC 8000PM series of equipment uses, for the first time, phase modulated tranmissions with massive radiated powers of up to 2 Mega-Watts to offer long range, excellent noise immunity and no scheduled maintenance periods.

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- Time code generators
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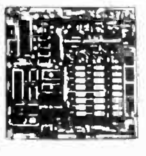

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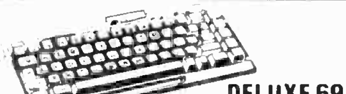

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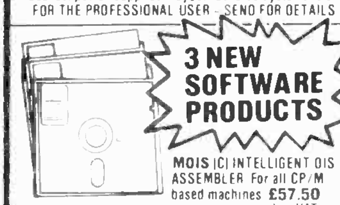

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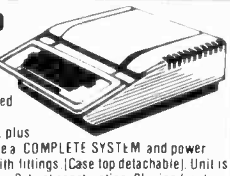

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SELECTION OF SPECIAL OFFERS - QUANTITIES AVAILABLE FROM HENRY'S

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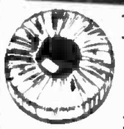

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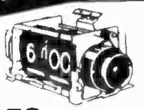

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Quantities available

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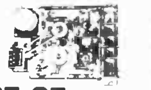

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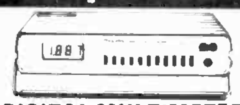
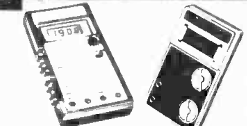


ALL MODELS 3½ DIGIT UNLESS STATED



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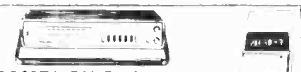

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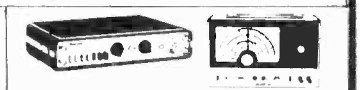

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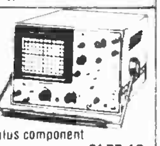

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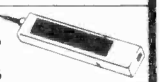

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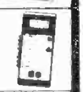

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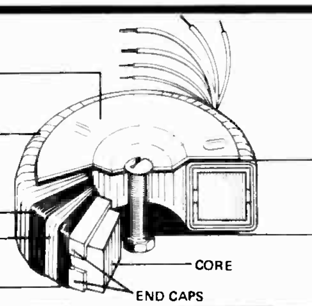

15 VA
62 x 34mm 0 35Kg
Regulation 19%

SERIES No	SECONDARY Volts	RMS Current
0x010	6+6	1 25
0x011	9+9	0 83
0x012	12+12	0 63
0x013	15+15	0 50
0x014	18+18	0 42
0x015	22+22	0 34
0x016	25+25	0 30
0x017	30+30	0 25

(encased in ABS plastic)

30 VA
70 x 30mm 0.45Kg
Regulation 18%

1x010	6+6	2 50
1x011	9+9	1 66
1x012	12+12	1 25
1x013	15+15	1 00
1x014	18+18	0 83
1x015	22+22	0 68
1x016	25+25	0 60
1x017	30+30	0 50

50 VA
80 x 35mm 0.9Kg
Regulation 13%

2x010	6+6	4 16
2x011	9+9	2 77
2x012	12+12	2 08
2x013	15+15	1 66
2x014	18+18	1 38
2x015	22+22	1 13
2x016	25+25	1 00
2x017	30+30	0 83
2x028	110	0 45
2x029	220	0 22
2x030	240	0 20

80 VA
90 x 30mm 1Kg
Regulation 12%

3x010	6+6	6 64
3x011	9+9	4 44
3x012	12+12	3 33
3x013	15+15	2 66
3x014	18+18	2 22
3x015	22+22	1 81
3x016	25+25	1 60
3x017	30+30	1 33
3x028	110	0 72
3x029	220	0.36
3x030	240	0 33

120 VA
90 x 40mm 1.2Kg
Regulation 11%

4x010	6+6	10 00
4x011	9+9	6 66
4x012	12+12	5 00
4x013	15+15	4 00
4x014	18+18	3 33
4x015	22+22	2 72
4x016	25+25	2 40
4x017	30+30	2 00
4x018	35+35	1 71
4x028	110	1 09
4x029	220	0 54
4x030	240	0 50

160 VA
110 x 40mm 1.8Kg
Regulation 8%

5x011	9+9	8 89
5x012	12+12	6 66
5x013	15+15	5 33
5x014	18+18	4 44
5x015	22+22	3 63
5x016	25+25	3 20
5x017	30+30	2.66
5x018	35+35	2 28
5x026	40+40	2 00
5x028	110	1 45
5x029	220	0 72
5x030	240	0 66

225 VA
110 x 45mm 2.2Kg
Regulation 7%

6x012	12+12	9 38
6x013	15+15	7 50
6x014	18+18	6 25
6x015	22+22	5 11
6x016	25+25	4 50
6x017	30+30	3 75
6x018	35+35	3.21
6x026	40+40	2 81
6x025	45+45	2 50
6x033	50+50	2 25
6x028	110	2 04
6x029	220	1 02
6x030	240	0 93

300 VA
110 x 50mm 2.6Kg
Regulation 6%

7x013	15+15	10 00
7x014	18+18	8 33
7x015	22+22	6 82
7x016	25+25	6 00
7x017	30+30	5 00
7x018	35+35	4 28
7x026	40+40	3 75
7x025	45+45	3 33
7x033	50+50	3 00
7x028	110	2 72
7x029	220	1 36
7x030	240	1 25

500 VA
140 x 60mm 4Kg
Regulation 4%

8x016	25+25	10 00
8x017	30+30	8 33
8x018	35+35	7 14
8x026	40+40	6 25
8x025	45+45	5 55
8x033	50+50	5 00
8x042	55+55	4 54
8x028	110	4 54
8x029	220	2 27
8x030	240	2 08

625 VA
140 x 75mm 5Kg
Regulation 4%

9x017	30+30	10 41
9x018	35+35	8 92
9x026	40+40	7 81
9x025	45+45	6 94
9x033	50+50	6 25
9x042	55+55	5 68
9x028	110	5 68
9x029	220	2 84
9x030	240	2 60

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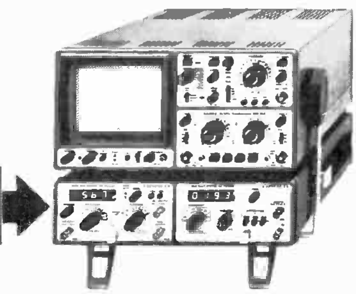

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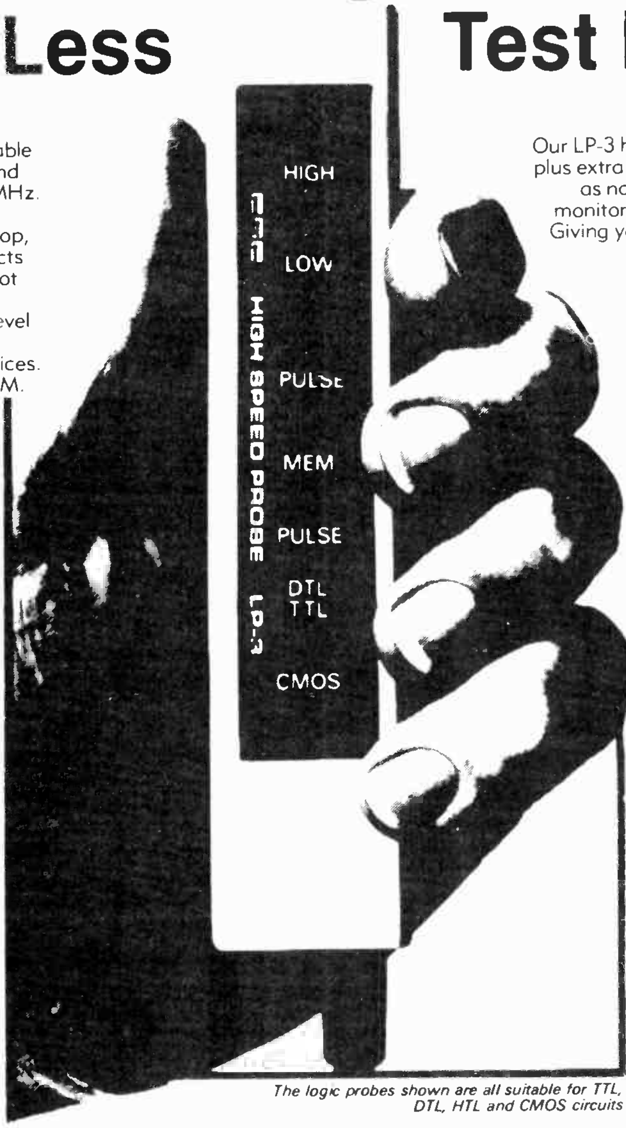

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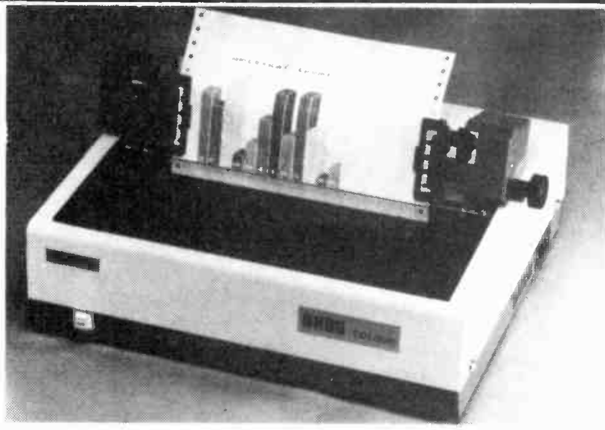

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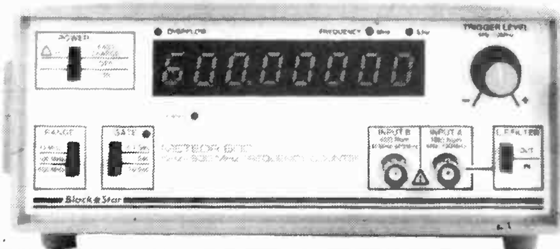

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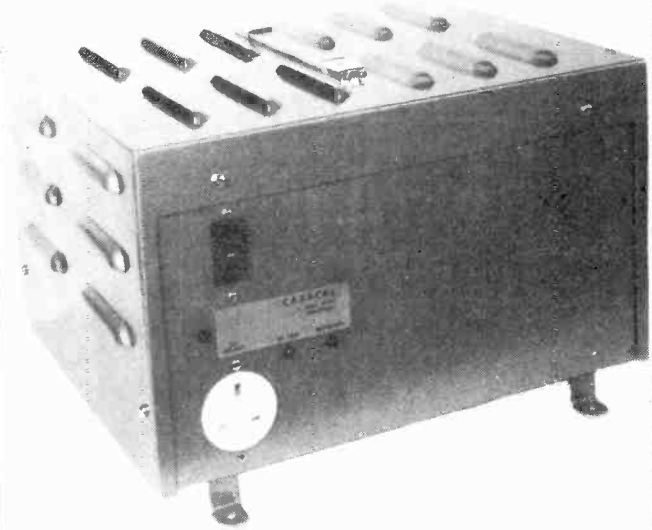

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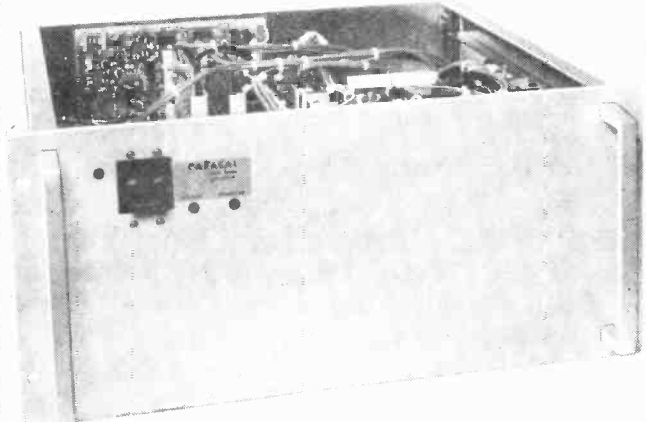

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8IL596	0 80
8IA597	0 80
8IL598	0 80
8T26A	0 90
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75150		0 64
75154		0.77
75160		2.56
75161		2 80
75162		3 95
75172		1 95
75173		1.44
75174		1 95
75175		1 44
75182		0 50
75183		0 50
75188		0 37
75189		0 37
75451		0 22
75452		0 22
75453		0 22
75454		0 22
75468		0 88
75491		0 31
75492		0 42
AY31015	D2	3 00
AY31270		6.47
AY38910	D6	4 40
AY53600	D2	6 70
DP8304	D1	2.50
MC1488	D1	0.37
MC1489	D1	0 37
NC3242A		6.30
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TL094	1.34
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TL489	0.62
TL494	1.63
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748	0 27

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7815	0.40
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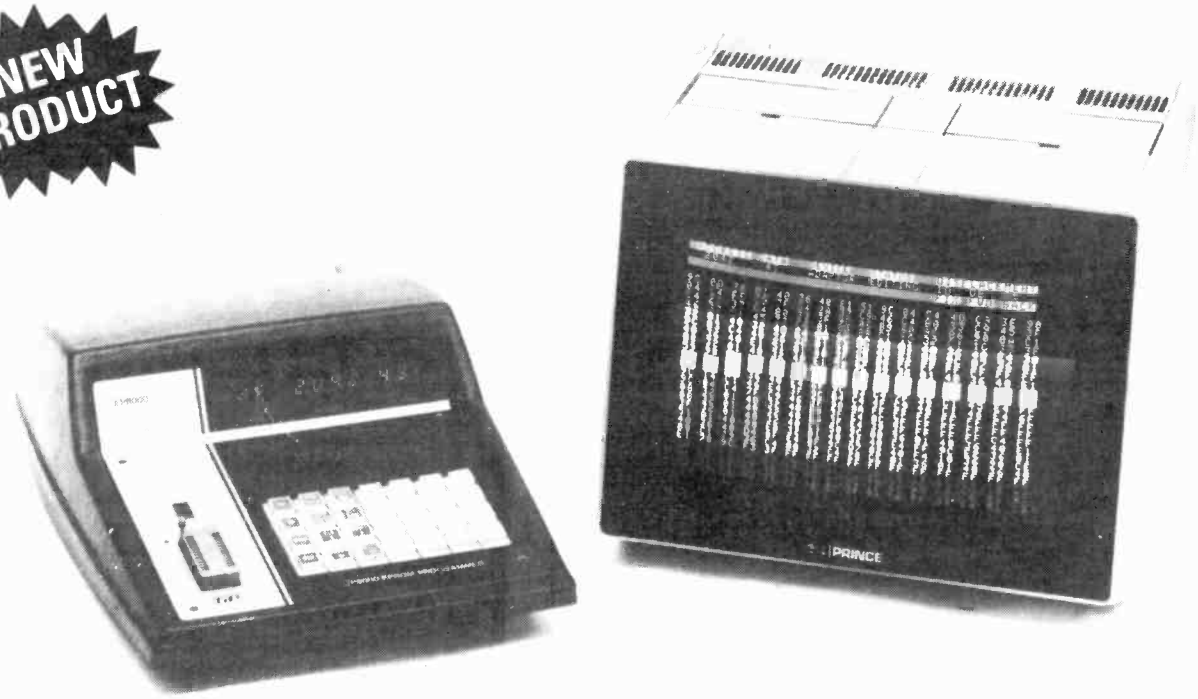

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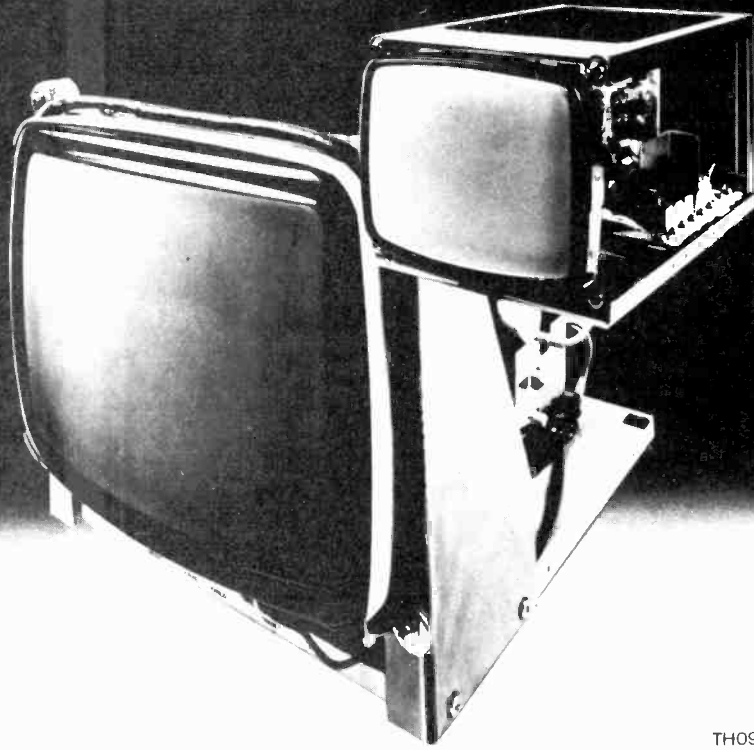

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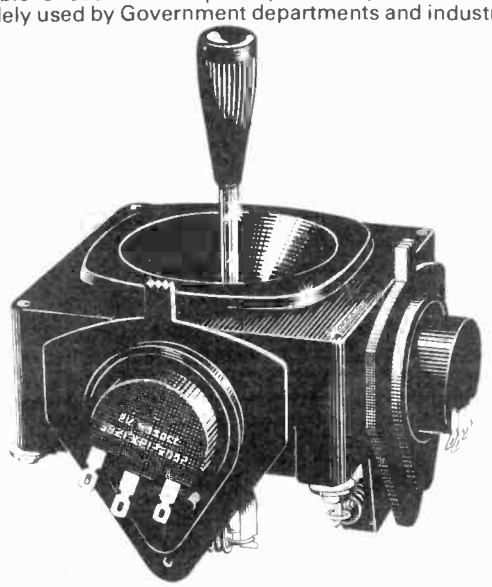

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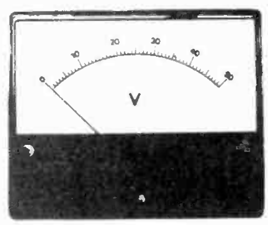

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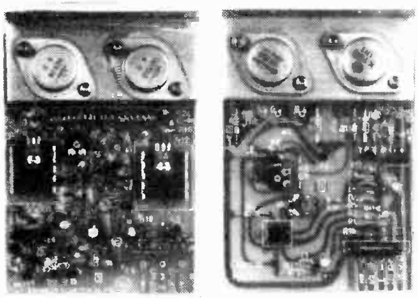

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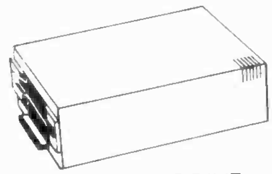

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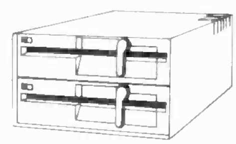

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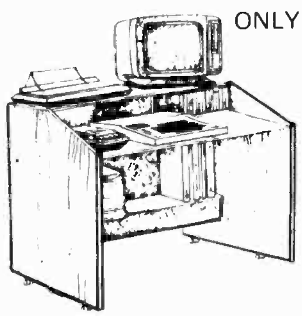

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Wireless World laboratory

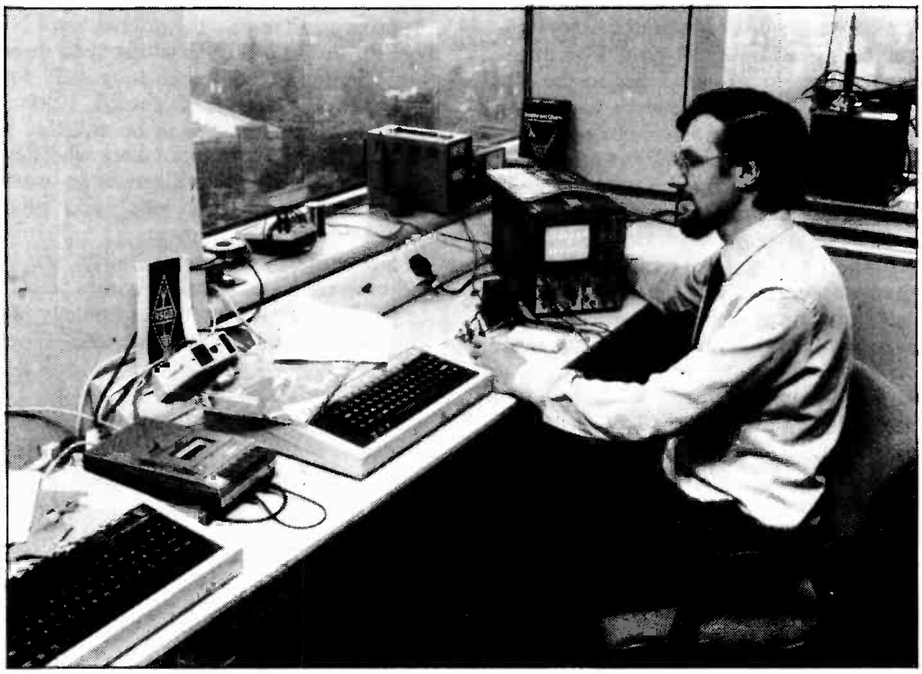
With this issue, we celebrate the re-establishment of the *Wireless World* laboratory on the 17th floor of Quadrant House. The journal has been labless for far too long, following the move from London, but this month sees the publication of the first design from the new lab. – a charger for nickel-cadmium cells incorporating several novel features, designed by Richard Lambley, *Wireless World's* projects editor.

Announcing one's intentions too far in advance has been known to cause red faces: with that in mind, therefore, broad statements of intent rather than detailed promises are on offer. We have made plans to publish a number of relatively inexpensive and simple designs to start with, to be followed by the more exotic variety of device – test gear, computer interfacing, and perhaps some fairly advanced satellite communications gear.

We intend these features to be entertaining, instructive and, perhaps, even money-saving, although that will not be of over-riding importance when we are deciding on a project – it never has been in the projects we have described in the past. We shall try to describe the design processes in detail, including false trails, in the hope that the articles will be readable in their own right, whether the equipment described is to be built or not.

Printed-circuit boards for our projects will be made available from at least one and maybe more sources, so that this stumbling-block will not exist, and we will ensure that components used in our designs are easily obtainable.

Although we do have a large number of projects in mind, we would be delighted to consider any ideas for development that might occur to readers. Any thoughts on this subject will be well received by Richard Lambley at the Quadrant House address.



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Super-high superhet

A group of German research engineers at the Heinrich-Hertz-Institut fuer Nachrichten Technik in Berlin have reported (*Electronics Letters*, August 18, 1983) the development of an experimental fibre-optic digital transmission experiment with heterodyne detection in a coherent single-channel, single polarization, system at 830 nm wavelength. The receiver has an intermediate-frequency of 1.5 GHz and proved capable of receiving 8.4 Mbit/s digital signals over 280m of fibre. It is recognized that the use of superhet-type techniques could not only reduce the minimum receiving level by 10-20dB in comparison with systems using intensity modulation and direct detection but also open the way to multichannel systems utilising the relatively high selectivity of i.f. filters. A second laser is used as the local oscillator in the receiver. The work is being supported by the Deutsche Bundespost.

The Canadian Broadcasting Corporation is now using fibre-optic links up to about 3.7 km between cameras and mobile control units on major o.bs. The system uses a two-way, dual-fibre cable. Video signal-to-noise ratio is about 60dB over a 3km link.

Broadband power banks

Although the concept of broadband power amplifiers and automatic tuning units is making an increasing impact in h.f. transmitters for many applications, including budget-design amateur radio, few of the lower-cost designs can claim the flexibility of the Marconi H1051 amplifiers. This design is described by R. E. J. Gerard in the current issue of Marconi's *Communication and Broadcasting*. It virtually reduces a medium power r.f. amplifier to the long-sought "black box" concept and can be used in power bank arrangements to feed separate multiple-channel transmissions in any mode including frequency-hopping and spread-spectrum signals, to multiple-port aerial systems. With no r.f. tuning or setting-up time required, the time to change frequency is measured in microseconds anywhere within a frequency span of over 26 MHz (1.6 to 28 MHz). It requires no protection against mismatched loads and can work at full-power into a short-circuit; similarly it can safely deliver full output under "keydown" c.w. conditions. The H1051 incorporates many of the innovative ideas on broadbanding developed by the company over more than two decades.

Earlier this year, the Japanese commercial broadcaster MBS, in Osaka, began using an all-solid-state v.h.f. television transmitter built by NEC with a vision output power of 10 kW. This has twelve 1 kW parallel-connected modules and uses a frequency-synthesizer based on a stable rubidium oscillator. Because of the absence of high-voltage supplies, a faulty amplifier unit can be withdrawn from service without any break in transmission and the transmitter requires no warm-up time. It must be one of the highest power all-solid-state v.h.f. transmitters yet in service.

Which video tape?

The problem of non-compatible professional video tape formats is highlighted in a table published recently by the EBU. This lists those European and North African broadcasters now using 1-inch helical-scan broadcast v.t.r. machines that will accept material in Format B (the Bosch-Fernseh developed format) and/or Format C (Ampex/Sony developed format). While some countries, such as Finland, Morocco, Netherlands, Norway and Sweden, will accept tapes in either format, most others opt for one or other, with the UK for example firmly geared to Format C. Moreover in some countries, such as France and Yugoslavia it even depends on the region or network: for example Antenne 2, FR3 (Dijon, Lille, Lyon, Marseilles, Nancy and Paris) accept Format B, but FR3 (Bordeaux and Limoges) want Format C tapes. It thus provides a good example of the man-made problems of non-compatible technical standards.

Medals for technology

The annual Queen's Awards for Technological Achievement are eagerly sought-after by British firms and organizations. There are also a number of awards and travelling fellowships that can be gained by engineers – though perhaps none that approach in prestige the international Nobel Prizes. The USA is taking such incentives seriously and is launching early next year a new series of annual National Medals of Technology to be awarded by President Reagan to innovators who have "advanced US competitiveness in world markets, created new jobs, and made technological improvements to industries and people everywhere". Medals will go either to individuals or companies directly responsible for translating technology into commercial products or processes.

Radio-linked appliances

Widespread use continues of illegal "cordless telephones" using frequencies between 1.6 and 2 MHz, 47.6 to 49.9 MHz and 70 to 70.5 MHZ (there are also some legal units between 1.632 and 1,792 MHz and 47.45 and 47.554 MHz). While very low-powered transmitters (about 100mW) are the more widely used, there are also 'long-range' mobile units. DoTI's Radio Regulatory Division appears to be waiting for the passage of the Telecommunications Bill, with its important amendments to the Wireless Telegraphy Acts, before attempting seriously to stamp out illegal operation.

Meanwhile, another contender for spectrum for short distance links has appeared in the form of portable computers which use integrated radio systems to link with the main processors located anywhere in a city or its suburbs. The radio links operate at rates of about 4800 bits/second to provide comparable signalling rates with 2400 b/s line systems (extra speed is needed because of additional error protection for the radio systems). Typically, American systems are being designed to use widely spaced incoming/outgoing channels between 800 and 900 MHz, with base-station powers up to about 50 watts.

Cold comfort farm?

Almost 20 years ago I visited the idyllically-sited research laboratories of the Hughes Aircraft Company in the foothills above Malibu Beach in southern California: advanced laser research in a setting more commonly associated with the out-of-town playground of the Hollywood film colony. Hughes were one of the first electronics companies to use a rural workplace to attract top-grade scientists and engineers. The idea has since spread to the UK.

Browsing through those vital back pages of a recent *Wireless World* my eyes alighted, in the "Appointments" section, on a large illustration of cottages set around a strangely familiar church steeple. An invitation by H.M.G.C.C. for graduate-status engineers and scientists to come and work in the "high-tech countryside" of Hanslope Park, Buckinghamshire.

My mind went back to a depressing evening in November 1941 when, still in my 'teens, I accepted an "invitation" to this country estate – to find myself working in a hastily converted granary. Nor do I recall, as the advert. puts it, that the Park was "a mere stone's throw away from this delightful rural village" with memories of the long footslog back to the Park from the four pubs, the one tea-shop, and later the excellent WVS canteen run by the good ladies of the village.

Times change. Nobody then suggested that it would be "particularly helpful" if I described "the type of working environment most suited by my career plans". Rather I recall a highly irate adjutant telling me in no uncertain terms that it was not my job to think!

The village served mainly as a dormitory for those employed in the railway and printing works of nearby Wolverton. The vicar made the "News of the World" for his alleged activities on visits to wicked London. Hanslope Park, itself, had been the scene of a notable pre-war murder . . . .

Nevertheless "The Farmyard", as it was

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COMMENTARY

then called, was not without distinction. Among those working there was the brilliant Alan Mathison Turing, pioneer of digital computing mathematics, and advanced cryptography, though he clashed with the local constabulary by riding his bicycle to work wearing a gas-mask (a sensible precaution in view of his hay-fever, a problem with rural workplaces). Engineering was under Dick Keen whose book "Wireless Direction Finding" (published by *Wireless World*) was for long the classic text in this field.

The station itself was at first under the command of a delightful character who told us never to ask permission to do something since he might have to refuse. "Do it and ask afterwards" he would say, though I did hear that he was later court-martialled for putting his precepts into practice.

Perhaps I had better make it clear to job-seeking readers that on the rare post-war occasions when I've been allowed inside the Park I could detect little of the spartan, if eccentric, regime of 1941-43!

AMATEUR RADIO

EMC problems

Radio operation from residential areas seems to be facing increasing difficulties from a variety of electromagnetic-compatibility problems, ranging from the long-standing difficulties due to electrical interference and interference to television reception, to a whole host of new problems arising from the connection of additional equipments to television sets, including video cassette recorders, video games, home computers. UK amateurs also face shortly the problem of multichannel cable systems that, in the USA, are proving a major problem. This is due to radio frequency leakage into and out of the cable that often distributes tv programmes on frequencies that include the amateur v.h.f. bands. Although e.m.s. problems often arise from shortcomings in domestic equipment, the radio amateur faces a social problem if he persists in using his blameless equipment when neighbours complain. The use of video cassette recorders is proving particularly difficult as most of these incorporate wideband amplifiers and inadequate shielding of the tape head amplifier. Channel 4 is also causing difficulties in some areas since frequency channel 53, quite often used for Channel 4 but virtually never for the other three tv channels, is very susceptible to low-level fifth harmonics from 144 MHz transmitters using the S20 "calling" channel.

It is also recognized that the increasing amount of "new technology" in homes and offices is emphasising the need for tighter legislation to reduce interference to weak signals from digital r.f.i. On September 1, the American FCC introduced new, tighter rules for checking interference radiation from computers, video games and other devices. These make it more difficult for manufacturers to obtain approval for class A and class B computer-equipment categories, for example by arranging cables in unrealistic configurations so as to minimize mains-conducted or radiated interference levels during tests. Arrangement of power cords, cables and peripheral devices are spelt out in greater detail. Permissible radiation levels are not changed. Radiated signals are specified between 30 and 1000 MHz, line-conducted emissions between 450 kHz and 30 MHz. The radiation specifications are regarded as significantly more difficult to meet. Earthing, bypassing, shielding and filtering techniques are all having to be improved. Failure to pass these tests can result in substantial delays since equipments now have to obtain FCC approval before they can be marketed.

Space news

AMSAT-UK has recently issued a comprehensive series of data sheets to form an "Oscar 10 Handbook". This gives full details of the new amateur radio satellite in a high elliptical orbit, together with operating data etc (price to non-members £3 plus postage from AMSAT-UK London E12 5EQ). Oscar 10 has been providing many long-distance contacts since its Mode B transponder was switched on on August 6, although problems are caused by some amateurs using excessive power on the uplink; maximum effective radiated power should not be more than 500 watts, remembering that e.r.p. represents aerial gain multiplied by power delivered to the aerial. The Oscar 10 microwave transponder (1269.5 MHz up, 436.5 MHz down) is due to be switched on late October. The H-one special service channel (145.972 MHz) is to be used to transmit a regular IARU Region 1 news bulletin prepared by AMSAT-UK in collaboration with the RSGB.

The eagerly awaited STS-9 Space Shuttle Mission during which Dr Garriott, W5LFL will operate a hand-held 144 MHz transceiver is now expected to begin about October 28.

Hazard for onlookers?

Recent advice from the NRPB confirms that under normal circumstances few hazards due to the non-ionizing radiation from amateur h.f. or v.h.f. transmitters are likely to arise. A situation in which this may not apply came to my notice recently when a North Country amateur described how he awoke one night with violent pains in the right-hand side of his head, close to his eyes, that persisted for several hours. The previous evening he had stood alongside the car of another amateur who was demonstrating his 25-watt mobile equipment from his parked car. My correspondent's eyes had been only a few inches from the mobile aerial during several transmissions.

While it is by no means certain that there was any connection between these two events, it would appear that these circumstances do represent a potential hazard. NRPB and other bodies point out that hand-held tranceivers where the aerial is within a few inches of the eyes should not exceed 7 watts. Since there are few battery-powered portable transceivers that exceed this power the advice seems not to have sunk in. Amateur mobile v.h.f. equipment however can now have 25 or 40 watts output. Again normally no danger in the driving seat, but advisable to stand clear of the aerial if you are a spectator and the car is stationary.

Here and there

The DoTI states that at the end of June 1983 the number of UK amateur licences was: Class A 23,204; Class B 22,904; plus 1694 "reciprocal" licences issued to overseas amateur while visiting or resident in the UK. The remaining G5-plus-three-letter type of callsigns previously issued to reciprocal licensees are being phased out by the end of this year. Reciprocal callsigns now take the form of G4/LA8AK etc. Three types of reciprocal licences are now issued: mobile licence valid for two months; temporary licence for up to one year; and permanent licence for UK residents.

The DoTI have stated that misunderstandings arise between the "Amateur Radio Certificate", which is now issued by or on behalf of the DoTI, and the "Radio Amateur's Certificate" issued by the City and Guilds of London Institute. The Amateur Radio Certificate is issued only to those who have passed both the Radio Amateurs Examination and the Morse Test and entitles the holder to operate the station of another amateur. The Radio Amateurs' Certificate is proof of having passed the RAE but does not itself entitle the holder to operate any amateur station.

Dr John Allaway, G3FKM recently received the "Golden Needle Award" of the Austrian OVSV society. He is only the third foreign recipient of an award normally given to Austrian amateurs for outstanding service to amateur radio.

PAT HAWKER, G3VA

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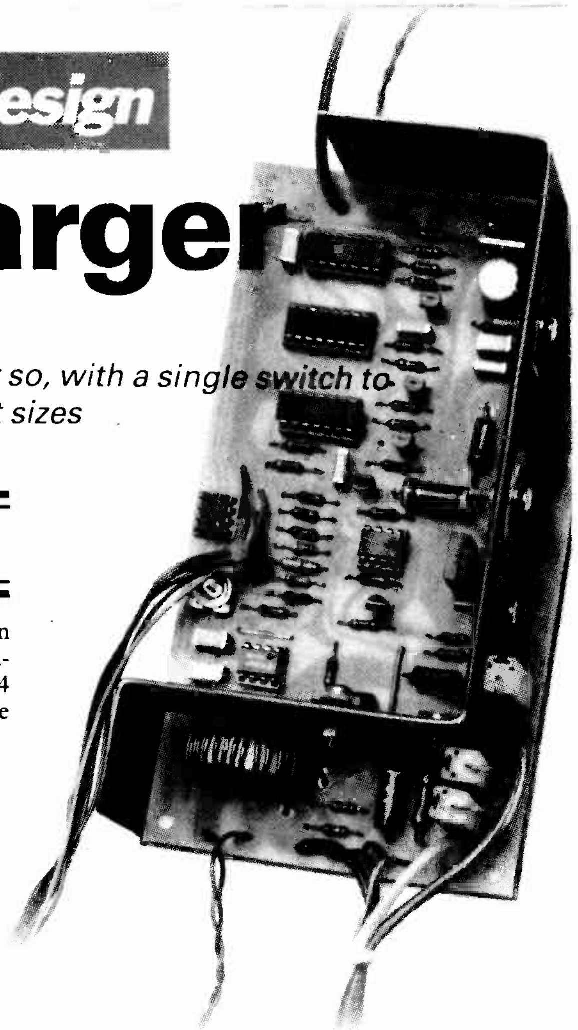
A Wireless World design

Fast NiCd charger

Capable of charging all common cell types in an hour or so, with a single switch to accommodate batteries of different sizes



by Richard Lambley*

Nickel-cadmium rechargeable cells, which until a few years ago were rarely seen except in equipment for the specialist or professional, are now widely used in consumer equipment and can even be bought in high-street multiple stores. Although many users find them an economical substitute for costly dry-cells, NiCd cells do have drawbacks – perhaps the most tiresome of which is the long time it can take to recharge them. Manufacturers generally recommend a period of 12 to 14 hours; and the usual rule is to divide the figure for the battery's rated capacity by ten to arrive at the charging rate. Thus a 500 milliampere-hour battery would be charged at 50mA. The extra two to four hours make up for loss in the charging and discharging processes.

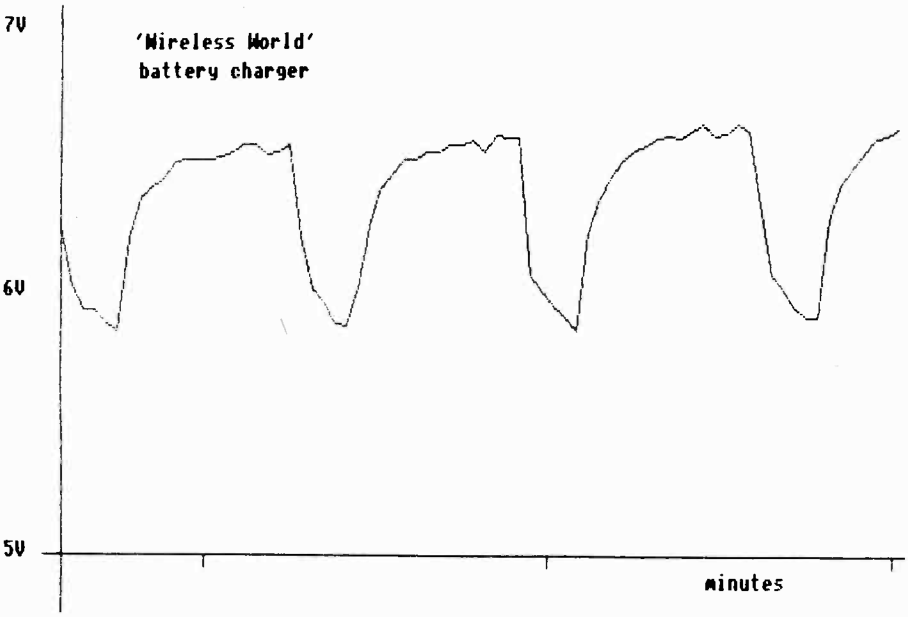


Fig. 1. Terminal voltage of a battery of four AA-size (500mA-hour) cells: a 30s period of charging at 650mA alternates with a 10s discharge at 50mA.

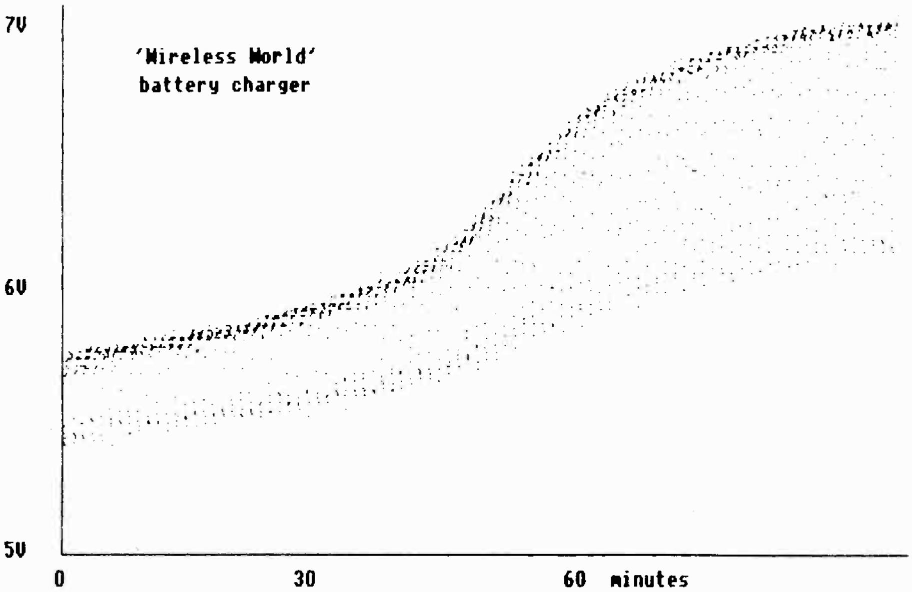


Fig. 2. As the charge-discharge cycle continues, the peak and trough voltages seen in Fig. 1 begin to diverge. Detecting this change makes it possible to shut off the current before the onset of overcharging. The points represent measurements taken at 2s intervals.

Slow recharging is advised mainly because leaving the cells in the charger too long is unlikely to do much harm to them. NiCd cells can safely be charged very much faster, but only if it is possible to guarantee that the current will be switched off as soon as charging is complete.

One way of doing this is to ensure that the cells are discharged completely and then to deliver a known current for a period corresponding to their capacity. The discharging process has to be carried out with care, however, since one cell in the battery will be the first to run out and its fellows will begin to drive current through it. The resulting polarity reversal may cause venting of gases and damage to the cell.

An alternative approach is to monitor the battery voltage during charging and to switch off when the voltage rises above a specified level. Unfortunately the cell voltage varies with temperature and so the end-point is hard to identify precisely. Furthermore, cells can become hot of their own accord if overcharged; and indeed this effect forms the basis of yet another fast charging method, by which charging continues until there is a rise in temperature. The problem here is to detect the temperature change soon enough.

*Projects editor

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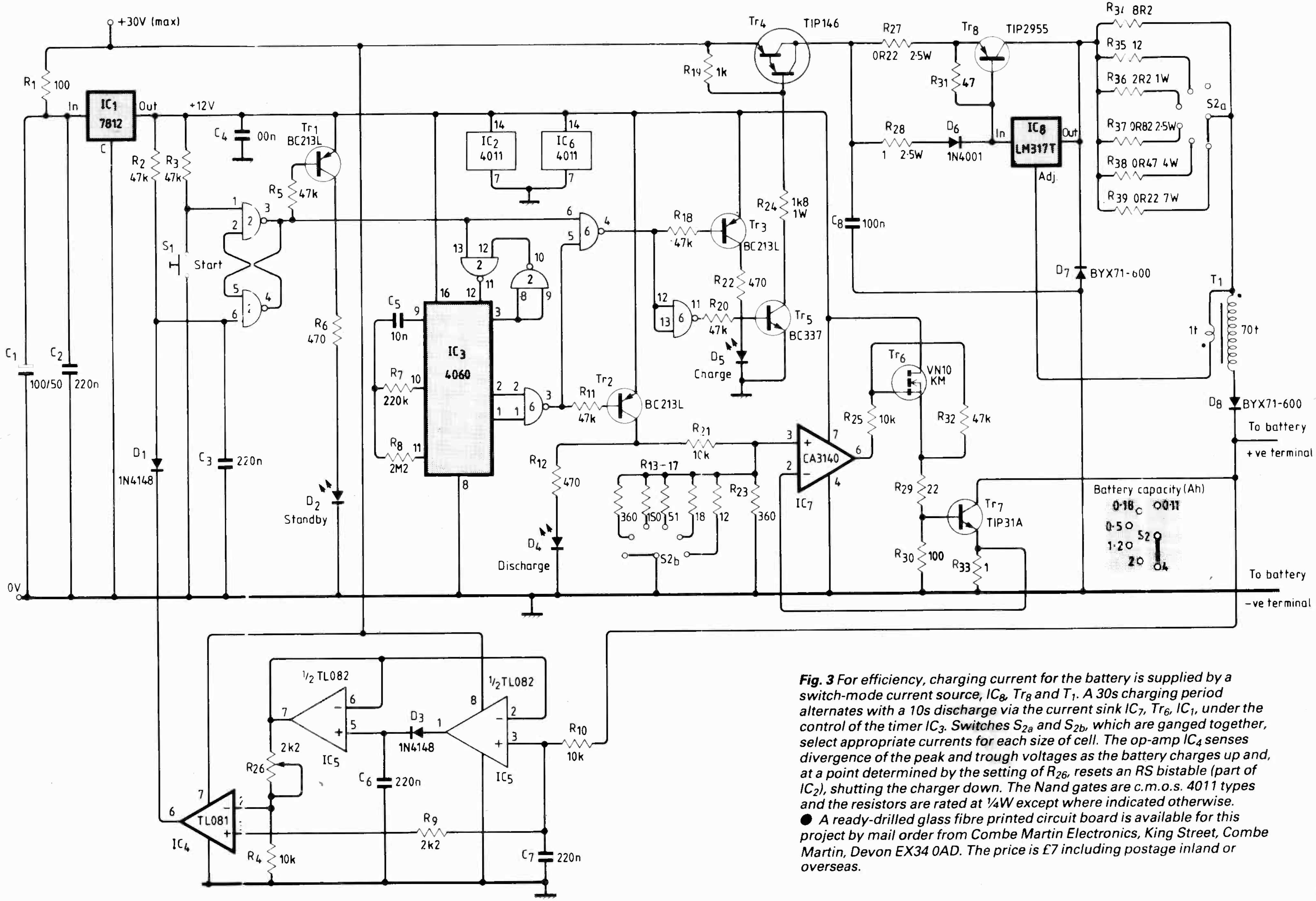

***Fig. 3** For efficiency, charging current for the battery is supplied by a switch-mode current source, IC_8, Tr_8 and T_1. A 30s charging period alternates with a 10s discharge via the current sink IC_7, Tr_6, IC_1, under the control of the timer IC_3. Switches S_{2a} and S_{2b}, which are ganged together, select appropriate currents for each size of cell. The op-amp IC_4 senses divergence of the peak and trough voltages as the battery charges up and, at a point determined by the setting of R_{26}, resets an RS bistable (part of IC_2), shutting the charger down. The Nand gates are c.m.o.s. 4011 types and the resistors are rated at ¼W except where indicated otherwise.*

● A ready-drilled glass fibre printed circuit board is available for this project by mail order from Combe Martin Electronics, King Street, Combe Martin, Devon EX34 0AD. The price is £7 including postage inland or overseas.

The charger to be described in this article relies on a voltage-sensing method, but a rather different one. If a moderately heavy charging current is applied to a NiCd cell for a short period, the terminal voltage will quickly rise to a level somewhat higher than the voltage marked on the cell. Discharging the cell a little will reduce the terminal voltage once more. A repeating cycle of rapid charge and light discharge will produce a succession of slowly rising 'peak' and 'trough' voltages, as shown in Fig. 1.

If the cycle is repeated for long enough (Fig. 2), there will come a stage at which the peak voltage is increasing much more steeply than the trough voltage. At this point the cell is losing the ability to accept further charge and the charger can be shut off. By measuring the trough voltage as a fraction of the peak voltage it is possible to make an end-point detector which works independently of the number of cells under charge, since the proportions will be constant whether there is just one cell or a dozen. If the charge and discharge currents are selected to correspond with the rated capacity of the battery, the same setting of the detector should be able to cope effectively with all cell sizes.

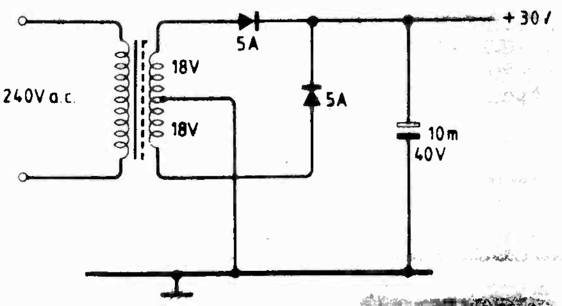

Fig. 4. Mains power supply for the charger. For batteries of 12V or less, reducing the supply rail to about 20V would lead to better efficiency.

Circuit description

The complete circuit of the charger is shown in Fig. 3. To keep heat dissipation within manageable limits, a switch-mode current source is used to supply the charging current. This part of the circuit is adapted from a design by Mike Davies (Circuit Ideas, *Wireless World*, February 1983). A series-pass transistor Tr_8 and current-sharing resistors R_{27}, R_{28} have been added to augment the current-handling capability of IC_8, but if the user has no high-capacity batteries to charge they may be omitted. The LM317T alone can provide up to about 1A. The current is selected by S_{2a}, and a power Darlington transistor Tr_4 is used to switch the current source on and off.

The current sink for discharging the battery is formed by IC_7, Tr_6 and Tr_7. S_{2b} selects the discharge current, which is given by the potential difference across R_{23} divided by the value of R_{33}.

When power is first applied, C_3 forces the R-S bistable formed by two of the gates in IC_2 to take up a state such that the current source and current sink are both turned off. Depressing the push-switch S_1 causes the bistable to change state, removing the 'reset' from pin 12 of IC_3 and allowing charging current to flow. IC_3 contains an oscillator and a 14-stage ripple counter. Its last two outputs, gated by a section of IC_6, yield a square-wave with a period of about 40s and a mark-space ratio of 1:3 (at IC_6 pin 3); and so for three-quarters of each cycle the charging source is activated, while for the remainder it is the current sink's turn.

The voltage peaks of the battery under charge are detected and stored by IC_5, D_3 and C_6. The output of this stage, stepped down a little by the potential divider R_{26} and R_4, is compared by IC_4 with the instantaneous battery voltage. If, during a trough, the voltage falls below the fraction of the previous peak defined by the potential divider, the output of IC_4 will go low, returning the bistable to its initial state once more. The 'standby' led D_2 will relight indicating that charging is complete.

No components have been provided for discharging C_6 when the standby mode is entered, since leakage across the board and through other components is likely to do the job quite adequately. However, if the p.c.b. is clean and the leakage very low the charger may at first refuse to restart. This point should be borne in mind during the setting-up procedure.

Construction notes

The printed circuit for the project accommodates all components except the switches, leds and the mains power supply. A length of 16 gauge aluminium bent into an L-shape should be fitted to the board as a heat-sink for Tr_4, Tr_7, Tr_8, IC_8 and D_8. It is worth extending one end of the strip off the edge of the board to fix to some metal part of the charger cabinet. To improve heat-sinking, the strip should be blackened. A useful heat-dispersant paint is obtainable in aerosol cans from motor-cycle dealers. The devices fitted to the heat-sink should be mounted with insulating washers and heat transfer compound. The component likely to run warmest is Tr_8. No heat-sink should be needed for the 12V regulator IC_1.

The switch S_{2a} in the 4A h position will have to carry about 5A, which is more than most wafer-switches are designed to take. RS Components can supply something suitable (catalogue number 327-585), though this is rather expensive. If the constructor has only a few different cell types to charge, a cheaper alternative would be a three-position toggle switch with a centre-off setting: this would allow for three sizes.

Since 0.22Ω resistors are sometimes difficult to obtain, provision has been made on the p.c.b. for R_{27} and R_{39} to be made up by paralleling 0.47Ω types.

The transformer for the current source is not a very critical component: any transformer capable of operating at a few tens of kilohertz will probably be suitable. In the prototypes, toroidal ferrite cores were used with Mike Davies's suggested turns ratio of 70:1. The ratio has to be fairly high since there might otherwise be a danger that the 'adj' terminal of the LM317T would go positive with respect to the output as the regulator switched.

The primary winding should be of 1mm (or thicker) enamelled copper wire, though the single-turn secondary can be much thinner. Some anonymous cores of about 30mm diameter from a mixed pack bought at a Tandy store seemed to work just as well as a more respectable Mullard FX3853. Many component dealers do not stock toroidal cores, but a wide range is obtainable from Ambit International. Uncoated cores should first be wound with tape to prevent abrasion of the enamelled wire.

A further wire passed through the core will pick up enough signal to allow the switching waveform to be examined on an oscilloscope – the squarer it is, the cooler Tr_8 will run. If the circuit fails to oscillate when loaded, try reversing the secondary winding.

The diode D_8 should be a fast recovery type: the BYX71-600 and BYX71-350, rated at 7A, would both be suitable. Note that the versions suffixed R have reverse polarity and will not fit the heat-sink. D_7 is simply to protect the regulator and can be a much less substantial device. In case of difficulty, the BYX71-600 may be obtainable from suppliers of television spares.

The remaining components should present no problems. Care should be taken, though, if it is necessary to find a substitute for the CA3140: the input terminals have to operate within a few millivolts of the negative supply rail and some fet op-amps may not operate satisfactorily in this region despite what their data sheets suggest. For the power mosfet, almost any n-channel device will do. The VN10KM (Siliconix) is a small, low-cost plastic-encapsulated device; alternatives would include the Ferranti ZVN1306A and ZVN1309A.

Connections for the main charging current pathway to the battery terminals and through S_{2a} should be of heavy-gauge wire since any resistance will mean that the setting of R_{26} may not hold good for all battery sizes. Wires should be kept short to reduce radiation of the switching waveform and it is desirable that the charger should be enclosed in a metal box to screen it.

Power supply

The unit requires a power supply capable of delivering 5A d.c. continuously at up to 30V. The mains unit for the prototypes incorporated a toroidal transformer with two 18V 3.3A secondary windings (ILP Transformers, type 42014). A suppression filter should be used at the mains input.

Setting up

The only adjustment to make is to set the

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shutdown point with R_{26}. Perhaps the quickest way is to apply the charger to a battery known to be more or less fully charged (by a trickle charger, for example) and during discharge periods to reduce R_{26} by degrees from its maximum resistance until the charger is reverting to the standby mode at the end of the discharge period. The wiper should then lie about half way along its travel.

Using the charger

Like other voltage-sensing charger circuits, this one relies on all the cells in the battery having the same state of charge. This means that cells of different types or cells taken from separate items of equipment must not be put together for charging. Some cells would inevitably reach the fully-charged state before the others and could become seriously overcharged before the unit shut down. The inclusion of faulty cells might also interfere with the action of the detector.

Values for the resistors around S_2 have been chosen for six of the most common types of NiCd cells to give a charging period of a little over an hour. If the constructor has no 4 ampere-hour cells (the largest size provided for), the values could be adjusted to give faster charging of the smaller sizes.

No problems with cell heating or other undesirable effects have been experienced with the component values shown, though care should be taken if faster charging rates are tried. Cells are liable to evolve gas at high charging rates, especially if the trough voltage is allowed to rise above 1.5V per cell. There is undoubtedly room for experiment with the length of the charge-discharge cycle: altering C_5 is perhaps the easiest way to adjust it.

The limit to the number of cells which can be charged at once is fixed by the input-output differential of the LM317T and by the power supply: to avoid damage to the 12V regulator i.c. the supply voltage should should not exceed about 30V off-load. Where there is no requirement for charging batteries of above 12V or so, the unit will run more efficiently with a somewhat lower supply rail.

If the supply voltage is relatively close to the battery's peak voltage, the differential across the LM317T will be low and it may refuse to switch; but it should operate satisfactorily in the linear mode so long as there is enough heat-sinking. Since the TIP2955 is thermally coupled to the LM317T, the i.c's thermal overload protection should ensure the safety of both devices.

LITERATURE RECEIVED

In addition to many many manufacturers exhibiting at Testmex '83 represented in our New Products section, there were also a large number of distributors and hire services which are of course useful sources of test and measurement equipment. Their catalogues can often provide useful references as to the equipment available. Some manufacturers, while not exhibiting new products, also provided literature on their equipment.

A wide range of Hitachi oscilloscopes, various digital and analogue multimeters, resistance test sets from AOIP, signal sources, power supplies and mains supply conditioners are all available from Danesbury Instruments, 22 Parkway, Welwyn Garden City, Herts AL8 6HG.
WW 401

Completely refurbished and guaranteed, second user test equipment from Electronic Brokers, can sometimes be better than new, as it is fully re-calibrated in their own service laboratory. They carry large stocks of instruments which are available from stock. Electronics Brokers Ltd, 61 King's Cross Road, London WC1X 9LN.
WW 402

A large number of new products are included in the latest edition of the Electroplan catalogue including computers from Hewlett-Packard, Tektronix 'scopes. Digital storage 'scopes from Gould. Also included are logic analysers, eprom programmers, computer interfaces, including the Microlink Signal Acquisition Interface and a wide range of meters and transducers. Electroplan Ltd, PO Box 19, Orchard Road, Royston, Herts SG8 5HH.
WW 403

Image processing systems are available from Elex Systems, who are the sole UK agents for International Imaging Systems. They also have a wide range of Kontron logic analysers. Brochures from Elex Systems Ltd, John Scott House, Market Street, Bracknell, Berks RG12 1JB.
WW 408

Known for their very large catalogue of components, Farnell also have an Instruments division and that division, with its own catalogue, stocks a wide range of oscilloscopes, signal sources, mobile radio test gear, analogue and digital test equipment some of which interfaces with the IEEE488 interface bus. Farnell Instruments Ltd, Sandbeck Way, Wetherby, W Yorks LS22 4DH.
WW 409

For some applications it may be necessary to use an instrument for a short while for setting up a testbed or an experiment and then it may not be needed again. This is where hire companies can be very useful. Three of them at Testmex had comprehensive catalogues. Rather like hiring a car, there are other advantages to this approach as the hire company should service and maintain the equipment. So it could be a long-term advantage as well. Instrument Rentals is an offshoot of the American Leasing International Inc, which claims to be the oldest leasing organization in the world. They offer for hire a wide range of general purpose instruments: logic analysers, network analysers, universal bridges, counters, generators, GPIB equipment, meters, microprocessor development aids and systems, Microwave amplifiers and other components, oscilloscopes, power sources, data recorders, telecommunications equipment and a number of computer peripherals. Instrument Rentals (UK) Ltd, Lab House, Horton Road, West Drayton, Middlesex.
WW 410

Livingston have of course also a long established name in equipment hire and have recently added to their list the IBM Personal Computer, the Intel Personal development system and a wide range of other instruments. Their catalogue now includes over 6000 items. Livingston Hire, Shirley House, Camden Road, London NW1 9NR.
WW 404

Another hire company, Microlease, specializing in computers and microprocessor systems also have a wide range of electronic instruments and offer a number of well-known names, such as Hewlett-Packard, Intel, Tektronix, Marconi Instruments and Racal in their catalogue. They tell us that new equipment is being added to their inventory at the rate of at least one item each day. Microlease plc, Forbes House, Whitefriars Estate, Tudor Road, Harrow, Middlesex HA3 5SS.
WW 405

A wideband multi-channel instrumentation tape recorder which features fully automatic calibration and equalization, is fully described in literature from Racal Recorders. They also had literature on a range of recorders and a time-code generator for use with the recorders that allows sections of a recording to be quickly identified and located. Racal Recorders Ltd, Hardley Industrial Estate, Hythe, Southampton, Hants SO4 6ZH.
WW 406

Optical fibres may be tested using the Siemens' L2225 optical time-domain reflectometer which has just been introduced to the UK. This was on display at Testmex along with the literature describing it, as was also two carrier-frequency test sets both of which measure level, attenuation and gain, especially in the frequency-division time multiplexed transmission systems. One of them, Type 2355, can also provide accurate determination of phase jitter. Siemens Ltd, Siemens House, Windmill Road, Sunbury-on-Thames, Middlesex TW16 7HS.
WW 407

Another well-filled catalogue comes from STC Instrument services, Edinburgh Way, Harlow, Essex CM20 2DF.
WW 411

Magnetic flux meters and Gauss meters along with microwave spectrum analysers and signal generators are featured in literature from Wessex Electronics who also deal in a wide range of test gear including calibrators for test and production applications. Wessex Electronics Ltd, 114 North Street, Downend, Bristol BS16 5SE.
WW 412

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NEWS

UK telecomms waves the flag at Geneva

Four years ago the proud centre-piece of the British joint stand at Telecom 79, the Geneva international telecommunications show, was the System X digital switching system. Four unhappy years later, after a notable lack of success in selling this system on world markets, the UK industry is putting on a brave face at Telecom 83 (Geneva, October 26 to November 1) still with System X hopefully included in the exhibit but drawing attention to a range of somewhat less ambitious projects using comparable electronic techniques.

For example there is a small stand-alone exchange, UXD5, for digital switching on up to 600 lines, which, like System X, is based on stored program control. Digital PABXs using similar principles include the modular OCS 300 from STC, for 50 to 300 extensions and operation with analogue or digital public networks; and the now well established Monarch (like System X made by GEC and Plessey) which gives the user many more facilities than conventional PABXs.

The 1983 joint display, in a 5000 m^2 British Pavilion at Geneva, is led by British Telecom and the five big companies in this field, GEC, Plessey, STC, Marconi and TMC. In addition, over 60 other UK firms are exhibiting under the aegis of the EEA, supported as a joint venture by the British Overseas Trade Board. This time the centre-piece is a co-ordinated display, occupying 2400 m^2, that shows British developments now available in the four areas of switching, rural communications (line and radio), transmission and advanced systems.

Digital microwave radio, for example, for line-of-sight paths in long- or short-haul routes, now operates in the 4, lower 6, 11, 13 and 19 GHz bands. A display of ISDN (Integrated Services Digital Network) technology reveals systems operating at 80kbit/s which provide a 64kbit/s channel for speech or high speed data together with a separate 8kbit/s data channel and a second 8kbit/s channel for signalling and control.

An alternative to going fully digital in the System X grand manner is to modestly clip-on, as it were, a clever box of digital electronics at your existing old-fashioned electromechanical exchange. Then only those subscribers who want to use the extra facilities of the digital system – and pay for them – need be connected through this unit, while other subscribers carry on as usual. An example of this approach is the Supplementary Services Exchange made by TMC. Using stored program control with a minicomputer for supervision, this equipment provides an impressive array of facilities including such things as call diversion, call waiting indication, incoming call queueing, three-party conferences, abbreviated dialling, call barring, alarm calls and automatic announcement of call charges. each subscriber using the system has his own particular set of the supplementary services he needs programmed into the add-on unit. BT will be using them in the UK.

With all this, GEC and Plessey are still very hopeful of getting export sales for System X, which Sir George Jefferson, Chairman of BT, recently described as "very good value for money" – even though BT can now buy from manufacturers outside of the UK. He said it was not to be compared with many of the competitive systems already sold, which, he claimed, were only "quasi-digital".

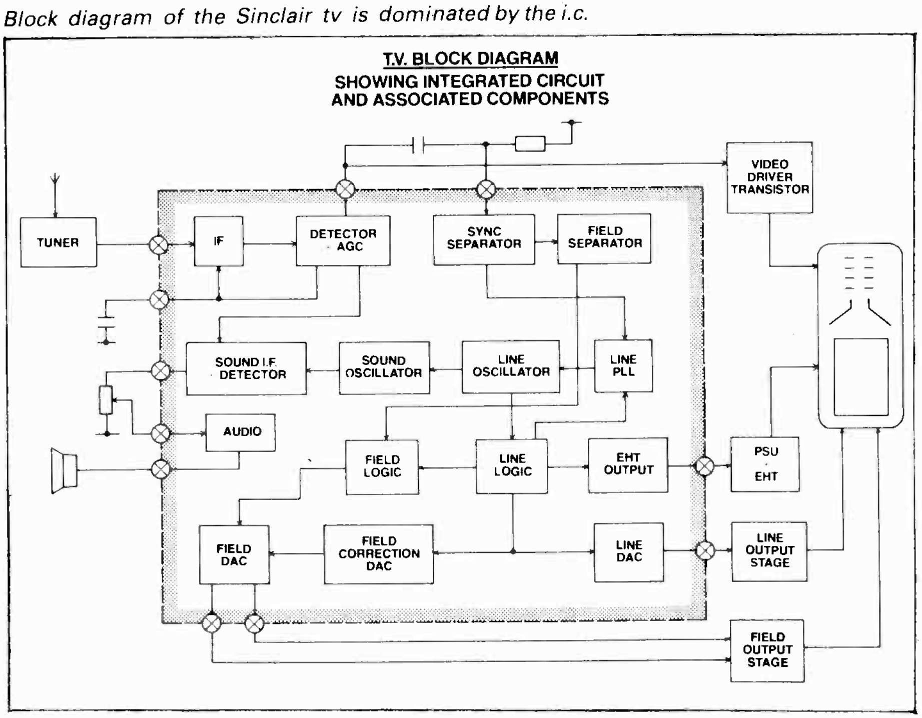
Sinclair's pocket tv

Over two years since the announcement of the 'flat' c.r.t., Sir Clive Sinclair has announced the completed tv set. What took the time was the development of the electronics that could be used to produce a very small set to be easily mass-produced. Sinclair and Ferranti designers worked together to produce a large-scale integrated circuit which contains virtually all the active components needed in the set. Sir Clive claims that this is the first one-chip tv anywhere in the world.

The i.c. caters for both 625 and 525 line systems and adjusts field and line timebases automatically. A v.c.o. is used to lock onto the line sync and another provides a local oscillator for the sound channel. As the c.r.t. has the electron gun to one side, a trapezoid picture is avoided by imposing a correction waveform on the field scan at line rate. The correction signal and field sweeps are generated digitally and converted to analogue signals on the i.c. The vision i.f. signal from the tuner uses an unusually high (230MHz) frequency, to avoid imaging problems in the u.h.f. band, which is amplified in fourstages with a.g.c. and fed to a low-level envelope detector. The recovered video is taken to a d.c. restorer for sync separation and then to an external amplifier to drive the c.r.t. The intercarrier sound signal, retrieved from the detector, is fed through a band-pass filter, converted to a 250kHz second i.f. passed through an a.c. coupled limiting amplifier and all coupling, decoupling and phase-shift networks are all on the same silicon chip.

Externally the set, only 140mm wide, looks like a small portable transistor radio with a telescopic aerial and a tiny (51mm diagonal) aperture on the front, improbably displaying a tv picture. The loudspeaker is small but adequate and there is

Block diagram of the Sinclair tv is dominated by the i.c.



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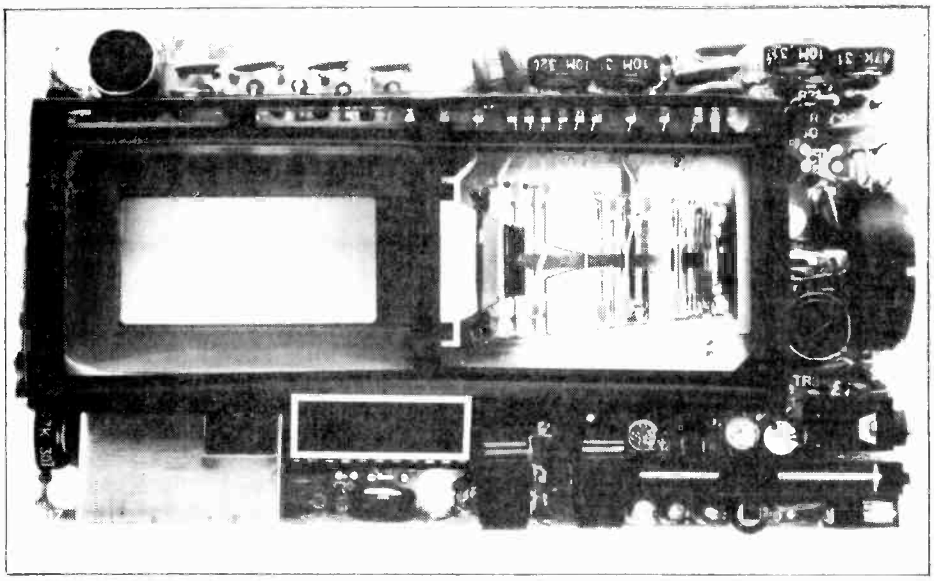

Inside the tv are the c.r.t. and i.c. (outlined).

also an earphone socket. Only two user controls are provided, an on//off switch combined with a volume control, and a continuously variable tuning control.

Another first for the set is the flat battery that powers it. Developed by Polaroid for use with their instant colour-picture camera, a lithium power source is included in the film pack. This has now been produced as a separate battery specifically for the Sinclair tv. It costs £9 for three of them, each with a viewing life of 15 hours. A mains adaptor is available for indoor use.

Initially the set will be available to mail order only at a cost of £79.95. Later, perhaps in six months' time, it will be sold through retail shops. Further developments include a set that will have radio reception. A colour set incorporating three of the c.r.ts in a projection system is likely to take another two years to develop. About a year is forecast for the use of the c.r.t. as a computer display, again using a projection scheme, possibly with a fold-down screen.

The UK set receives u.h.f. only but a v.h.f./u.h.f. is to be sold in the USA where there are a large number of v.h.f. transmitters.

Another microdrive

For mass storage in computer memories, cassette tape is slow and discs are expensive. A middle way has been found by using very fast tape storage which can operate, as far as the user is concerned, as if it were discs. The Sinclair Microdrive was one example and another has been developed in America by Entrepo Inc. The tape cassette in this case is claimed to be about the same shape and size as a credit card, to be known as the Microwafer. What is of interest in the UK is that BSR International, famed for autochanger turntables, has through its subsidiary, Astec, bought a 30% share in Entrepo and the manufacturing and marketing rights. They will be making the drive in the UK and in the Far East and by the time you read this it should already be in high-volume production. Entrepo has applied for a number of patents and copyrights covering various aspects of the mechanical tape transport, the microwafer medium, the read/write and motor control circuitry and the operating software. The system is claimed to be very fast and reliable. BSR has been going through a thin time with reported losses of £17.3M last year, so they are looking to the Microwafer to lift them out of the trough. They expect sales of the hardware as high as £50M and £70M by the end of next year.

Mercury gets green signal from British Rail

British Railways board have signed an agreement with Mercury Communications giving them access to the railway lines for the laying of their fibre optic communications network. Clear routes from one city centre to another are provided complete with ready-made ducts for power and telecommunications cables. The main network is to be a figure-of-eight loop centred on Birmingham with a southern loop incorporating London and Bristol and a northern loop taking Leeds, Manchester and Stoke-on-Trent. Smaller loops and microwave links will extend the system. Terminals with repeater stations at about 25 mile intervals are to be built along with a network control centre in Birmingham, which will monitor all operations and detect potential faults.

Mercury gets the wayleaves and BR gets a rental for wayleaves and sites and also for the maintenance of the cable and opto-electronic equipment. Both parties seem very happy with the deal.

Beeb's baby brother

While the general opinion is that the Acorn/BBC computer is a good thing, it is also expensive. Acorn themselves are, of course aware of this and for some time have been working on a cut-down version to be known as the Electron. Following the usual, almost obligatory, delays that seem to accompany all such projects, the computer has at last been launched and seems set to enjoy a good following. It has left out a lot of the facilities of the BBC Micro but for the average user many of them were not required. It has taken several leaves out of Sinclair's book and so has drastically reduced the number of integrated circuits inside and also has the single key work entry system beloved of ZX followers. By contrast however words can also be entered as words unlike the ZX Spectrum where, on occasions more key depressions are needed to access the word than the number needed to type that word. Other features are a keyboard with real keys, good colour and graphics, BBC Basic and many add-ons which will extend it and replace those facilities taken away from the BBC. Actually, it could never be upgraded sufficiently to equal the BBC and even if it were, it would cost more than the BBC. It is expected to retail at £199.

Video fiction

A new sort of computer game is to be launched. Still involving science fiction, the adventure games are to be tied in with stories. Readers of the stories will be able to enact the scenes from the stories on their home computers and determine the outcome by their own games-playing skill. The first production of a new publishing venture, Mosaic Publishing, is to be a book-and-game combination created by Harry Harrison, American Sci-fi author, best known to aficionados for his *Stainless Steel Rat* novels. Future plans include other sci-fi stories, and a selection of children's detective and educational non-fiction packages. They will have to work out for themselves whether the butler did it. In addition to these 'interactive fiction' packages, the company are also planning a series of home computer users' books.

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Electronic shopping must be fair

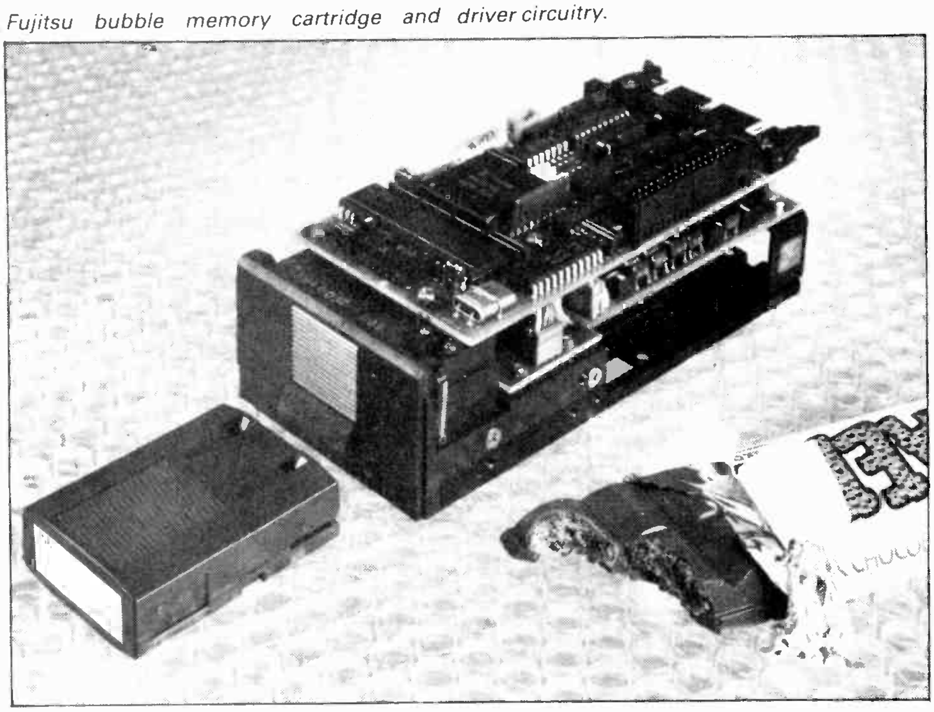
If the public are to be persuaded to accept electronics fund transfer systems, the computerized method of buying goods which are directly debited to the customer's bank account, then the system must be safe against error and fraud, says Clive Newton, Director of Consumer Affairs at the Office of Fair Trading. He was speaking at the European Conference on Automation in Retailing. Commenting that such systems can lead to greater efficiency in retailing and banking, he said; "For consumers this should mean greater convenience and the containment of price increases. However it is important that those planning and designing the introduction of these systems recognise that they take account not only of the need of the traders but also the interests and reasonable expectations of the consumers".

Mr Newton went on to discuss some possible problems: If bar-code readers are used at the checkout it may not be necessary for each individual item to have a price label. In this case there was a danger of the shelf being labelled with one price while the computer has been programmed with a different one, especially if there is a price change. Such bar-code readers were not always perfect and a proportion of items have to be re-scanned to give an accurate reading. If there are fewer checkouts because the system has been installed, this could lead to delays for shoppers. Electronic Fund Transfer systems (EFT) could invade the financial privacy of a customer and permit the building of personal profiles of an account holder's financial status and buying behaviour. The establishment of large data bases of this sort could be accessible to a number of institutions. Finally, such large EFT data bases could enable the sophisticated criminal to defraud large amounts of money by altering many accounts each by a small quantity. An unscrupulous trader or an employee could record the transactions passing between a point of sale and a bank computer and then repeat the recoding later. Many such crimes had occured in the United States.

Bubbles in cassettes

Another alternative to the disc memory for computers is the magnetic bubble which has gone through some bad patches during its development with many manufacturers falling by the wayside. However some have persisted and Fujitsu and 1M-bit memory cassettes which plug into a controller/driver which is about half the size of a slim 5¼in floppy disc drive. In fact two can fit in the space taken by such a drive and use the same power supply lines. The advantages of bubble memories, if you need reminding, are that they are non-volatile, easily eraseable, have no moving parts and are proof against hostile environments. Average access time is 12.5ms with a data transfer rate up to 12500 byte/s. Expansion unit may be added to give a memory expansion up to 512Kbytes.

Fujitsu bubble memory cartridge and driver circuitry.



Software piracy and copyright

An attempt has been made by the Computer Retailers' Association Ltd, to clear up any misconceptions there may be about the rights of the writers of computer programmes with respect to the law on copyright.

A. J. Harding, on behalf of the CRA, has written a lengthy statement of which we reproduce the chief arguments:

Computer software can be defined as 'code generated by an author on paper or entered into a computer memory'. In the UK it is not necessary for an author to make any formal registration of the work. The copyright arises automatically when an appropriate work is generated. It is, of course, wise to state the copyright of the work and there are a number of conventions, such as the letter 'c' with a circle round it though a simple 'Copyright 1983 J. Bloggs' is sufficient to be recognized worldwide. It is not necessary to publish the work in order to claim the copyright, although when published this affects the 'life' of the rights of the author.

There has been some confusion as to whether computer software actually qualifies under the Copyright Act of 1956. Although such software is not included specifically, works of a literary, artistic or artistic craftsmanship are included. In three recent litigations, settled out of court, such works were deemed by Judges to be within the provision of the Act.

Infringement of the Act can take place in a number of ways but the most relevant of these are: 1. Reproducing the work in any material form; 2. Publishing the work without authorization of the author; 3. Making an adaptation of the work. These are fairly straightforward and the third point could apply if, for example, a subroutine from one author's program were to be included in another program. The first restriction presents some problems. Is the work 'reproduced in material form' when it is entered into a computer's memory? In practice, it would seem to be difficult to use the program without reproducing it in a material form.

One common misconception is that the offender must copy a program for gain. However the Act makes ample provision and specifically states that infringement takes place even if the offender is no infringing for the purposes of trade. So theoretically someone who copies *Space Invaders* to give to a friend is as guilty as a company who specifically sets out to copy for profit. The penalties might be different but in most cases any judgement against a defendant will include costs which would bankrupt the defendant.

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The Personal Computer World Show

Such large general shows as the PCW Show give one a good opportunity to catch up with hardware and software that may have been missed. Most of the major manufacturers of home and personal computers exhibit and there are some interesting stands in amongst the myriads of schoolboys (and a few girls) playing the latest video games.

ACT Holdings were showing off their latest 'executive' business computer, the Apricot. Portable (10kg), it offers 16-bit processing using the Intel 8086 processor running at 5MHz, includes 3½'' floppy discs, has a green phosphor screen (229mm diagonal), and offers an optional modem with autodialling facilities, in addition to the standard RS232 port and a parallel Centronics port. The computer may be unplugged from its v.d.u. and use a two-line display which is also used to give the date and time and to display the chosen functions of the six programmable keys. A calculator, electronic mail through the modem and a socket for a 'mouse' controller to give 'desktop' facilities. There is also a choice of six computer languages and the 256K memory is expandable to 768K-bytes. The computer is to be assembled in a new factory at Glenrothes, Fife.

Firmly in the home computer field is the Elan Enterprise, with 64K or 128K user ram, the prototype Enterprise gave an impressive display of its 84-column, 56-line text capability which can be used as a 'window' on a large document. Graphics offer 256 different colours on a 672 × 512 pixel display. The keyboard uses 'real' keys and offers eight special function keys. It also has a built-in joystick which is not only usable for games but can be used for cursor control in serious applications. Four voice sound is available with eight octaves and *stereo* output. Cassette handling offers the ability to connect two cassette players each with remote motor control and a built-in indicator to tell if the recorder is set to the right level for data transfer. Various outlets permit the connection of other Elan computers through the built-in interface. There is an RS432, a Centronics and a dual remote control interface. The Elan uses a Zilog Z80A running at 4MHz. The ram and the internal 32K rom are both expandable up to 3.9M-bytes each, and there is provision for plug-in roms in cartridge format. All-in-all a very impressive specification, and as the computer has been designed by a software house there should be an ample supply of software available for it. The Elan is not to be launched on to the market until next April and the projected price for the 64K model is £200.

Elan Enterprise, star of the PCW Show, but not to be released until April, 1984.

The portability of programmes between various computers has always presented a headache. For £255, Iansyst are offering Ianstal which can translate the machine-dependent functions, such as cursor position, clear screen, inverse video etc, between some 72 different micros in a growing list.

Over on the professional part of the exhibition, Io Research were showing Pluto, a colour graphics system which is modular and allows the addition of further colours and resolution as the need increases. Up to 256 of Pluto's 16 million colours can be used at the same time.

Memotech established a reputation for producing add-on memory and other extensions for the Sinclair ZX81. Now they have branched out on their own to produce the MTX500 and 512 computers. Based on the Z80A running at 4MHz, they include many firmware features, such as a real-time clock and a 24K rom which has their own version of Basic, incorporating Logo-type graphics controls and Noddy, an interative screen selection program that may be menu driven. A Z80 assembler/disassembler is also included with register memory and program display and manipulation. Externally the computer is very solid. It is based on a mild steel chassis which supports the 79 keys. These include a separate numeric keypad which also may be used to control the cursor and editing function. Eight programmable function keys may be used with the shift key to give 16 functions. Expansion has been made an important part of the system so that the internal memory (32K or 64K for the two models) may be expanded up to 256K. Plug in rom cartridges are available for alternative languages, Pascal and Forth. The 40-column, 24-line display may be expanded to 80 columns if a disc drive is added. An add-on communications board allows the addition of two RS232 ports, and a network bus. The graphics display has its own 16K ram and offers up to 256 × 192 pixels in 16 colours. Memory may be further expanded by floppy or hard disc drives and also by solid state 'silicon discs' which offer up to 14Mbytes of storage at an even faster read/write cycle than hard discs.

Sinclair Research have introduced a second interface board for the ZX Spectrum which includes the facility to use two joysticks and plug-in rom cartridges for instant arcade games and other facilities.

For the do-it-yourself enthusiast, Stirling Microsystems were demonstrating Dennis, a kit-built 6809-based computer which has a number of facilities selectable by the addition of various function boards but may be expanded up to a full disc-drive system, running Flex, a standard 6809 disc operating system which has a great deal of business and technical software already available.

Marine plotter

A new marine Automatic Radar Plotting Aid (ARPA) has completed successful sea trials and is available in time to meet the new ship safety regulations due to come into force in September 1984.

Designed and developed by Marconi International Marine's research and development team, ARPA has met the design brief to be simple to operate by significantly reducing the number of controls and readouts when compared with other current equipment. This has been achieved by the use of a dynamic visual display unit and a control system with programmed keys. Basic radar controls are retained in their conventional form. The two push buttons, a joystick and eight keys are used to control all the ARPA primary functions and this compares favourably with some units which may have up to 100 controls for the same functions.

Using automatic and/or manual acquisition, the ARPA can track 25 different targets at a distance of 24 nautical miles. All functions required by International Marine Organization regulations are provided along with some extras such as true motion, ground stabilization from a reference target and a video map facility. The display can be integrated with Marconi's Radiolocator radar in a system which provides instant switching between 3cm and 10cm radars. Used with other dual systems it may select information from either radar, ensuring that the navigation officer can select the most appropriate system for the prevailing conditions.

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Versatile toneburst gate

A wide range of duty cycle, integral cycle counting and single-shot working in a practical instrument for audio and acoustic testing.

by D. S. Taylor-Lewis

Five years ago when KEF wrote back to me to say I had burnt out my tweeter and suggested that my power limiting circuits be rated to fall within the burst handling capability of their units, I decided to pull the toneburst gate ideas out of the file and build a cheap, good piece of test equipment. The peak output capability of an amplifier can be observed using a low duty-cycle toneburst. This peak value is usually much higher than the r.m.s. output figure, which depends on the load regulation of the transformer/rectifier/reservoir capacitor combining to form the usual unregulated d.c. supply. When one gets into active loudspeaker circuitry with h.f. drive amplifiers giving a peak-to-r.m.s. ratio of the order of 10:1, this instrument becomes quite essential.

Another use would be in testing for room resonances. A short toneburst can be made to excite a standing wave and the rate of decay observed on an oscilloscope during the tone gap. I have not yet tried this, but I expect that low-frequency resonances can be triggered by gating a high frequency; for example 100 Hz by gating 10 kHz with a mark: space ratio of 1:1.

Gating high-frequency sinewaves can produce some weird synthesizer effects for musical freaks – I recommend anyone to try it. However, I suspect that unless the potential constructor is interested in designing and testing ever more powerful loudspeaker and amplifier combinations, or engaged in extensive pulse-counting logic, this circuit will prove no more useful than an educational exercise.

Theory of operation

Referring to Fig. 1, the input signal is simultaneously fed into a 3302 comparator and two 4016 signal gates. The rectangular output waveform from the comparator is used to clock two 4017 counters, which advance by one count on every rising edge the upwards zero crossing points of the input waveform. With either counter enabled and free-running input waveform, a logic "1" will ripple through the outputs with each output remaining high for one input cycle in ten as is illustrated in Fig. 2. A logic "1" applied to the reset pin will inhibit further counting and return the counter to its output zero state.

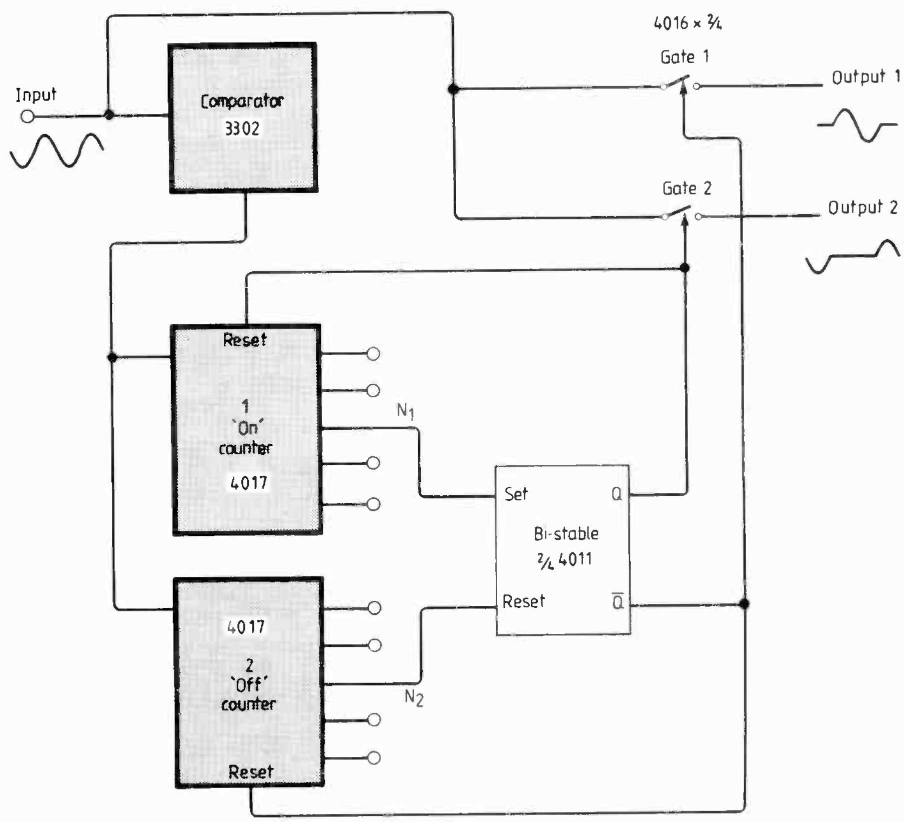
In the circuit of Fig. 1, also assume that output N2 of counter 2 has just gone high. This sets the Q output of the bistable low ($\overline{Q}$ high). Gate 1 now starts to conduct. At the same time, counter 2 is disabled with its count reset to zero. Counter 1 is enabled and starts to count the input cycles.

After N1 cycles, the output N1 of counter 1 goes high. The bistable is reset to its other state (Q high and $\overline{Q}$ low). Gate 1 ceases to conduct, while gate 2 now starts to conduct. Counter 1 is disabled and reset to zero and counter 2 commences to count. The process repeats itself after N2 cycles when output N2 once again goes high.

The result is a toneburst from gate 1 with 'on' cycles and 'off' cycles respectively equal to N1 and N2. Gate 2 provides the alternative tone-gap. If the counter outputs on each side are fed into a multiway switch, N1 and N2 both become variable. A further improvement can be made by cascading counters in the manner shown in Fig. 3. Here, each cascaded counter increases the count capability by a factor of 10. An extra multiway switch is required for each addition. The and gate ensures that the bistable will only trigger when the selected outputs of both A and B are high, i.e. when NA + 10NB input cycles have passed. In theory, counts of any magnitude are possible with enough counters per side.

Delays. In the real world, the circuit of Fig. 1 will prove unsatisfactory because of the switching delays associated with all its elements. This is particularly bad in the counter i.cs, where the delay becomes worse for larger values of N. The effect on typical toneburst waveforms is shown in Fig. 4: where counters are cascaded in the manner of Fig. 3, the situation can be worse still. With a high value of NA, counter B has time to adopt its new output state before the selected output of A again goes high. This only the delay of counter A is noticeable. However, when NA is set to zero, counter B is given no time to settle before the selected output of A goes high. For this case only, the delays of A and B are additive. It is possible, with NB set to a high value, for A to pass through its zero counter before the selected output of B starts to rise. This may mean that a spur-

Fig. 1. Simple toneburst gate.



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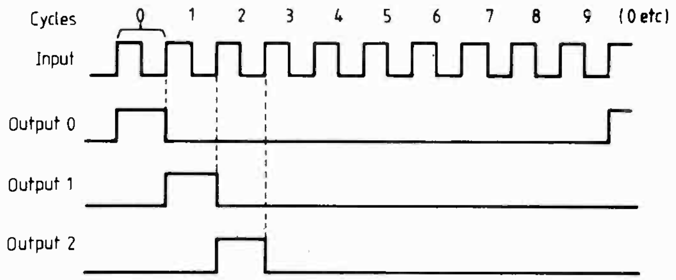

***Fig. 2.** Timing diagram for 4017 counters in Fig. 1.*

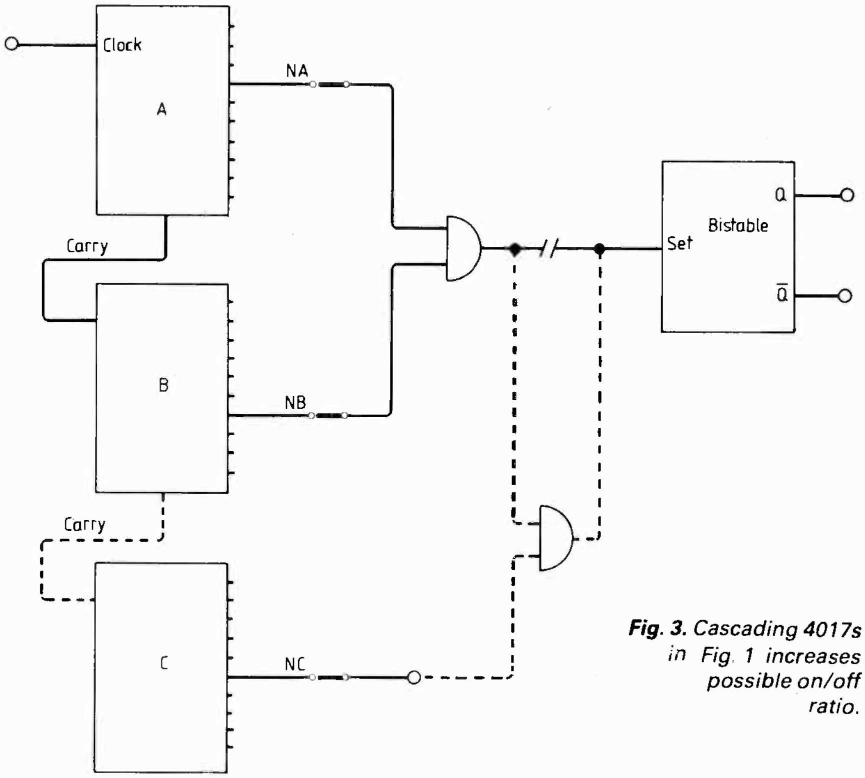

***Fig. 3.** Cascading 4017s in Fig. 1 increases possible on/off ratio.*

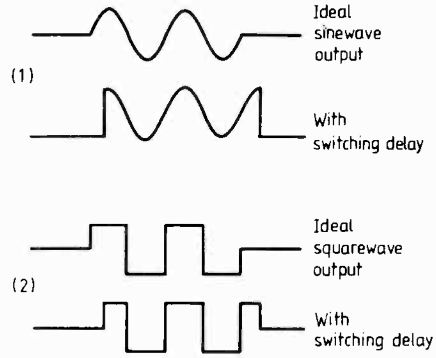

***Fig. 4.** Effect of switching propagation delays on outputs in circuit of Fig. 1.*

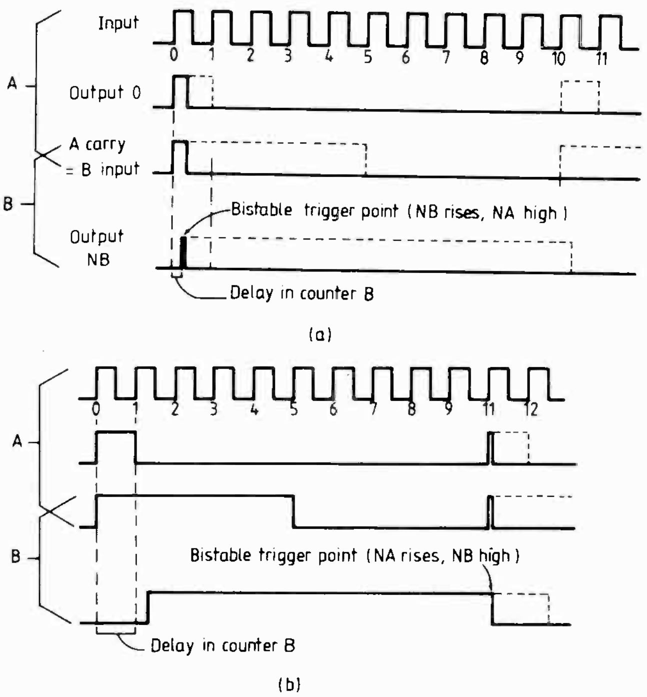

***Fig. 5.** Timing diagrams showing effect of delays on outputs In (a) NA waits for NB, NB rises, bistable triggers and resets all outputs. At (b) NB fails to rise during NA high. NB waits until NA again goes high and once more resets all outputs.*

ious 10 cycles will be added while A counts round again.

Settling time. The effect of propagation delay in the counters on output waveform purity can be eliminated if they can be allowed to settle some time before the signal gates are switched, by using the rising edge of the input to operate the counters and the falling edge, in conjunction with the And logic, to trigger the bistable. The circuit of Fig. 6 does this as the following description will show.

The input signal is inverted by the input buffer $IC_{1(a)}$, and is then fed to the comparator and the (4016) signal gates. The 4016 package holds 4 gates: the first two are used for signal gating as before, and the remaining two to short the respective outputs to ground while the series gates are in their 'off' states. This eliminates any signal breakthrough. The toneburst and tonegap signals are again inverted by the output buffers $IC_{1(b)}$, and $IC_{1(c)}$, before being made available to the outside world. The spare op-amp. in the quad package ($IC_{1(d)}$), is used to recombine the outputs to give an amplitude – modulated output, which is inverted with respect to the input.

The gain of the input buffer can be altered between ± 20 dB (± 10 times) by VR_1, which acts in conjunction with resistors R_1 and R_2. Capacitor C_2 prevents h.f. instability. The output amplitudes are adjustable between $-\infty$ dB (zero) and that set on the input buffer, using VR_2 and VR_3. The remaining buffers are configured for 0dB (unity) gain by resistor combinations $R_4 + R_6$, $R_5 + R_7$ and R_8 (or R_9) + R_{12}. Resistors R_{10}, R_{11} and R_{13} provide protection against capacitive loading and output short-circuits. Similarly R_3 prevents C_3 or C_4 from unduly loading the input buffer. These capacitors remove zero-crossing glitches caused by residual logic-switching delays.

A 3302, open-collector comparator ($IC_{13(a)}$) squares the input waveform. This process is given a slight amount of hysteresis by positive feedback through R_{16}. Resistor R_{14} prevents this from being fed back to $IC_{1(a)}$output. The components VR_4, R_{18} and R_1 allow accurate input offset nulling.

The rising edges of the clock correspond to the negative zero crossings of the input waveform, and are fed to the first counter in each chain. One output from each counter (IC_3 to IC_6 or IC_7 to IC_{10}) is selectable by a 10-way* switch (SW_1 to SW_4 or SW_5 to SW_8). In this circuit, four counters are used in each chain to give counts ranging between 1 and 9999. The common terminals from the switches are Nanded together by $IC_{11(a), 11(b)}$ and when all of the selected outputs become simultaneously high, the output goes low. This output is Nored with the original clock waveform in $IC_{12(a), (b)}$. The output of IC_{11} will become low sometime during the high part of a clock cycle, when the last counter output in a chain changes state (all being selected) to trigger the Nand. Until that time, the Nand gate output has been holding one

* Depending on which type of switches are used, outputs 1 to 9 only on the first counter in each chain need be selectable. A separate toggle switch – SW_9 provides the continuous on/off selection).

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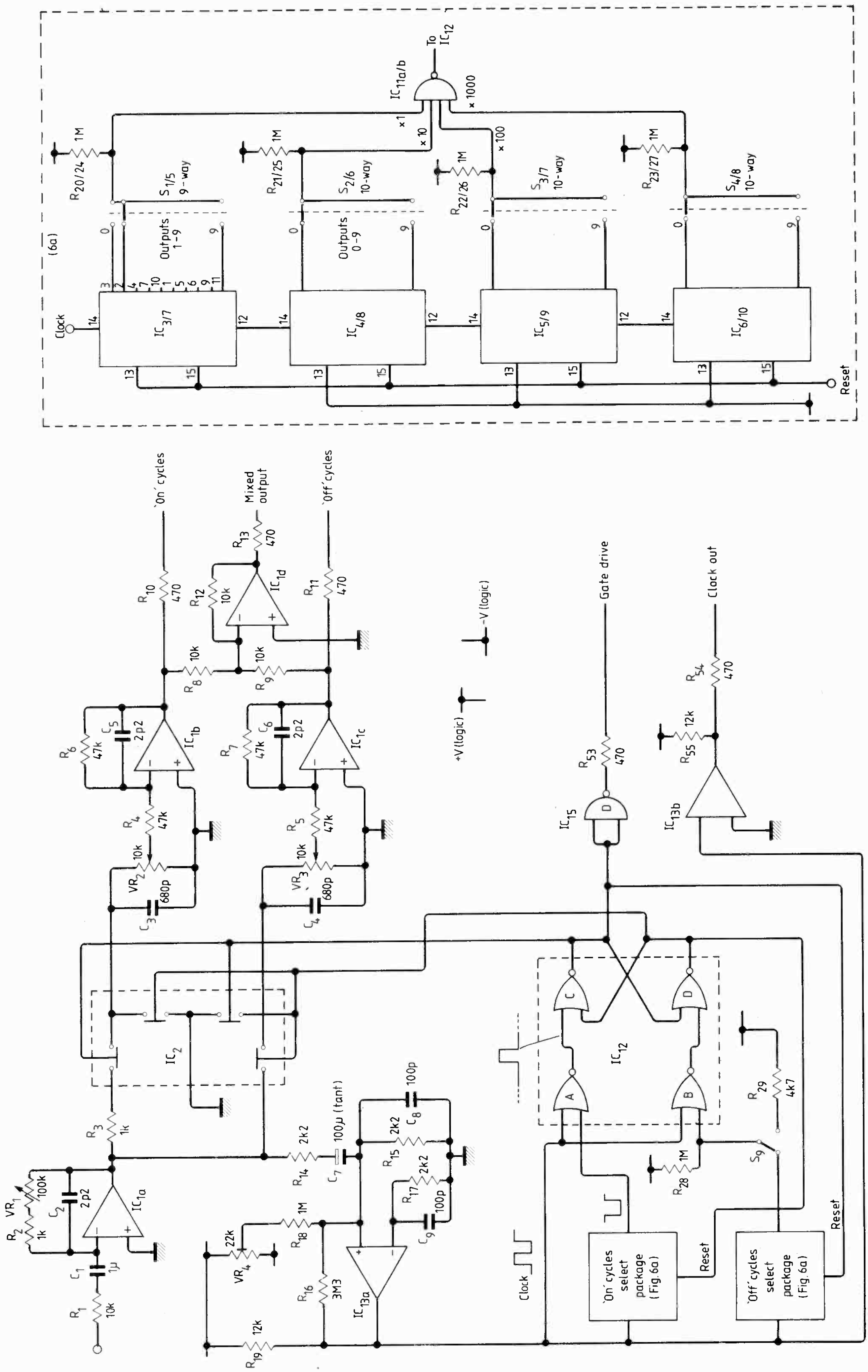

Fig. 6. Main circuit diagram.

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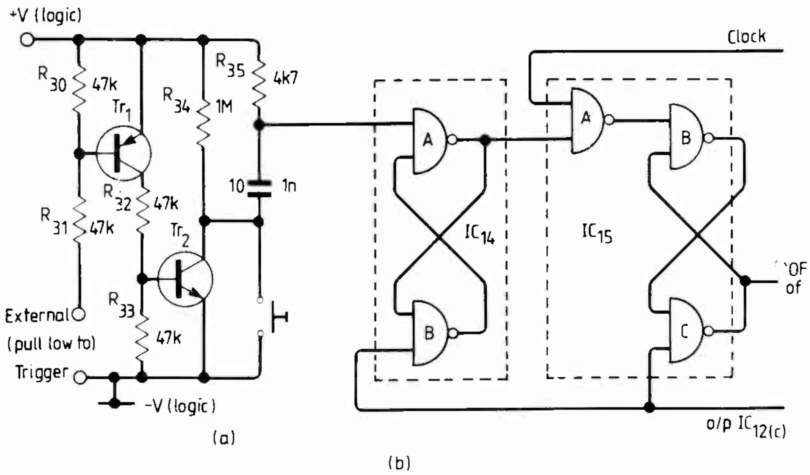
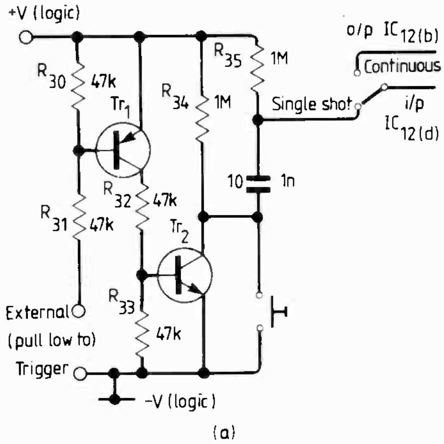




input of the Nor gate high and therefore its output low.

The output of the Nor gate goes high when the clock waveform goes low, and provides the trigger pulse for the bistable formed by the remaining two Nor gates ($IC_{12(c)}$, $_{(d)}$. Note that this trigger pulse starts at the positive zero-crossing of the original input waveform and occurs only on the coincidence of all counter outputs being high and the clock waveform being low. The counter outputs are effectively being allowed to settle during the negative part of the input preceding the switching point. The bistable outputs change state and reset the counter that produced the trigger waveform. The counter being reset terminates the trigger pulse.

Switch SW_9 is included in the signal path of the 'off-cycles select' section to provide the option of selecting a continuous tone, by holding the reset input of the bistable permanently high via R_{29}. The two outputs from the bistable become the control voltages for the 4016 signal gates.

Propagation delays in the 4017 counters no longer affect the circuit operation except where the input frequency or a short negative duration of the input waveform do not allow sufficient time for them to settle. Ideally, the signal gates should be switched at the exact zero-crossing point of the negative-going output from $IC_{1(a)}$. In practice, this occurs approximately 500 ns later, this figure being invariant.

The resistors R_{20} to R_{27} are necessary to prevent count rollaround, which would occur if for any reason an end-of-count coincidence is missed through any output 'high' from IC_3 to IC_{10} not connecting through to the corresponding Nand input. The side on which the count is taking place will cycle through 9999, back to zero and on once again to coincidence. If the input signal frequency is (say) 1kHz, this will mean a ten-second latch-up before tone-bursting resumes.

The switches SW_1 to SW_8 are the break-before-make type, to avoid shorting the decade counter outputs together while changing count (series resistors will prevent this from causing damage, but 78 take a lot of space!). The slowness of manual switching makes a missed trigger pulse a distinct possibility while changing count. The pullup resistors render the opposite default; that premature triggering may occur.

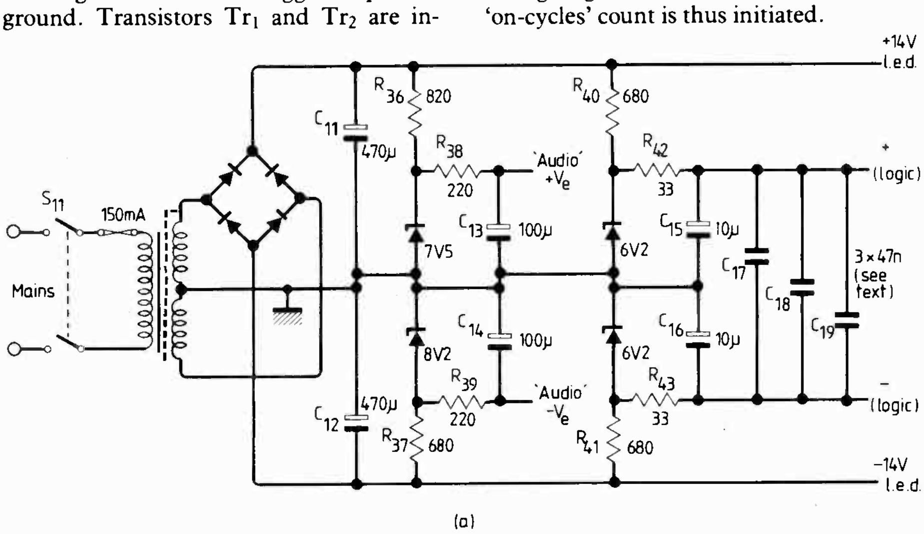
Fig. 7. Trigger circuits. Simple one-shot trigger is at (a), while (b) shows zero-crossing one-shot trigger.

Single-shot operation

A very simple single-shot facility can be achieved using the circuit of Fig. 7(a), which has one disadvantage in that the trigger pulse will not necessarily coincide with the zero-crossing point of the input waveform.

To ensure that the single-shot trigger always occurs at the start of a complete cycle, the circuit of Fig. 7(b) can be used. The trigger is operated manually using the pushbutton (PB_1), or electrically by shorting the external trigger input to ground. Transistors Tr_1 and Tr_2 are included to speed-up a slow-acting device. This particular configuration was chosen to allow the connection of one or more remote trigger switches (push-to-make) or open-collector devices.

The trigger action produces a negative-going transient at the input of $IC_{14(a)}$ (¼ 4011). $IC_{14(a)}$ and $IC_{14(b)}$ form a bistable which triggers on the negative input pulse. The output of $IC_{14(a)}$ which is normally low, now goes high, allowing $IC_{15(a)}$ to trigger the second bistable, which is formed by $IC_{15(b)}$ and $IC_{15(c)}$ when next the clock goes high. If the clock already is high, this happens immediately. Finally the output of $IC_{15(c)}$, now low, resets the bistable in the main circuit on the next falling edge of the clock waveform. The 'on-cycles' count is thus initiated.



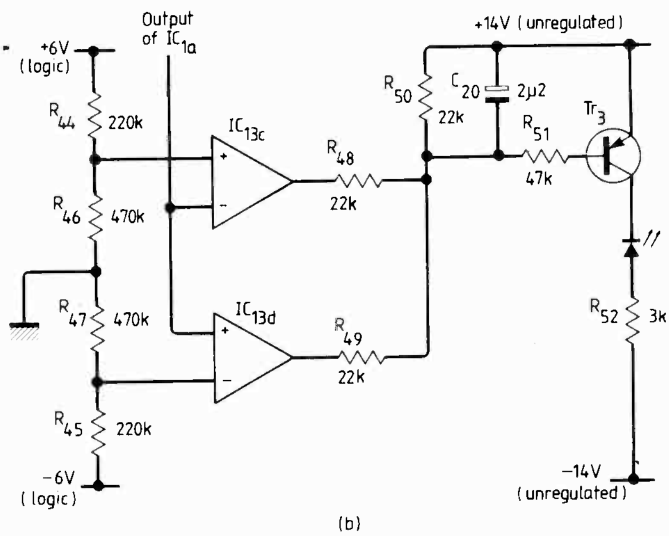


Fig. 8. Power supply (a) and overload indicator (b).

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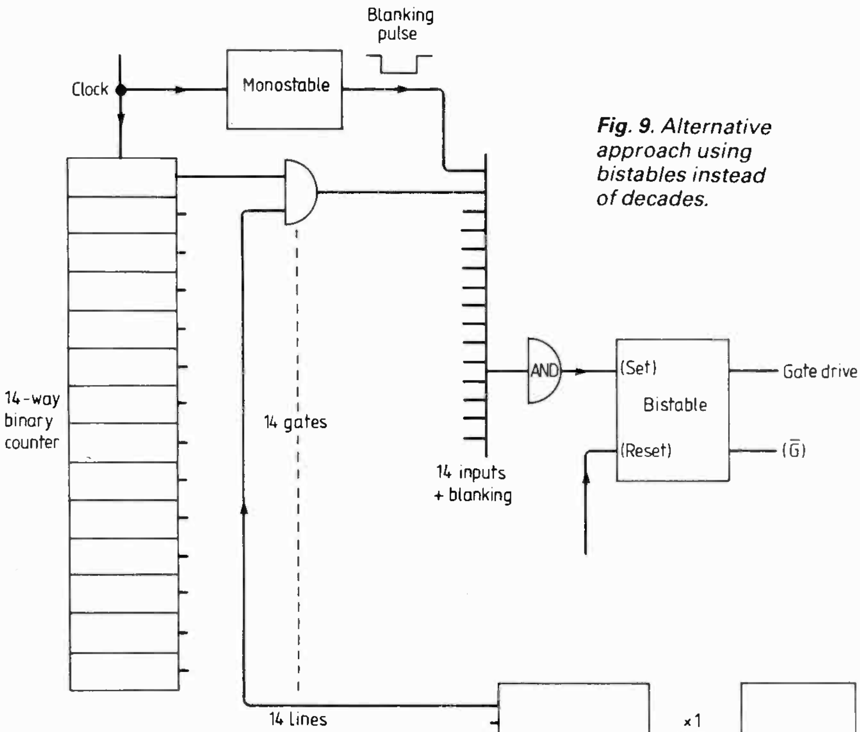


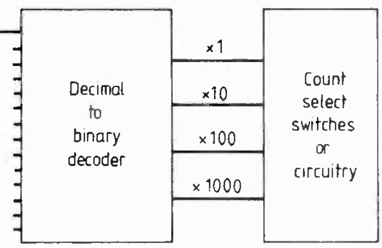


Fig. 9. Alternative approach using bistables instead of decades.

On completion of the tone burst, the bistables in the trigger circuit are both returned once more to their original state. Any attempt to trigger a single-shot tone-burst before the current one is complete will be ignored.

Peripheral circuitry

Figure 8(a) shows the power supply. Two split rails are generated. The first is for the "audio" circuits, encompassing IC_1 and IC_{13} alone: the slight imbalance here is to achieve symmetrical clipping of the op-amp outputs. The voltages are also higher than the logic supply to allow more filtering and to allow for the fact that the output swing of the op-amps falls far short of the supply lines.

Overload indicator. In Fig. 8(b) when the signal swing exceeds the threshold set by R_{44} and R_{46} or R_{45} and R_{47}, the output of the corresponding comparator pulls low, driving Tr_3 into conduction. A single indicator led forms the collector load with a series resistor to limit the 'on' current.

Only one prototype of the circuit has been built at the time of writing. This was constructed on Veroboard in a rather unorthodox manner, by placing the c.m.o.s. counter chips piggy-back onto their related selector switches. Two earlier models plus a test bench version using rotary switches led me to realise that the best way to build a compact and serviceable unit was to eliminate the section of densest wiring to and from these switches.

Reappraisal

The design is perhaps the most compact that it can be using readily-available components. There are of course improvements that can be made at added cost: this section offers some suggestions to the demanding constructor.

The propagation delays of the comparator and decade counters pose a severe limit to the highest frequency which the circuit can handle. Faster comparators are available and only a single high-speed unit is required to replace IC_{13a}: the remaining three comparators can be done away with by using transistors or c.m.o.s. gates. The decade counters have no high-speed equivalent, but a t.t.l. version of this circuit would be to use the 4090 b.c.d. counter instead, coupled to a b.c.d.-to-decade converter. An original version of the circuit was based on this principle and does, in fact, give an improvement in speed at the cost of increased component count (such as level shifting transistors) plus an extra 5V/300 mA power rail.

An alternative to replacing the c.m.o.s. 4017s with t.t.l. is to use the entire clock cycle before the zero crossing point to settle the counters. This will give a small improvement again at the cost of complexity.

The more sensible approach to speed will be to scrap the use of decade counters altogether and go binary. The counter section will now comprise a cascade of fast bistables, the output of each feeding into an And gate: the terminal or coincidence count will be fed into the second input of each And gate, the outputs all being Anded together and with an added blanking pulse. The duration of this pulse will be set equal to the total propagation delay through the counter chain (refer to Fig. 9). Assuming a maximum counter of 10,000 is again desired which approximates to 2^{14} (or 16,384), then where for example each bistable has a 25ns propgation delay, the total propagation delay of 14 × 25ns (=350ns) becomes the length of the blanking pulse. Now if one adds the delays of a fast comparator, three more gates (2 levels of And as shown in Fig. 9 plus bistable) and an analogue switch, one will arrive at a final figure of around 500ns. It only remains to select the coincidence count which can be decoded from decimal switches into the binary equivalent – unless the constructor prefers to think in binary, octal or hex.

Taking care not to labour the point that any working electronic circuit is out of date, I shall briefly mention a third possible approach equally exotic as a binary approach as outlined above coupled to hardware or m.p.u.-driven ram decoding on the selector switches. This third approach is to delay the input waveform by a constant amount between the input buffer (where it generates the logic clock signal) and the 4066 analogue gates. Next, the switching delay in the logic can be designed to be constant – the reader can work out for himself how to ensure this. Make these two delay paths equal and this elegant and most expensive solution promises the ultimate goal of no upper frequency limit(!).

Circuit performance

Maximum output 3V r.m.s. (± 4.5Vpeak)
Frequency response –3dB at 20Hz and 150 kHz (unity gain)
Tonegap signal breakthrough 72dB
Distortion below –80dB (1kHz)
Slew rate 2V/μs
Gate switch-on delay 2 μs (1:1 cycle out)
Noise below –80dB
Maximum input frequency for reliable counts 120 kHz (9999: n cycle out, square in)

The author

David Taylor-Lewis started electronics as a hobby during his first year in college, constructing audio circuits and associated test equipment. After graduating with a B.Sc. in chemical engineering and an M.Sc. in industrial safety, he worked for three years as an audio and test engineer with Soundcraft Electronics in London on studio mixing consoles and then for a further year with their newly-formed studio Magnetics division on logic-driven studio multitrack tape machines. Since 1980, he has been with the Digital Technology Centre of the Lummus Company. Lummus are chemical engineering contractors, and the Digital Technology Centre specialises in applying digital computers to process control and simulation.

Assembly language programming

Any computer, no matter how powerful, is of little use without some means of communicating with the outside world. In this seventh tutorial, Bob Coates discusses input/output and illustrates it by turning the Picotutor into a simple musical instrument.

Generally speaking the computer's means of communicating with the outside world – its input/output – is implemented by connecting one or more special-purpose i.cs to the microprocessor buses. These i.cs come in various forms.

– serial-interface devices for transferring one bit at a time to and from printers, v.d.us, etc.

– c.r.t.-control i.cs for converting data for displaying on a screen

– analogue-conversion circuits for changing logic levels into analogue signals and vice versa

– devices for feeding levels in and out of the computer system usually called peripheral i/o or peripheral-interface adaptors.

Two devices in the last category are the Zilog Z80 P10 and Motorola MC6821. Both have connections to allow them to 'talk' to the microprocessor through their buses and 20 t.t.l.-level lines, most of which can be set as either input or output.

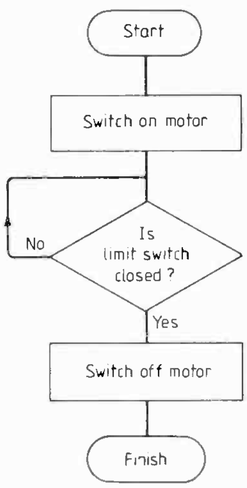
Digital i/o

To illustrate why we need these external connections, consider an automatic garage door opener that is being controlled by a microprocessor. Power to the motor must be switched in order to lift the door but most peripheral i.cs can only drive light loads. Figure 1, a simple solution to this problem, uses a vmos fet to amplify the logic signal so that a relay may be used to switch high currents to the motor. If the output line is logical zero the transistor is turned off and no current flows through the relay coil but when the output is at logical 1, i.e. at around 5V, the transistor is turned fully on and the relay coil is energized.

Now the microprocessor can turn the motor on and off, but it also needs to know when the door is fully raised so that it can stop the motor. Figure 2 shows a circuit for allowing the processor to sense the contacts of a limit switch whose contacts close when the door is fully open. While the door is down, the switch is open and the resistor pulls the high-impedance input line up to 5V so the processor sees the input as logical one but when the door is fully open the contacts short the resistor to ground and the line becomes logical zero. Using an algorithm like the one in the flow chart, the processor can be programmed to

by R. F. ates

switch on the motor and keep it on until it senses that the limit switch is closed.



Picotutor i/o lines

Peripheral i.cs such as the 6821 cannot easily be connected to the Picotutor 68705 processor as it does not have an external bus, but an equivalent circuit providing 20 i/o lines is built in. These lines, grouped as two sets of eight bits, ports A and B, and one four bit set, port C, account for 20 of the processor's 28 pins and may be programmed as either input or output. Each port has its own unique address in the memory map, Fig. 3, and is accessed as though it were a memory location. Ports B and C are used to interface the keypad and display in Picotutor and their operation will be described later; this leaves eight lines of port A available for other purposes.

Reading a memory location by means of a load instruction results in the eight bits from the addressed location being transferred along data lines into the accumulator or index register depending on the type of instruction. Assuming that the lines of an i/o port are programmed as inputs, reading the port address location will result in the logic state of each of its pins being transferred through the data bus to the c.p.u. Port A line numbering coincides with data bus numbering, i.e., PA_0 data is transferred to data-bus line D_0, PA_1 connects to D_1 and so on.

Using i/o lines as inputs

On Picotutor, the eight port A pins are taken to two 16-pin i.c. sockets as shown in the circuit diagram on p.53 of the December 1982 issue. An eight-way dil switch may be plugged into the lower socket and eight elements of a 10-element led array into the upper socket. With resistors R_{8-19}, these elements form a means of providing an input signal to each of the eight port A lines as shown in Fig. 4. Leftmost switch and led elements are connected to PA_7, rightmost elements to PA_0; when a switch is open its port line is pulled to logical one by the resistor and no current flows through the led element. If the switch is closed, the port line is grounded. i.e. logical zero, and current flows through the resistor to light the led. Try this short program

```
030   B600  LDA 0
032   83    SWI
```

$S_{2/1}$	(PA_7)	open
$S_{2/2}$	(PA_6)	closed
$S_{2/3}$	(PA_5)	open
$S_{2/4}$	(PA_4)	closed
$S_{2/5}$	(PA_3)	open
$S_{2/6}$	(PA_2)	closed
$S_{2/7}$	(PA_1)	open
$S_{2/8}$	(PA_0)	closed

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with the elements of switch number two open (down) or closed (up) as indicated. Switch $S_{2/1}$ is leftmost.

Examining the accumulator using the register key should reveal 55_{16}, which is 01010101 in binary form, since the accumulator content reflects the state of each bit of port A. Repeating the program with different switch settings will confirm this.

Bit-test-and-branch instructions are used when only one bit of the port is of interest. Try this program with $S_{2/1}$ open to set a logical one on PA_7.

```
030 1E00FD SELF  BRSET 7,0,SELF
033 83           SWI
```

Display blanking should occur as the first instruction BRSET 7,0,SELF causes a branch to the label SELF, or the start of the same instruction, if bit seven of address zero is set to logical one. When the switch is closed, the bit is cleared to logical zero so the branch does not occur and software interrupt SWI is executed which causes the display dash prompt to reappear.

Using i/o lines as outputs

Port A lines are automatically programmed as inputs after a reset, through a memory location called the data-direction register (d.d.r.). There is one of these registers for each port, each with its own memory location, and they can be written into by a program. Whether a bit of a port is an input or an output depends on whether its corresponding d.d.r. bit is zero or one respectively. So if the port A d.d.r. holds 80_{16} (1000 0000), PA_7 is an output and PA_{0-6} are inputs. This remains so until a new value is written into the d.d.r. or a reset occurs, such as at switch on, when all d.d.r. bits are cleared to zero.

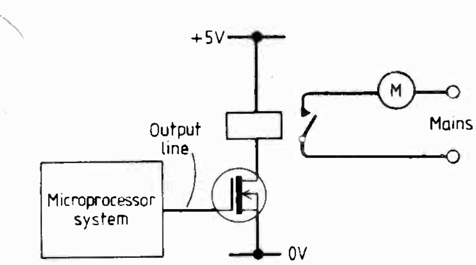


Fig. 1. Peripheral output line. Signals from the microprocessor are low level but a vmos fet buffer can drive a relay coil allowing high currents to be switched.

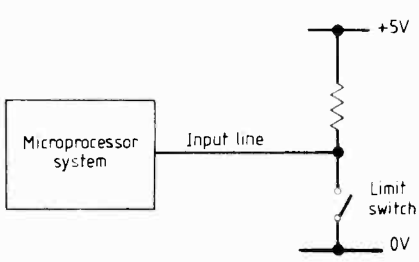
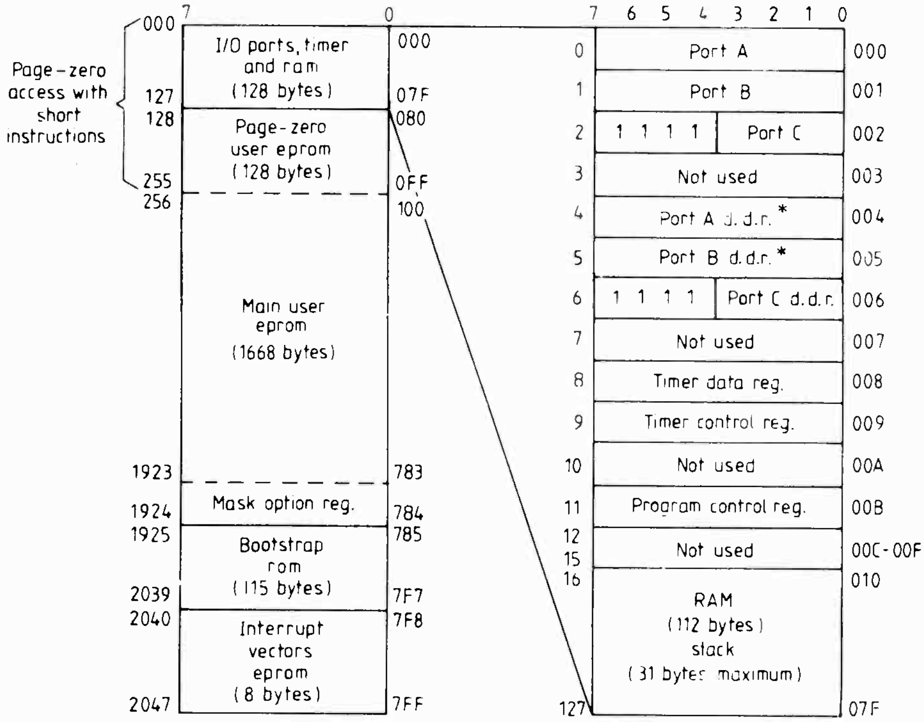


Fig. 2. Peripheral input line. Only a resistor is needed to sense the contacts of a switch – microprocessor system input lines are usually high impedance.



* Data direction registers (d.d.rs) are write-only, they read as FF

Fig. 3. Memory map of the 68705 microprocessor. Input/output ports A, B and C are addressed as memory locations. Their 20 lines may be set as inputs or outputs depending on the level of corresponding bits in one of the three data-direction registers (d.d.r.s).

Status indication of port A lines is provided by the led array when all elements of S_2 are open, a logical zero being indicated by a lit element and a logical one by an unlit element. This example sets all port A lines as outputs.

```
030   A6FF   LDA   #$FF
032   B704   STA   PADDR
034   A6AA   LDA   #$AA
036   B700   STA   PA
038   83     SWI
```

All ones are put into port A's d.d.r. in the first two program lines, which sets all the lines as outputs. Value AA (1010 1010) is then stored in port A and the leds should reflect this. Try the program again using different accumulator values in line three of the program. To illustrate how some lines are set as inputs and some as outputs, the following program sets port A lines PA_{0-3} as inputs and PA_{4-7} lines as outputs. Port A is read then shifted left four times to put the four bits read from PA_{0-3} into PA_{4-7}. Then the accumulator content is put back into port A location to light leds for PA_{4-7} according to the states of the switches for PA_{0-3}. Switches for PA_{4-7} must be open.

```
030 A6F0         LDA   #$F0
032 B704         STA   PADDR
034 B600   LOOP  LDA   PA
036 9D           NOP
037 48           LSLA
038 48           LSLA
039 48           LSLA
03A 48           LSLA
03B B700         STA   PA
03D 20F5         BRA   LOOP
```

Storing data in port bits configured as inputs does no harm but has no effect as the output drivers are not enabled. Try replacing the no-operation instruction, NOP, with COM A, INC A, DEC A, LSL A and LSR A in turn and examine the effect of different switch settings on the display.

Data-direction registers

First note that with the Picotutor, data-direction registers should only be written into by a program. If you use the memory-open key, mo, to change the contents of a d.d.r. an error message will be displayed unless you are setting all the lines as outputs because these registers on the 68705 can only be written into and not read from. An attempt to read one of these registers will result in a display of FF. After data have been written into an opened location using the Picotutor memory-open function, the monitor reads back the data for verification. If data read back are not the same as was written, i.e. if you try to alter an eprom location or d.d.r., Picotutor displays the error message as a warning.

Mini-organ

To demonstrate what has been discussed so far, this section shows how the Picotutor can be turned into a mini-organ using hexadecimal keys of the keypad to generate different notes and a port A output line to drive a small loudspeaker. A suitable algorithm for the organ is given in the second flow-chart (see over). Only one of the port A lines is used but all of them are set as outputs for ease.

Scanning the keypad to see if a key has been pressed is the first function of the main program loop. We can use Picotutor system call KEYIN for this purpose (see p.49 of September issue), to scan the key-

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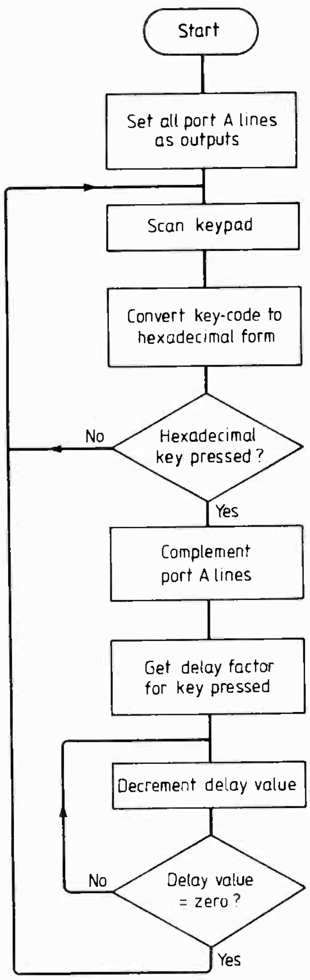
pad and return to the main program with the code of the key pressed in the accumulator; if no key is pressed the accumulator will be clear.

Moving down the flow diagram, code now in the accumulator is a function of the key's physical position on the keypad matrix and needs to be converted to give a hexadecimal value for the key using a second system call – HEXCON. If this subroutine is entered while the accumulator contains a key code the program first checks that the key is a hexadecimal one. If it is, the program loads the accumulator with the appropriate value (00 to 0F) and clears the condition-code register carry bit. Should the key code represent a function key or no key pressed, the subroutine returns control to the main program with the accumulator content unaltered but with the c.c.r. C bit set to inform the calling program that the key pressed was not a hexadecimal one. As seen in the flow diagram, the algorithm tests whether a hexadecimal key has been pressed and if not loops and rescans the keyboard until a hexadecimal key is detected.

On detection of a hexadecimal key being pressed, the value in port A's location is complemented to reverse the logic states and a delay value determining the pitch of the note for the key pressed is obtained from a table. A further loop then decrements the delay value until it reaches zero so the larger the initial delay value the longer it takes for completion of the delay loop. Consider what happens when a key is




```
024   A6FF            LDA   #$FF       SET UP PORT A AS OUTPUTS
026   B704            STA   PORTAD
028   BD86    LOOP    JSR   KEYIN      GET KEY CODE
02A   BD8F            JSR   HEXCON     AND CONVERT TO HEX (00-0F) IN A
02C   25FA            BCS   LOOP       IF 'C' SET, NO HEX KEY PRESSED, BRANCH
02E   3300            COM   PORTA      TOGGLE THE OUTPUT BIT
030   97              TAX              PUT HEX CODE IN 'X' AND USE
031   E638            LDA   PERIOD,X   AS OFFSET UP KEY PERIOD TABLE
033   4A      DELAY   DECA             WAIT FOR THIS KEY HALF-PERIOD
034   26FD            BNE   DELAY
036   20F0            BRA   LOOP       AND BACK TO THE BEGINNING
038           PERIOD  FCB   $FF,$DD,$C5,$B0,$9E,$8D,$6A,$60
040                   FCB   $4D,$40,$35,$2A,$1C,$0F,$0A,$E7
```

List 1. Using this program and a high-impedance loudspeaker, Picotutor forms a simple organ.

held down to envisage how this algorithm generates a note. The program loops continuously, changing the states of port A lines each time round the loop so a square wave whose period is determined by the time taken for a complete loop appears on all port A output lines. Time taken for the delay loop to be completed varies according to the key pressed so the frequency of the square wave varies accordingly. While no key is pressed the instruction which changes the output state is not executed so a constant d.c. level appears on the output.

Mini-organ output. Although drive capabilities of mos outputs are low, a high impedance loudspeaker of around 80Ω connected between a port A output line and +5V will produce an audible output. Connections may be made using the 16-way led-array socket with one loudspeaker terminal connected to a point on the lower row (pins 1-8) and the other terminal on the upper row (pins 9-16). This will place a 270Ω resistor in series with the 5V rail, limiting current to a safe value. Alternatively, a circuit similar to the one in Fig. 1 could be used but with the loudspeaker and a series current-limiting resistor in place of the relay coil.

Mini-organ program. The first two lines of assembly language for the mini-organ program shown in List 1 set port A lines as outputs. System calls KEYIN and HEXCON scan the keypad and clear the c.c.r. carry bit if a hexadecimal key is being pressed. If the carry bit is set, the next instruction BCS LOOP causes a branch back to rescan the keyboard but when the carry bit is clear port A outputs are complemented by COM PORTA. At this stage the accumulator contains a value between 00 and 0F according to the key pressed which is transferred to the index register using the TAX instruction. Now the accumulator is loaded with a value from the table labelled PERIOD which is a block of

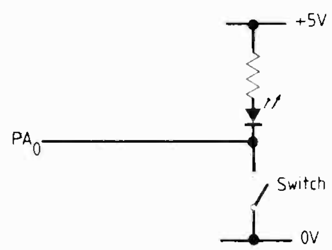


Fig. 4. Picotutor's eight port-A i/o lines are available for external use and have programming switches and an led array connected to them as shown.

memory containing a data byte for each of the hexadecimal keys. Loading of the accumulator with the appropriate byte from the table is done using an indexed load instruction with the address of the start of the table as the offset, i.e., LDA PERIOD,X. Unless the program is relocated, the value of PERIOD will always be 038 and the effective address for the instruction is formed by adding the values of PERIOD and X. If key 0 is being pressed, X will contain 00 so the effective address is 038 and the accumulator is loaded with the contents of address 38, the first location in the table, delay value FF. When key 1 is pressed, the index register contains 01 so the effective address becomes 039 and the accumulator is loaded with the content of that address which is a delay value of DD.

A new mnemonic appears in this program, FCB, which stands for form constant byte and is an assembler directive to inform a computer assembler that data in the operand field is to be inserted in the program as bytes of data and not as instructions.

Entering and running the program. Normal procedure is carried out for entering the program into Picotutor memory but for the FCB instruction, each byte in the operand is entered into successive memory locations, i.e., FF goes into location 038, DD in 039 and so on up to address 047. Now press the go key and enter address 024 and pressing a hexadecimal key should produce a note from the loudspeaker. Two octaves are covered by the 16 keys, with key 0 producing the lowest note and key E the highest. Key F produces the same note as key 0. Looking at the PERIOD table, although the values for keys 0 (FF) and F (E7) are different, they both produce the same note. This is because system call KEYIN takes a varying amount of time to execute according to how far it has to search through the matrix before it finds a pressed key. It takes longer for it to discover that the F key is pressed than the 0 key so entries in the period table have been adjusted to compensate.

The Picotutor monitor assembly language list, which includes the two system calls mentioned in this article, can be purchased from Magenta Electronics Ltd, 135 Hunter Street, Burton-on-Trent, Staffordshire DE14 2ST, as can complete Picotutor kits.

Bob Coates looks more closely at Pictotutor in the next article, in particular at how the keypad and display operate. Picotutor is turned into a simple stop watch to illustrate the 6805 hardware timer.

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Common-mode rejection explained

Op-amp common-mode rejection is cloaked in mystery for many engineers. Bryan Hart describes an accurate but inexpensive measurement technique, with practical examples that show how c.m.r.r. may be handled in circuit calculations. The September part gave the origin and meaning of c.m.r., together with a graphical interpretation.

by B. L. Hart

Two examples illustrate the practical significance of the analysis in the first part of this article. Consider first, a transducer in which a signal voltage of 5mV is developed corresponding to the change in some physical variable under observation, for example temperature. Because of unavoidably long lead lengths connecting the transducer to its amplifier, and because of mains proximity problems, assume a common-mode signal of 500mV amplitude at the input to the amplifier. What rejection ratio is required of the amplifier if the magnitude of the output c.m.c. is to be less than 1% of the amplified d.m.c.?

The requirement is $500/\rho<5/100$ because the signals V_C/ρ and V_D that appear in series with the input of an amplifier (now assumed to have an infinite c.m.r.) are both treated in the same way by the amplifier. Hence $\rho>10^4$ or 80dB. This calculation assumes perfect matching in the resistors associated with the V_+ and V_- inputs of the op-amp, that set the closed-loop gain. (Resistor mismatches degrade the overall c.m.r. performance but that is beyond the scope of this article, which is specifically concerned with the c.m.r. of the op-amp itself.)

Consider next, the voltage follower circuit of Fig. 15. Writing the loop equation for the input circuit gives

$$V_+-V_{IO0}+(V_+/\rho)-(V_O/A_D)=V_O$$

which reduces to

$$V_0=\frac{V_+(1+(1/\rho))-V_{IO0}}{1+(1/A_D)}.$$

As $A_{DM}\gg1$, use the binomial expansion and write

$$1/\{1+(1/A_D)\}\approx1-1/A_D.$$

Recognize now that the *signs* of ρ and V are not specified. So neglecting the term $1/\rho A_D$, the equation further reduces to

$$V_0\approx V_+[1-(1/A_D)\pm(1/\rho)]$$
$$\pm V_{IO0}[1-(1/A_D)].$$

This reveals an interesting fact: without prior knowledge of the sign to be associated with ρ, the magnitude of which may not be constant over the input voltage, it cannot necessarily be assumed that $dV_O/dV_+<1$. The analysis of the effect of

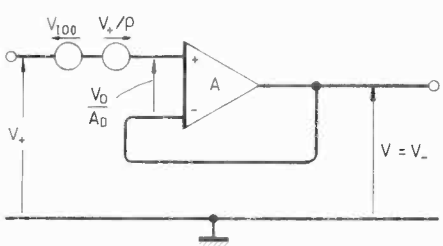

Fig. 15. *Voltage follower circuit for calculating effect of finite common-mode rejection ratio k_{CMR} or ρ.*

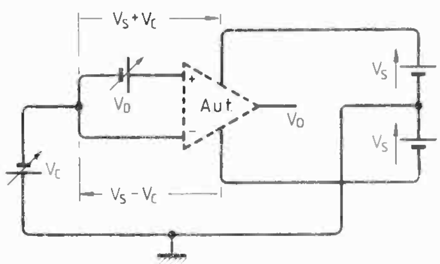

Fig. 16. *Rejection ratio can obviously be found by separate measurement of A_C and A_D but equation 8 enables a single direct measurement to be made.*

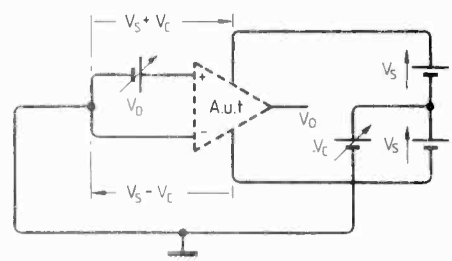

Fig. 17. *To avoid the need for variable floating voltage source V_D and a voltmeter of high c.m.r.r., the earth is relocated though d.c. operating conditions are identical with Fig. 16.*

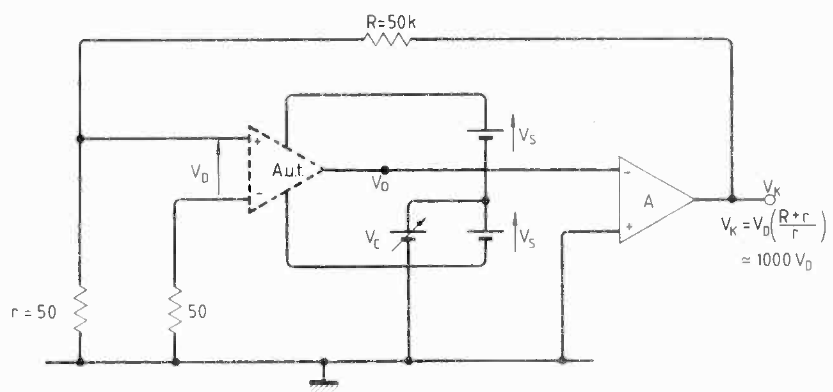

Fig. 18. *In this improved test circuit V_O is maintained automatically at earth potential, and the voltage source of Fig. 17 isn't required.*

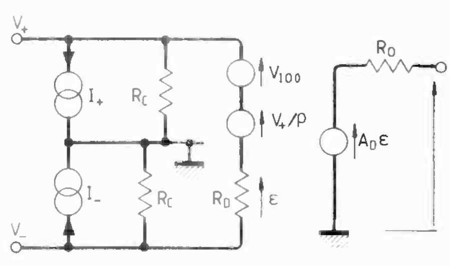

Fig. 19. *More complete equivalent circuit takes into account input currents and input resistances, and could be styled a 'class 5' op-amp but if these were troublesome an op-amp with mosfet input stage would be preferable.*

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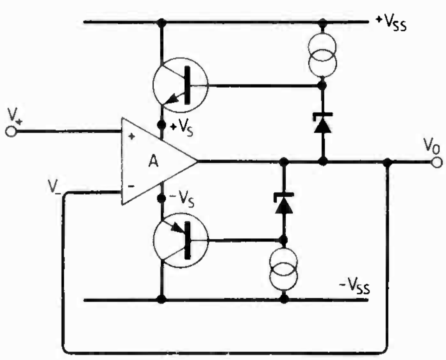


Fig. 20. Low-frequency common-mode effects can be eliminated in certain circuit schemes, as in this example of a voltage follower with its supply lines bootrapped to its output.

Fig. 21

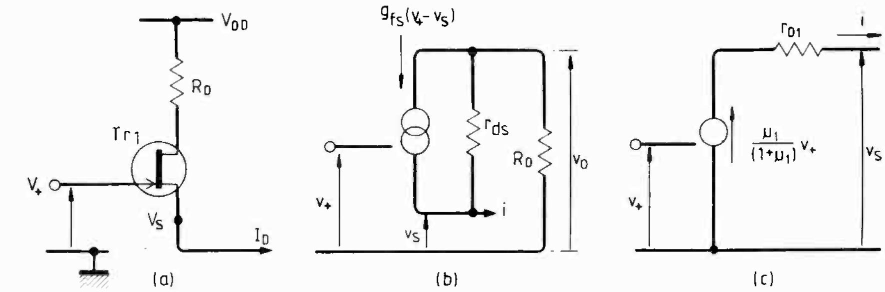
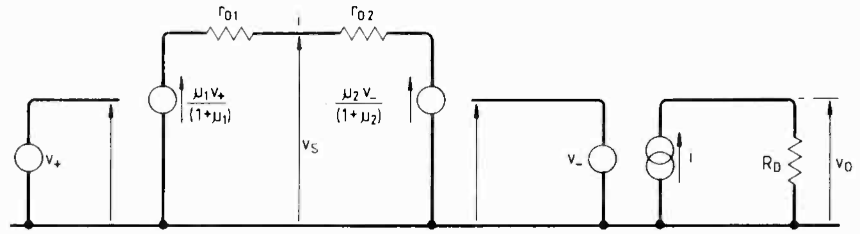


Fig. 22



finite ρ on the performance of a voltage-follower with gain (a non-inverting amplifier) is basically an extension of that for the unity-gain stage.

Measurement of c.m.r.r.

The ratio ρ can obviously be found by separate measurements of A_D and A_C. However, a single direct measurement is preferable, particularly if it can be mechanized to give a c.r.t. display of common-mode performance. The basis of the direct technique is the use of equation 8, but there are problems. Consider, for example, the circuit of Fig. 16 in which a.u.t. is the amplifier under test. A test procedure for ρ could be as follows:

- set $V_C=0$ and adjust V_D so that $V_O=0$
- set V_C at a convenient value V_C (e.g. 5V) and note the change ΔV_D required to restore V_O to zero
- calculate $\rho=|\Delta V_C/\Delta V_D|$.

Fundamental difficulties in such a scheme would be the provision of a small floating adjustable bipolar voltage source V_D, and the requirement for a voltmeter (to measure V_D) having a known c.m.r.r. significantly better than that of the a.u.t. These restrictions can be eased by relocating the earth on the circuit, as shown in Fig. 17. From the potential differences labelled on the two diagrams, the d.c. operating conditions are identical for the amplifiers in both Fig. 16 and Fig. 17.

In the final, more elegant, form[4] of the test circuit, Fig. 18, the connection of an auxiliary amplifier A, and the addition of a feedback loop from its output, produces two benefits: V_O is maintained automatically at earth potential, and the adjustable bipolar voltage generator of Fig. 17 is no longer required. When V_C is varied, V_D changes to maintain the condition $V_O=0$. The output voltage change ΔV_K of A is an amplified version of the change ΔV_D. For the resistor values shown,

$$\rho \approx 1000|\Delta V_C/\Delta V_K|.$$

The voltmeter used to measure ΔV_C and ΔV_K can have one terminal earthed and need not have a high resolution. Thus if $\rho=100$dB a 10V change in V_C is accompanied by an easily measured 100mV change in V_K. The circuit of Fig. 18 has a high low-frequency loop gain. Depending on the particular amplifiers used, an appropriately located frequency-compensation capacitor may be needed to prevent sustained oscillation.

For more detailed investigation the c.m.r. performance of the a.u.t. can be displayed graphically if V_C is made a sweep voltage and applied to the x-channel of an oscilloscope, or x-y plotter, and V_K is applied to the y channel. The sweep rate for V_C will be limited by the frequency response of the amplifier test scheme.

A fifth class?

The op-amp classification scheme introduced, has disregarded other d.c. and low frequency effects. Fig. 19 shows a more complete d.c. and low-frequency small-signal equivalent circuit that takes into account input currents (I_+, I_-), common-mode input resistance R_C, differential-mode resistance R_D, and output resistance R_O. For completeness we could have styled this a class 5 op-amp but there are relatively few applications (precision analogue storage circuits and electrometer schemes) that would warrant the use of such a complete circuit. If it appeared that I_+, I_-, R_C, R_D might be troublesome in a proposed application, then an obvious solution would be to use an op-amp with a mosfet input stage.

Finally

Because of its introductory nature, this article has considered only low-frequency c.m.r. without being specific about the meaning of 'low'. But don't forget that ρ, like A_D, varies with frequency. This is because of the different frequency dependence of the voltage gains A_1 and A'_1, caused by mismatches in the dynamic parameters (e.g. interelectrode capacitances) of the active devices, or unequal capacitive loading resulting from the configuration adopted for the following stage and from asymmetries in circuit layout. Literature on the subject is sparse but an analysis of the popular 741 op-amp by Mack and Fidler[5] predicts a response for ρ that is sensibly single-pole in nature with a cut-off frequency of some 300Hz, in general accord with published experimental data.

References

1. Middlebrook, R. D., Differential Amplifiers. Wiley, 1963.
2. Parnum, D. H., Biological amplifiers, *Wireless World*, vol. 51, Nov. 1945, pp. 337-40; Dec. 1945, pp. 373-6.
3. Hart, B. L., Offset voltage, c.m.r.r. and p.s.r.r. of a long-tailed pair: an integrated approach, *Electronics Letters*, vol. 17, no. 15, July 1981.
4. Gray, P. R., and Meyer, R. G., Recent advances in monolithic operational amplifier design, *IEEE Trans. on Circuits & Systems*, vol. CAS-21, no. 3, May 1974, pp. 317-27.
5. Mack, R. J., and Fidler, J. K., Simple second-order amplifier model for differential and common-mode gain, *Electronics Letters*, vol. 12, no. 6, March 1976.

Appendix

Common-mode rejection analysis for circuit of Fig. 7. Consider the circuit in Fig. 21(a): the small-signal equivalent of which is shown in (b).

$$i=g_{fs1}(v_+-v_s)+(v_{ds}/r_{ds1})$$

Substituting $v_{ds}=-iR_D$ and $r_{ds1}=\mu_1/g_{fs1}$ and rearranging gives

$$v_s=\{\mu_1/(1+\mu_1)\}v_+-ir_{o1},$$

where $r_{o1}=(r_{ds1}+R_D)/(1+\mu_1)$. Fig. 21(c) is an equivalent circuit representation of this. Using this result the signal current change circulating in the source circuit of Fig. 7, and the output voltage, can be calculated from the small-signal equivalent circuit of Fig. 22

$$\begin{aligned} A_1&=(v_o/v_+) \text{ with } v_-=0\\ &=\{R_D/(r_{o1}+r_{o2})\}\{\mu_1/(1+\mu_1)\}\\ &=\lambda\mu_1/(1+\mu_1)\approx\lambda[1-(1/\mu_1)]\end{aligned}$$

where $\lambda=R_D/(r_{o1}+r_{o2})$ and $\mu_1 \gg 1$. Similarly,

$$\begin{aligned} A'_1&=(-v_o/v_-) \text{ with } v_+=0\\ &=\lambda\mu_2/(1+\mu_2)\approx\lambda[1-(1/\mu_2)].\end{aligned}$$

From equation 4,

$$\begin{aligned} 1/\rho&=\Delta A_1/A_1\\ &=\frac{\{1-(1/\mu_1)\}-\{1-(1/\mu_2)\}}{\tfrac{1}{2}[\{1+(1/\mu_1)\}+\{1+(1/\mu_2)\}]}\end{aligned}$$

and putting $(\mu_1+\mu_2)/2=\mu(\gg 1)$ and $\delta\mu=\mu_1-\mu_2$ gives equation 5 in the text, i.e. $1/\rho=\delta\mu/\mu^2$. WW

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Video disc programming for interactive video

Interactive video discs are likely to be useful in education, training and areas involving the use of quasi-static data. But before its facilities can be used to the full three problems need to be solved – provision of suitable office workstations, availability of an adequate authoring tool, and provision of resources to aid automatic searching.

by Philip Barker

Combined with an interactive computer system a video disc creates a useful tool to aid dissemination and assimilation of pictorial material. This article outlines the type of facilities provided by an optical disc and describes some programming techniques for an interactive video disc system based on a Philips Laservision disc player interfaced to an Intertec Superbrain computer. The system that we have been using consists of a teletext tv receiver with an associated remote control function pad, an Intertec Superbrain microcomputer system and a Philips professional VP705 Laservision disc player.

The Superbrain microcomputer is a Z80-based system fitted with twin integral flexible disc drives and two RS232C serial communication ports. The main port connects to the optical disc unit, while the auxiliary attaches to a conventional printer. Each of the ports operated asynchronously at speeds of 1200 and 300baud, respectively. All programs were developed under the CP/M operating system using Basic and Intel 8080 assembler. For programs written in Basic both an interpreter and a compiler were used. Details of software development appear later.

The VP705 Laservision player differs from conventional commercially available players in two ways. It has an asynchronous serial RS232C interface operating at 1200baud to enable connection to the computer; and second, it contains a special teletext encoder to encode program-generated teletext character strings (and/or graphics) in such a way that they can be transmitted to the teletext tv, decoded and then displayed on top of the video images originating from the optional disc.

The video disc may be controlled in one of three ways: manually, remotely, and/or by computer. The manual mode of operation uses control buttons and switches located on the front panel of the player. Each of the functions may be invoked remotely via the use of a hand-held infra-red controlled remote keypad. Because this provides facilities for the entry of strings of decimal digits, it can be used to effect operations that are not possible using the front-panel controls alone – for example, direct retrieval of individual pictures and entry of data into the start and auto-stop memory of the player. The third method of controlling the video player is via a computer – the most versatile method, as all the functions that the player is able to provide may be invoked by operational programs running within an attached computer system. This is achieved by sending a suitable string of control characters to the player RS232C port and, if need be, waiting for an acknowledgement to indicate that the control operation has been performed.

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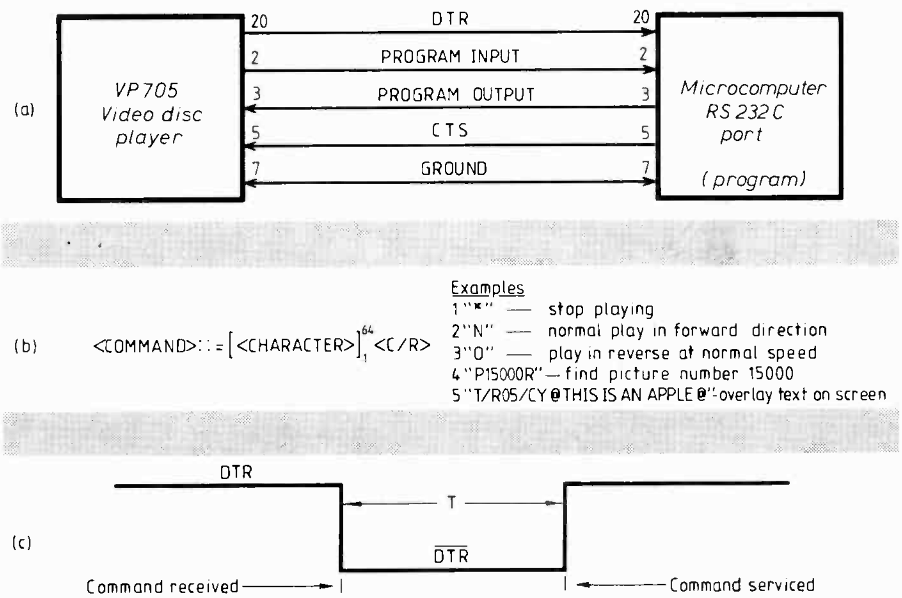
Computer interface

Command strings from the microcomputer to the player are transmitted via the standard RS232C output line to the complementary input pin on the player – Fig. 1(a) shows the connections and pin numbering. Similarly, character string information is returned from the video disc to the control program via the serial input line. The control command format, illustrated schematically in Fig. 1(b), specifies that a command string may consist of from one to a maximum of 64 characters. The command must be terminated by a carriage-return character (C/R). Examples of single and multiple character command strings are presented in Fig. 1(b). When the "*" character is sent to the player, it causes the player to stop playing and "frame-freeze" on the particular picture it happens to be displaying. Similarly, sending the character "N" to the player causes it to commence normal playing again. In contrast, use of the letter "O" as a command character would cause the player to go into reverse mode and show frames at normal speed while traversing the disc backward. The multi-character command shown in example 4 is used to

Fig. 1. *To avoid problems with the 'busy' state, synchronization is either by putting a delay loop into the control program, or by watching for video disc feedback via the data-terminal-ready line, or serial output line.*



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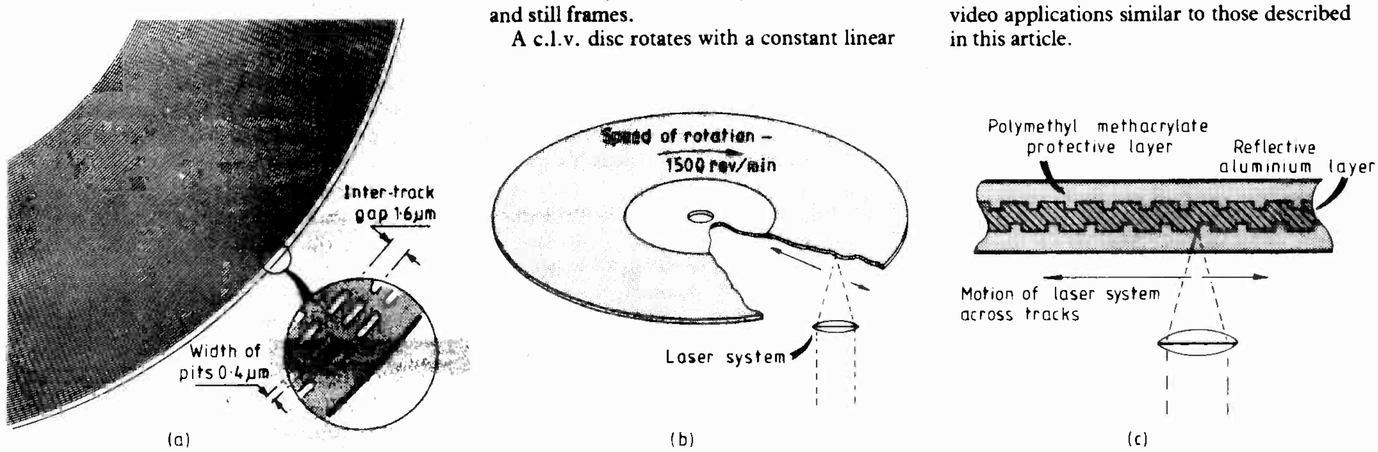
Optical video discs

Discs for laser playback contain a spiral track of optically tiny pits embedded in a reflective layer. The complete video signal – liminance, chrominance and sync – along with the sound information associated with one or two audio channels are stored in the track by varying the length and the spacing of the pits, see Fig. (a). During playback, the rotating disc is scanned by a laser beam that is focused on the track containing the required frame, Figs (b) and (c). Reflected light from the disc is modulated with the track information and, by means of a suitable photodetector, subsequently transformed into an electrical signal and processed to decode the video, audio and control information.

There are two types of disc available for use with optical disc players. A c.a.v. disc rotates with a constant angular velocity (1500 rev/min) such that the time for one revolution of the disc is exactly equal to the time for one video frame. For such a disc, the mean length and spacing of the pits increases linearly with increasing track radius' The discs contain a maximum of 55,500 frames, equivalent to a playing time of 37 minutes. Such discs offer the capability of providing a number of special effects such as fast forward, slow motion, reverse motion and still frames.

A c.l.v. disc rotates with a constant linear velocity which means that the disc rotation speed decreased linearly with increasing track radius. For this kind of disc the mean length and spacing of the pits is constant over the disc, which therefore contains more information and the playing time for one side is about 60 minutes. Discs of this type can only be used for normal speed playing in a forward direction; they cannot be used to achieve any of the special effects that may be created using c.a.v. discs.

The two discs differ in an important way in that the former contain 'picture numbers' as part of the information stored on each track. These are not present in c.l.v. discs, and therefore cannot be used for interactive video applications similar to those described in this article.



make the read-head move directly to the track or picture having the number 15000; it would then display this as a still picture on the tv screen. When the command string shown in example 5 is sent to the player it would activate the internal teletext encoder causing the message "this is an apple" to be overlaid on the screen in yellow characters (CY) at row 5 (RO5) starting at the left-hand screen margin.

When commands are sent to the disc player a finite amount of time is required to service them. Thus the stop command (*) requires 40ms, the normal play forward (N) takes 200ms to action, and the teletext command (T) takes 60ms. Most commands take a fixed length of time to execute. However the length of time that the "GOTO picture number" command (P) takes is completely variable, because it depends on the number of disc tracks that have to be traversed in going from the current track to the destination target track.

When a command has been down loaded to the player a second command must not be sent until the first has been completed; any additional commands sent to the disc while it is "busy" will be lost. To avoid problems associated with the busy state a suitable synchronization procedure is required, which can be achieved in either of two ways. One of these involves putting a delay loop into the control program, thereby halting it for the length of time needed to service any particular command. Alternatively, the computer system can watch for feedback information sent to it by the video disc from the data-terminal-ready line or its RS232C serial output pin (Fig. 1(a)).

The way in which the DTR line may be used is illustrated schematically in Fig. 1(c). When the player is not busy and waiting to receive a command from the computer it will indicate this via its DTR line. The computer can examine this line before it sends a command string to the player. Provided the player is ready, the computer can send its command. This is not executed by the player until it receives a carriage-return character (decimal 13). Once received, the player changes the status of its line to indicate "not ready for data", and then actions the command. As soon as the command has been implemented and the player is ready to receive another command the DTR condition is restored. Provided the computer always checks this line before sending commands to the disc, subsequent ones will not get lost.

The second way in which the microcomputer can acquire feedback information from the disc is via the serial output line. Consider the "GOTO picture number" command illustrated in example 4 of Fig. 1(b). When this command is sent to the player it causes the laser read head to move to the specified frame. When the head is positioned at the destination track, the player sends the decimal value 6 back to the computer; it then displays the still picture on the tv monitor. If the player reaches the end of the disc and has not found the required picture it will return an acknowledgement value of 21 back to the computer. Another example of a command that uses the serial communication port for feedback is the "read picture number" command (?). When this control character is sent along to the player it causes the number of the picture that is currently being displayed to be sent back to the computer. To ensure that the software in the host computer is ready to receive transmitted data, the player always checks the clear-to-send line before starting to transmit.

Software control of the interface between the computer and the video disc is fairly straightforward. Two Basic primitives are available: OUT and INP. The mode of using these is illustrated in the following simple program:

```
10 OUT I,J
20 N=INP(K)
```

where I and K are port addresses. The OUT command outputs the value J ($0 \leq J \leq 255$) to the machine port whose address is I, and the INP function assigns to the variable N the value read in from the machine port having the address K. Provided the port addresses of the RS232C i/o and status lines are known, these primitives can be used to program the interface. So send a stop command to the video player via the Superbrain's auxiliary communication port (address 64), only two lines of Basic code would be needed:

```
10 OUT 64,42
20 OUT 64,13
```

The way in which the i/o and status ports are programmed is discussed in more detail later.

Computer control

The main facilities that can be controlled by the computer are summarized in Table 1. These may be used to effect the following operations.

Random access. Using either the enter (/)

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and run (R) commands or the picture command (Pxxxxx) the player can be made to display any of the available pictures on the disc. This is achieved by moving the read head directly to the track containing the required picture.

Freeze frame. At any time during the display of a series of frames the picture sequence can be stopped. This enables a single picture to be viewed for as long a period as is required. Freeze frame can be achieved either by passing a stop command (*) to the player or by using the auto-stop facility (see later).

Single stepping enables the system to step forward (control code L) or backward (control code M) a frame at a time, thereby enabling each picture in a sequence to be viewed individually.

Slow motion enables the speed of presentation of both forward and reverse picture sequences to be reduced to any value from normal (25 frame/second) down to a single frame every 4s. The slow speed change is effected by means of the Sxxx command string; here xxx is a number in the range 2 to 255; multiplication of this value by 20 gives the time lapse between each new picture. For example, the command U followed by the command string S50 would cause slow motion in the forward direction with one second intervals between pictures.

Fast motion. To facilitate the quick preview of a section of the disc contents, the fast-forward command (W) causes the display speed to be increased to a value that is three times the normal rate.

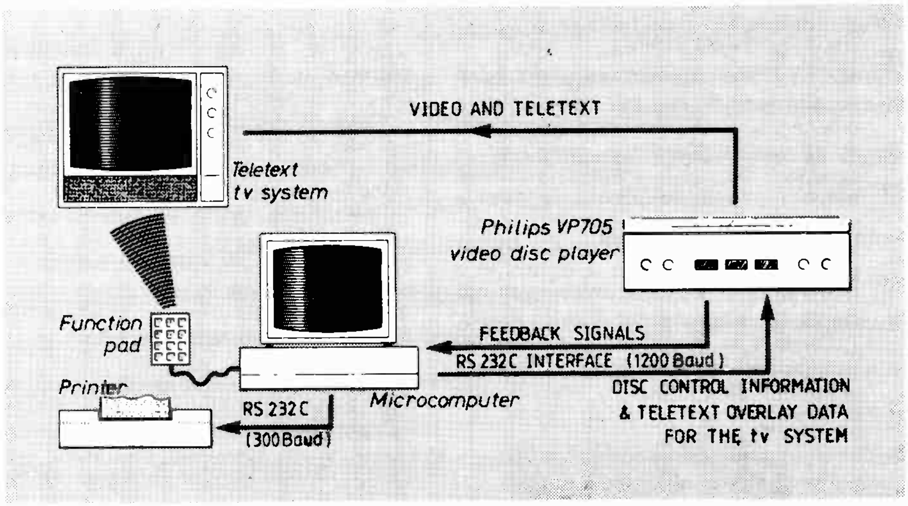
Search forward (>) and search reverse (<) commands can be used to scan the disc at 70 times the normal playing speed to visually locate particular sequences of interest. During the search, every hundredth frame is briefly displayed.

Indexing operations. Each picture on the disc is labelled with a five digit frame number. This number can be displayed on the top left hand corner of the tv screen by issuing a D_1 command; similarly, display of the frame number can be inhibited by means of the inverse command D_0. The picture number can be used by a computer program to start, stop and initiate a variety of different facilities, for example the computer can find out which frame is being displayed by means of the "read picture number" command (?). Similarly, the three variants of the picture (P) command:

(A) PxxxxxR
(B) PxxxxxS
(C) PxxxxxI

also allow several useful facilities. In the first of these, (A), the player finds frame xxxxx and then displays the still picture. The second command, (B), instructs the player to go into still mode when it encounters the specified picture number; an indication of this state of affairs is then sent to the computer (acknowledgement code 6). The final example, (C), is similar to (B) but the player does not stop when the specified frame is displayed.

The player has a built-in memory that is able to store two five-digit frame numbers;



Interactive video disc system comprises Z80-based microcomputer with disc drives and two RS232 ports, main one connecting the video disc player and the other a printer. Programs are developed using CP/M.

these are referred to as the ordinary memory (M) and the auto-stop memory (AS). Values are entered into these by using the enter (/), memory (;) and auto-stop (=) commands. Values may be erased from these memory locations by means of the clear command (X). When values are stored in these two memory locations some interesting effects can be achieved, for example

- auto stopping
- repetition
- frame skipping.

In the first case, the video player will enter still mode whenever it encounters the picture number value that is contained in the auto-stop memory. In the second example, whenever the repeat command (Y) is issued, the player will replay the sequence of frames commencing at the number defined by the contents of the M memory and proceeding through to the value contained in the AS memory. Frame skipping is achieved by using the plus (+) command in conjunction with the enter command. Thus, the command sequence: "/300+" would cause the player to skip to the frame which is 300 ahead of the value contained in the M store. These facilities can be used under computer control to achieve a variety of interesting animation effects.

Teletext. The built-in teletext encoder enables static images (text and graphics) to be overlayed onto images that are being displayed on the tv screen. The facilities provided by the encoder are invoked by means of the teletext command (T). Teletext may be displayed against either a black video background or against a normal picture where the text itself is contained within a background "box" which may be either black or coloured. When using the teletext command it is possible to use both alphanumeric characters and graphics (shapes based around a 2×3 matrix) as with broadcast teletext. The desired graphic characters are then produced by transmitting the appropriate ascii codes within the teletext command (T). The format of this is as follows:

T/<control info>[<display info>!<control info>](1:N)

The teletext command contains two types of parameter: control codes; and, information that will appear on the screen. Control and display information may be freely intermixed, subject to the limitation that the overall length of the command is not greater than 64 characters. Control codes are separated from each other by oblique strokes (/) while information that is to be presented on the screen is delimited by @ characters. A simple teletext command was shown in Fig.1(b), example 4; further examples are presented in Table 2.

The teletext command contained in example 1 would cause the string of characters "What is it called?" to be overlayed on top of the video pictures. The teletext characters would be coloured red and would be positioned on the screen at row 12 starting 15 spaces in from the left hand margin. Example 2 is similar to example 1 except that two colours (yellow and red) are used for the displayed text; also, 'Bizet' would flash on and off. Box creation facilities are illustrated in example 3. Here the new background (NB), start-box (SB) and end-box (EB) control codes are used to create a yellow background box upon which is displayed red text. In example 4, the double height code (DH) is used to cause yellow text to be displayed at twice its normal size within a black background box. Similarly, the sequence of instructions shown in example 5 would cause two double-height teletext overlay lines to appear. The first would occupy lines 1 and 2 and would contain red letters within a white box; the second would appear at lines 22 and 23 and would contain a yellow box with blue letters. The final example in Table 2 illustrates the use of some of the teletext graphic codes. When down-loaded to the video player these commands would cause a yellow square to appear on the teletext screen; its top left hand corner would be located at column 12 within row 6.

Other special effects. Audio commands (A_x and B_x, where x=1 or 0) can be used to control the playback of the individual audio tracks on the disc. Similarly, the audio beep command (!xy) can be used to produce simple sound effects via the loudspeaker contained within the teletext tv.

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The video mute command (E_x, where x=1 or 0) mutes both video and sound simultaneously – also achieved with the pause command (:). Several other useful facilities can be controlled by the computer – such as activation/deactivation of the manual controls on the front-panel of the player, and of the remote control keypad.

Programming techniques

Programming the video disc is straightforward. Both Basic and Intel 8080 assembly language have been used to construct programs. Wherever feasible, it is easier to program in Basic, but, certain situations can arise in which the 'slowness' of Basic can cause some anomalous effects. In these cases assembler (or compiled Basic) must be used; examples of situations requiring this approach are described later. Consider first the use of conventional interpreted Basic. Two approaches to command downloading are possible:

– by means of direct commands typed in through the computer keyboard, and
– via strings that are generated by a stored operational program.

In both cases, string transfer to the disc may be achieved using the LPRINT statement or by use of the OUT command. When the first is used, it is assumed that the disc is connected to the computer via its standard serial RS232C printer port (the auxilliary port in the case of the Superbrain). The OUT command does not require this assumption. As an example, consider a system in which the video disc is attached to the Superbrain via the standard printer port. Either of the following commands, when typed in directly, would cause the optical disc unit to halt operation:

(A) LPRINT "★"
(B) OUT 64, 42 : OUT 64, 13.

These same commands could of course be embedded within a Basic program and would achieve the same effect. The use of LPRINT and OUT within an interpreted Basic program is illustrated in the following lines of code:

```
10 LPRINT "P1500R"
20 FOR I= 1 TO 1000
30 K=K
40 NEXT I
50 OUT 64, 78 : OUT 64, 13
```

Execution of these statements would cause the video disc player to move its read head to frame 1500 and then start normal image display from that point. A timing loop prevents the N command (embedded in line 50) being sent to the player before it has completed actioning the P command that was issued in line 10.

An example of a situation where it is necessary to wait for feedback information from the disc is illustrated in the following section of code:

```
10 PRINT "Enter your frame number"
20 INPUT N
30 LPRINT "P"+N$+"R"
40 A=INP (64)
50 IF A<>6 THEN 40
60 LPRINT "N"
70 STOP
```

Here the user is asked to type into the computer the frame number at which image display is to commence. A P command is then constructed and sent to the video unit (line 30). The computer then waits for an acknowledgement signal from the player (lines 40 & 50) before attempting to issue an N command to start the display of images. Unfortunately, when this code is executed using a Basic interpreter the results are non-deterministic. That is, when it is invoked, sometimes it works correctly while at other times the program fails to terminate. Bearing in mind the slowness of interpreted Basic, the reason for this is easy to see. The function of lines 40 & 50 are to 'watch' for a value of 06 transmitted from the video player. If this value is transmitted while the computer is executing line 50 of the program then obviously this feedback signal will be missed. The way around this problem is to either use a handshaking procedure based upon the CTS line in the RS232C interface, or increase the speed of execution of the program. In the last case this could be achieved by compiling the Basic program to produce executable machine code or by actually coding the software in Intel 8080 assembler.

A slightly more advanced application of the basic control operations outlined above is depicted in Table 3. This shows how a Basic program can be constructed to show the same animated sequence repeatedly. The user enters the four important control parameters for this mode of operation by means of the simple dialogue sequence, specifying the starting frame number, the final frame number, the number of times the sequence is to be repeated, and the time interval between successive repeat showings. Once entered, computer contol can commence. The read head is first positioned at the starting track by means of the LPRINT command in line 200. Before a subsequent command is given, the computer must wait for the disc to send an acknowledgement signal indicating that it has arrived at the required track (line 210). The N command embedded in line 220 initiates display of the animated sequence.

Table 1

COMMAND CODES

REQUIRED DISC FUNCTION	CONTROL CHARACTER	DECIMAL CODE	TIME (ms)
Audio Beep	!	33	
Stop	*	42	40
Correction	.	46	40
Enter	/	47	40
Digit 0	0	48	40
Digit 1	1	49	40
Digit 2	2	50	40
Digit 3	3	51	40
Digit 4	4	52	40
Digit 5	5	53	40
Digit 6	6	54	40
Digit 7	7	55	40
Digit 8	8	56	40
Digit 9	9	57	40
Pause	:	58	40
Memory	;	59	500
Search Reverse	<	60	40
Auto-Stop	=	61	500
Search Forward	>	62	40
Read Picture Number	?	63	200
Audio I	A1=ON A0=OFF	65	200
Audio II	B1=ON B0=OFF	66	200
Picture Number Display	D1=ON D0=OFF	68	200
Video Mute	E1=ON E0=OFF	69	40
Normal Play Forward	N	78	200
Normal Play Reverse	O	79	200
GOTO Picture Number	Pxxxxx	80	-
Run	R	82	40
Slow Speed Change	Sxxx	83	40
Teletext	Txxxxxx	84	60
Slow Motion Forward	U	85	200
Slow Motion Reverse	V	86	200
Fast Forward	W	87	40
Clear	X	88	40
Repeat	Y	89	40
Plus	Z	90	40

Table 2

EXAMPLES OF TELETEXT COMMANDS

```
1  T/HBL
   T/R12/15/CR@WHAT IS THIS CALLED?@

2  T/HBL
   T/R03/05/CY@THIS BALLET IS BY@CR/05/FL@BIZET@

3  T/HCL
   T/R04/CY/NB/CR/SB@THIS IS A BALLET@EB/

4  T/HCL
   T/R08/CY/DH/05/SB@WHO WROTE IT?@EB/

5  T/HCL
   T/R01/CW/NB/CR/DH/05/SB@THIS IS A BALLET@EB/
   T/HCN
   T/R22/CY/NB/CB/DH/05/SB@CAN YOU NAME IT?EB/

6  T/HBL
   T/R06/GY/12@######k@
   T/R07/GY/12@5@05@j@
   T/R08/GY/12@5@05@j@
   T/R09/GY/12@upppppz@
```

Table 3

(A) USER INTERFACE

TYPICAL VDU DIALOGUE

```
ENTER STARTING FRAME NUMBER: 12000
ENTER LAST FRAME NUMBER: 12500
ENTER NUMBER OF REPEATS: 10
ENTER INTERVAL BETWEEN REPEATS (SECS):  65
```

(B) PROGRAM CODE

```
100   PRINT CHR$(12) + CHR$(7)
110   INPUT "ENTER STARTING FRAME NUMBER: ", S$
120   PRINT ""
130   INPUT "ENTER LAST FRAME NUMBER: ", F$
140   PRINT ""
150   INPUT "ENTER NUMBER OF REPEATS: ", N
160   PRINT ""
170   INPUT "ENTER INTERVAL BETWEEN REPEATS (SECS): ", T
175   I=0
180   IF F$>S$ THEN 200
190   GOTO 110
200   LPRINT "P"+S$+"R"
210   IF INP(64)<>6 THEN 210
220   LPRINT "N"
230   GOSUB 1000
240   LPRINT "P"+F$+"S"
250   IF INP(64)<>6 THEN 250
260   I=I+1
270   PRINT "FINISHED ",I
280   IF I<N THEN 300
290   PRINT "ALL DONE"
295   STOP
300   GOSUB 2000
310   GOTO 200
1000  REM TEST LASERVISION DTR SIGNAL LINE
1010  IF INP(65) AND 128) = 0 THEN 1010
1020  RETURN
2000  REM TIME DELAY FOR T SECONDS
2010     etc
```


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When the disc reaches the end of the display sequence another P command must be given to the player – this time having an S suffix.

A check must be made to ensure the video player is not in a busy state, by the subroutine located at line 1000.

The computer can then down-load a PxxxxxS command (line 240); and go into a loop waiting for an indication that the last frame in the sequence has been shown (line 250). When terminated a counter increments (line 260) and is then tested (line 280) to see if the overall control sequence is complete. If the animated sequence has not been shown the required number of times then a timer subroutine is invoked (line 300). The code contained in this subroutine would simply halt execution of the computer program for the delay period specified in the initial user dialogue (Table 3).

Video disc applications

The convergence of computer and optical disc technology to produce interactive video systems provides a completely new resource for information system designers. A number of important areas are likely to benefit from the advantages offered by this new approach to information handling. This section of the report briefly outlines areas where the impact of this technology is likely to be most significant.

As a medium of instruction, the computer alone is quite restricted in what it can achieve. Although it is useful for the storage and presentation of textual and numeric information, it is limited with respect to its ability to store and present sonic and pictorial information. However, when the data processing capability of the computer is combined with the data storage capacity of the video disc, a powerful instructional medium can be produced. Learning centre based upon this type of technology can provide interactive access to significant volumes of pictorial/sonic information. It is thus likely that they will provide many novel approaches to learning that will be applicable within a wide range of educational and training environments. Possibilities currently being investigated are outlined elsewhere.

Within marketing, two important applications of this type of technology are quite obvious. On-line point-of-sale catalogues, and the provision of marketing support in the way of sales promotion and advertising material. Examples of each of these approaches are already appearing within many commercial establishments. Mothercare, for example, use interactive video discs to store details of their product ranges – customers call-up details of products through a simple interactive keypad. BL Systems Ltd have been investigating the potential of the video disc for setting up automated display systems – similar to that illustrated in Table 3. As an illustration of this approach, consider a system in which customers could call-up, on demand, intelligent 'movies' showing all the salient details (and giving demonstrations) of the particular models of car in which they are interested. Such a system could enable customers to browse and enquire in the absence of a forceful and persistent sales attendant. As a marketing tool, this type of technology could have considerable impact if used in an appripriate fashion.

Knowledge archives require the storage of three basic types of information: text, sound, and, images. The optical disc can provide facilities for the storage of substantial volumes of each of these. Disc storage capacity is typically in the region of 55,000 frame/side, which is equivalent to about 12,000Mbytes of conventional digital information. Discs of this type thus offer a means of storing vast quantities of knowledge. As an example, consider the storage requirements for a typical paperback containing 200 pages of printed text. Assuming that each page is composed of 40 lines and that each of these contains 64 characters. The total storage requirement is thus about 0.51Mbyte. An optical disc would thus, in principle, be able to store over 20,000 such books.

Of course, one of the main advantages of the optical disc as a knowledge-storage medium is the fact that it can also store computer programs. When 'intelligent' software is combined with text, sonic and pictorial data, it is possible to construct highly reactive media capable of supporting communicative techniques hitherto impossible to achieve using the more conventional approaches.

Problems for the future

Disc production involves three basic steps: pre-mastered, mastering, and replication. In the first of these, all the basic material that has to be put onto the disc has to be collected together and stored on a master tape containing the composite video and audio signals along with the control codes that are required for the production of the master. This is then achieved via laser photography: a recording laser modulated by the signals on the master tape writes a pattern onto the photosensitive material contained on a master disc. After development, the master can be used to mould or stamp replica discs for distribution purposes. At present disc production is entirely manufacturer-based and is costly for individual users. Philips, for example, charge £1,500 to produce a master disc and then between £80 and £20 for replica discs depending on the quantity. Disc production is undoubtedly an expensive process and so is likely to provide a problem area until costs fall significantly, and facilities are provided to enable end-users to create their own discs.

Authoring techniques

Discs intended for use in a turnkey computer-based interactive video environment require substantial planning and testing. Indeed, disc authoring involves a number of complex functions: preparation of the pictorial information, preparation of the supporting sound tracks, production of computer software for programme control, creation of special effects – for example, sound and teletext overlay, and coordinating and testing the results of integrating each of the communication media. To achieve these objectives in a facile way, conventional computer programming languages are quite inadequte, particularly for users who are not technically orientated. This point easily be seen by analysing and nature of the teletext commands presented in Table 2. Complex instructions are needed to produce what are, in principle, very simple screen effects. Because of the need to provide a 'friendler', easier to use programming interface for this type of system specially-oriented languages are being developed. Their design objectives are to remove the technical complexity associated with using the kind of sophisticated interaction environments provided by computer-based video disc systems, and to provide the dialogue designer with an easy way of soliciting user input, analysing it, and then making the system react in an appropriate way. Authoring languages for simple computer-aided instruction and learning have been available for some time, but the new facilities provided by video disc technology have shown up many of their inadequacies. Much current research and development in this area is therefore oriented towards the addition of facilities that will enable them to incorporate techniques for handling interactive videa disc. Unfortunately, many of these are presently little understood.

Automatic searching via scene analysis

Pictorial data retrieval from disc may be accomplished in either of two ways: by indexing, and by content analysis. The first depends on knowing what part of the disc the required image or sequence resides in. The second method requires a knowledge of the required content of the images that are sought, and the availability of techniques for finding them. This latter approach is relatively each to implement manually but is much more difficult to automate.

The problems associated with automatic image retrieval arise from two sources – the complete lack of end-user facilities for image specification, and the limited capability of currently available hardware/software pattern-matching technology for implementing content (or scene) analysis in effective ways.

In due course, v.l.s.i. technology will undoubtedly produce appropriate chips to handle content analysis in both an efficient and effective manner, though adequate solutions to the problem of image specifications are not yet in sight. We are currently working on a technique called "specification via synthesis". This involves building an image from parts (or sub-components) contained within a video disc library, and involving the user in an interactive dialogue called "importance contouring". This means using methods that enable the user to specify the portions of an image or sequence wherein the most important pieces of pictorial information lie. Our results are as yet inconclusive. But, they do provide us with many interesting and novel views of user interaction with dynamically changing images. WW

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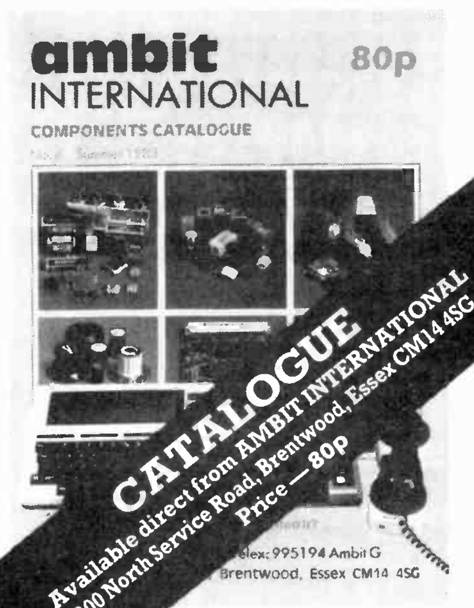

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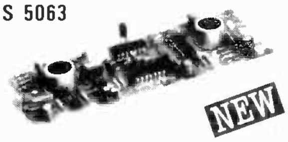

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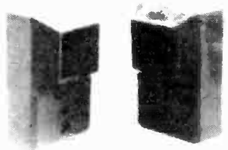

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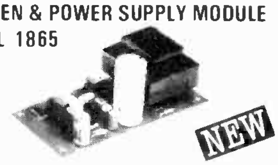

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DF96	0.70	EL32	1.10	PL519	5.80	1U4	0.80	6CY5	1.15	12AU7	0.60
DH76	0.75	EL34	1.80	PL802(SE)	2.95	1X2B	1.40	6D6	0.70	12AV6	0.95
DL92	0.60		2.90*	PY80	0.70	2X2A	2.50	6F6	1.60	12AX7	0.65
DY86/87	0.65	EL37	5.20	PY81/800	0.85	3A4	0.70	6F6GB	1.10	12BA6	0.90
DY802	0.70	EL82	0.70	PY82	0.65	3AT2	2.40	6F7	2.80	12BE6	1.25
E92CC	2.80	EL84	0.80	PY88	0.60	3B28	12.00	6F8G	0.85	12BH7	1.95
E180F	7.70	EL86	0.95	PY500A	2.10		19.50*	6F12	1.50	12BY7A	2.30
E182CC	6.25	EL90	1.00	QQV03/10	3.20	3D6	0.50	6F14	1.15	12C8	0.65
EA76	2.25	EL91	4.20		7.50*	3D22	23.00	6F15	1.30	12E1	18.95
EABC80	0.80	EL95	0.80	QQV03-20A		3E29	19.00	6F17	3.20	12J5GT	0.55
EB91	0.60	EL504	1.70		21.50	3S4	0.60	6F23	0.75	12K7GT	0.70
EBC33	1.15	EL803	5.90	QQV03-25A		4B32	18.25	6F24	1.75	12K8GT	0.80
EBC90	0.90	EL509	3.95		36.50	5R4GY	1.80	6F33	10.50	12Q7GT	0.60
EBF80	0.60	EL821	8.20	QQV06/40A		5U4G	0.75	6FH8	12.50	12SC7	0.65
EBF83	0.60	EL822	9.95		16.10	5V4G	0.75	6GA8	1.95	12SH7	0.65
EBF89	0.80	ELL80(SE)	2.80	QV03-12	4.20	5Y3GT	0.95	6GH8A	1.95	12SJ7	0.70
EC52	0.65	EM80	0.85	SP61	1.80	5Z3	1.50	6H6	1.60	12SQ7	1.45
EC91	4.40	EM87	1.30	TT21	23.00	5Z4G	0.75	6JU6	5.85	12SQ7GT	0.85
EC92	0.85	EY51	0.95	TT22	23.00	5Z4GT	1.05	6J4	1.35	12Y4	0.70
ECC81	0.85	EY81	0.65	UBC41	1.20	6/30L2	0.90	6J4WA	2.00	13D3	2.80
ECC82	0.60	EY86/87	0.60	UABC80	0.75	6AB7	0.70	6J5	2.30	13D5	0.90
ECC83	0.65	EY88	0.65	UAF42	1.20	6AC7	1.15	6J5GT	0.90	13D6	0.80
ECC84	0.60	EZ80	0.70	UBF80	0.70	6AG5	0.60	6J6	0.65	14S7	1.15
ECC85	0.60	EZ81	0.70	UBF89	0.70	6AH6	1.15	6J6W	0.90	19AQ5	0.85
ECC88	0.80	GM4	5.90	UCC84	0.85	6AK5	0.65	6K7	0.80	19G3	11.50
ECC189	0.95	GY501	1.30	UCC85	0.70	6AK8	0.60	6KD6	4.50	19G6	8.50
ECC804	0.90	GZ32	1.05	UCF80	1.30	6AL5	0.60	6L6M	2.80	19H5	39.55
ECF80	0.85	GZ33	4.20	UCH42	1.65	6AL5W	0.85	6L6GC	2.65	20D1	0.80
ECF82	0.65	GZ34	2.75	UCH81	0.75	6AM5	4.20	6L6GT	1.25	20F2	0.85
ECF801	1.05	GZ37	3.95	UCL82	0.95	6AM6	1.50	6L18	0.70	20E1	1.30
ECH34	2.25	KT66	7.80	UF41	1.35	6AN8A	2.50	6LD20	0.70	20P1	0.65
ECH42	1.20		11.20*	UF80	0.95	6AQ4	3.40	6Q7G	1.30	20P3	0.75
ECH81	0.70	KT88	10.50	UF85	0.95	6AQ5	1.00	6SA7	1.00	20P4	1.25
ECH84	0.80		13.80*	UL84	0.95	6AQ5W	1.80	6SG7	1.15	20P5	1.35
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Low-harmonic s.c.r. voltage controller

Zero-crossing switching and programmable burst mode give wide voltage range and low r.f.i.

by R. T. Irish

Radio-frequency interference, emanating from many silicon-controlled-rectifier (s.c.r.) mains controllers is extremely strong and, in many cases, totally swamps radio reception on nearby receivers over the long, medium and parts of the short-wave spectrum. This interference stems from the very fast voltage and current transients associated with simple phase-control systems and is frequently very difficult to suppress. Figure 1 shows the skeleton components of such a system, together with the associated load voltage waveform. It is immediately evident that the sudden voltage transitions result in high energy harmonics and, as has already been indicated, are a potential source of considerable high-frequency interference. The spectrum of the voltage shown in Fig. 1 has been Fourier analysed for the case when $\alpha = 90°$ (for future comparison) and the spectral components are shown in Fig. 2. The slow fall-off in the amplitudes of the harmonics as their number is increased is clear.

A better solution than heavily filtering the system is to use zero voltage switching, where the supply is switched to the load as it crosses zero voltage. Bursts of complete cycles, or, in some cases complete half-cycles, are thus applied to the load. These have negligible harmonic content within the radio spectrum and are therefore found to produce minimal interference.

The logical development of the zero crossing switching is a programmable s.c.r. voltage controller, using complete cycles of mains waveform applied to the load, followed by a "rest" interval of a generally different number of cycles. If M cycles of mains waveform are applied to the load, followed by N cycles "rest", the r.m.s. load voltage is $\sqrt{M/(M + N)}$ times the input r.m.s. voltage – as indicated in Fig. 3.

The application of this technique lies principally in the area of resistive loads of moderately high thermal capacity. It is not envisaged that it would be useful for the control of lamps, in view of the flicker which would be introduced due to the low thermal capacities of the filaments.

The author, Reginald T. Irish, B.Sc. (Eng), M.Phil., M.I.E.E., F.I.E.R.E., was demobilised from the Royal Air Force in 1954 after National Service and joined the Mullard Radio Valve Co. Ltd. at their Mitcham works. Appointed lecturer in the Electronics Branch of the Royal Military College of Science in 1961, Senior Lecturer in 1964 and Principal Lecturer in 1971, Mr Irish has taught a wide range of courses at the College. His principal research interests are electronic circuit design and electromagnetic wave theory, and his publications on this topic have been awarded prizes by both the Institution of Electrical Engineers and the Institution of Electronic and Radio Engineers.

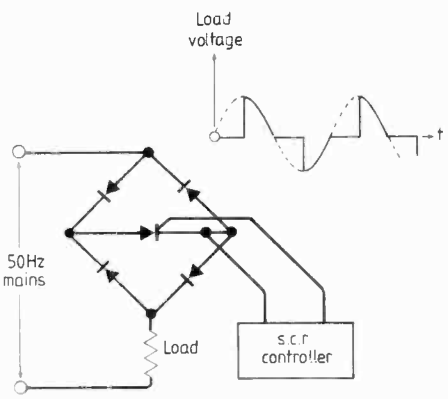

Fig. 1. Skeleton circuit of basic-phase-controlled s.c.r. controller with no anti-r.f.i. precautions. Sharp transitions in output are fruitful source of harmonics.

Circuit

The complete circuit is shown in Figs 4 and 5. Referring to Fig 4, the 50 Hz transformer output is full-wave rectified, smoothed and then regulated by the 78L12. This forms the d.c. supply to the LM348 quad operational amplifier, the TIS43 unijunction and the pulse-counting circuits shown in Fig. 5.

A sample of the mains is taken by the potential divider consisting of the 33 kΩ variable resistor. Facilities for the connection of a 0.1 μF phase-correction capacitor, either in parallel with the variable resistor as shown, or in parallel with the 33 kΩ fixed resistor, are included in the circuit to correct for any small phase shifts within the transformer. This mains sample is then fed via the 1N4148 diode to the first of the operational amplifiers. The

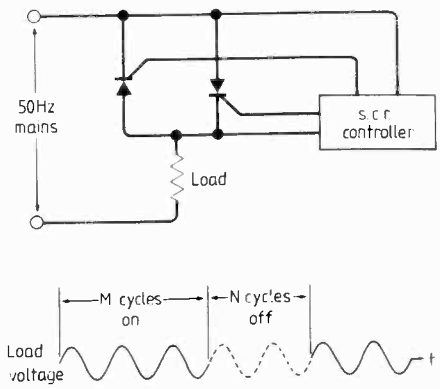

Fig. 3. Development of ordinary zero-crossing controller, switching numbers of whole cycles, rather than parts of cycles.

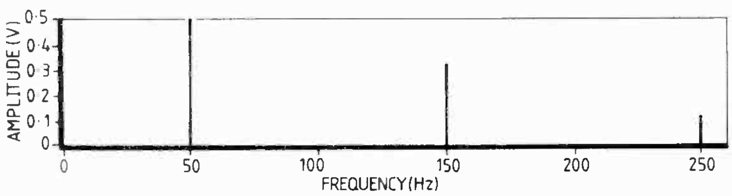

Fig. 2. Slow fall-off in amplitude of harmonics produced by basic circuit of Fig. 1.

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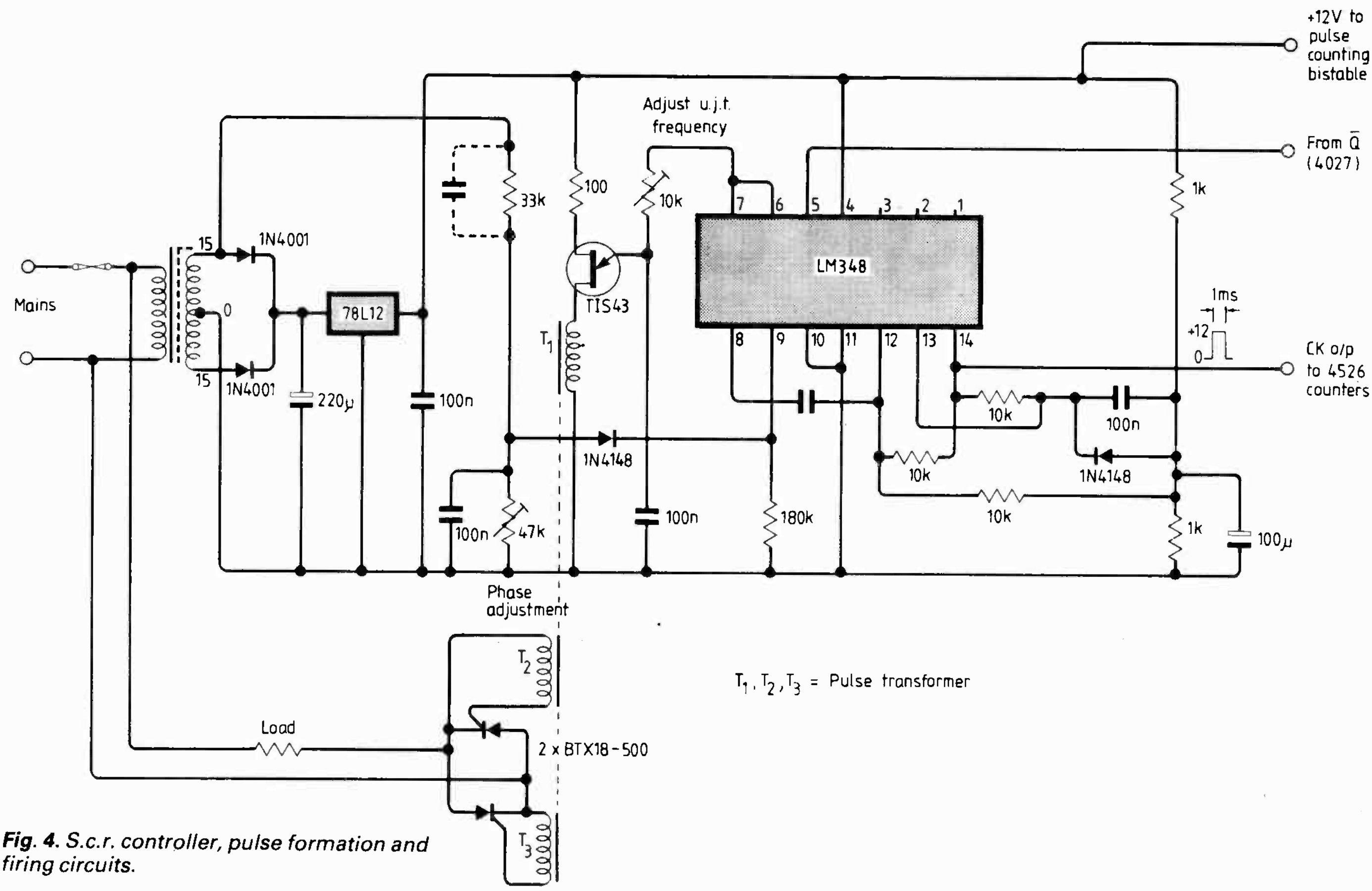
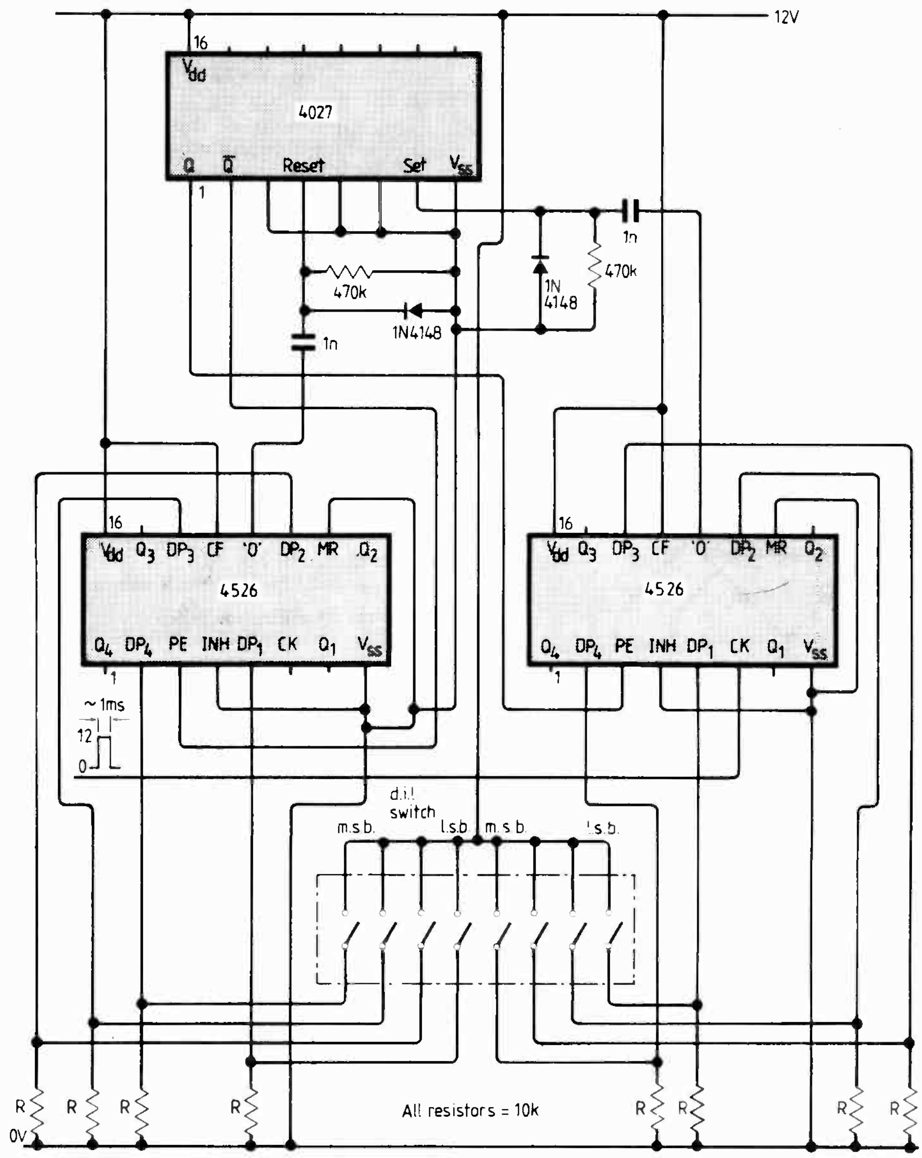


Fig. 4. S.c.r. controller, pulse formation and firing circuits.

Fig. 5. Cycle-counting bistable switch.



zero crossings of the mains waveform thus appear as rapid rises and falls in the voltage at the output (pin 8) of this amplifier. After some differentiation, provided by the 0.01 μF coupling capacitor, these transitions are used to trigger the monostable, formed by using the amplifier connected to pins 12, 13 and 14 of the LM348. Pulses 1 ms in duration are thus produced every time the mains waveform crosses the zero axis in a particular direction.

Referring now to Fig. 5, these 1ms pulses are fed simultaneously to both clock inputs of the 4526 down-counters. The count of each of these is individually, externally programmed from one to fifteen by means of the d.i.l. switch system shown.

To appreciate the action of the circuit, assume initially the 4027 $\bar{Q}$ to be high and Q low. The right hand 4526 counter is thus enabled and the left hand one disabled – both by means of their PE terminals. Input clock pulses are thus counted by the right hand 4526 until it has counted down to zero, starting from the binary count set on the d.i.l. switches. The 0 condition is indicated by the appearance of a high on its 0 terminal. This thus sets the 4027 – via the 1000pF capacitor, 470 kΩ and diode network. The $\bar{Q}$ output now becomes low, enabling the left hand 4526 to count subsequent input pulses and inhibiting the right hand counter. When this has run down to zero, after the number of pulses set on the d.i.l. switch, the cycle repeats.

The count of each of the two 4526 integrated circuits, as shown, is a maximum of fifteen, but this may be

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readily expanded by cascading 4526 circuits to cover the desired range.

The $\overline{Q}$, 4027 output is then fed to another operational amplifier (pins 5, 6 and 7 of the LM348) and its output is used to provide continuous firing of the u.j.t. device when $\overline{Q}$ is high, thus triggering the s.c.rs, via pulse transformer T_2. Since the u.j.t. is now firing continuously for M cycles and is resting for the following N cycles, the r.m.s. load voltage is now the desired $\sqrt{M/(M + N)}$ times the mains supply voltage.

The range of load voltages available with this system is shown in Table 1 but, as has already been indicated, this may be extended by cascading 4526 counters.

Setting-up

Initially, it is recommended that the two pulse counters should each be set at two and the 10 kΩ, u.j.t. frequency control to its maximum value. The 1 ms pulse and its relationship to the mains waveform should be monitored on an oscilloscope and the 47 kΩ phase-adjustment resistor (together with the possible repositioning of the 0.1 μ capacitor) should be coarsely varied to position the pulse at the mains zero crossing. The count ratio should then be increased to 15 when a further, finer adjustment of the 47 kΩ phase-control resistor enables correct operation to be obtained. This will then be found to be maintained over the whole count range. If one particular r.m.s. output voltage only is envisaged, the 10 kΩ u.j.t. oscillator frequency control may be finely adjusted to fire the s.c.rs precisely at the beginning of each cycle.

As expected, when this circuit was operated, no radio interference could be detected on either the long or medium waveband, using a portable receiver (nested within the wiring!). A simple phase-controlled s.c.r. circuit was set up for direct comparison and radio interference was immediately apparent up to a range of some six feet from the system.

The Fourier analysis of a range of waveforms with M = N was performed for direct comparison with the phase-controlled system ($\alpha = 90°$) and the high rate at which components fall off with frequency are immediately apparent – Fig. 6 – in stark contrast to the phase-controlled circuit in Fig. 2. Providing the thermal capacity of the load is high, the harmonic content of the load waveform may be improved further by the selection of high values for M and N, rather than the lower values which are able to be used when M and N have common factors.

Table 1. R.m.s. load voltages for M cycles on, N cycles off, when supplied from 240V.

N \ M	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	170	196	208	215	219	222	224	226	228	229	230	231	231	232	232
2	139	170	186	196	203	208	212	215	217	219	221	222	223	224	225
3	120	152	170	181	190	196	201	205	208	210	213	215	216	218	219
4	107	139	157	170	179	186	191	196	200	203	206	208	210	212	213
5	98	128	147	160	170	177	183	188	192	196	199	202	204	206	208
6	91	120	139	152	162	170	176	181	186	190	193	196	199	201	203
7	85	113	131	145	155	163	170	175	180	184	188	191	193	196	198
8	80	107	125	139	149	157	164	170	175	179	183	186	189	191	194
9	76	102	120	133	143	152	159	165	170	174	178	181	184	187	190
10	72	98	115	128	139	147	154	160	165	170	174	177	180	183	186
11	69	94	111	124	134	143	150	156	161	166	170	173	177	180	182
12	67	91	107	120	130	139	146	152	157	162	166	170	173	176	179
13	64	88	104	116	126	135	142	148	154	158	162	166	170	173	176
14	62	85	101	113	123	131	139	145	150	155	159	163	166	170	173
15	60	82	98	110	120	128	135	142	147	152	156	160	164	167	170

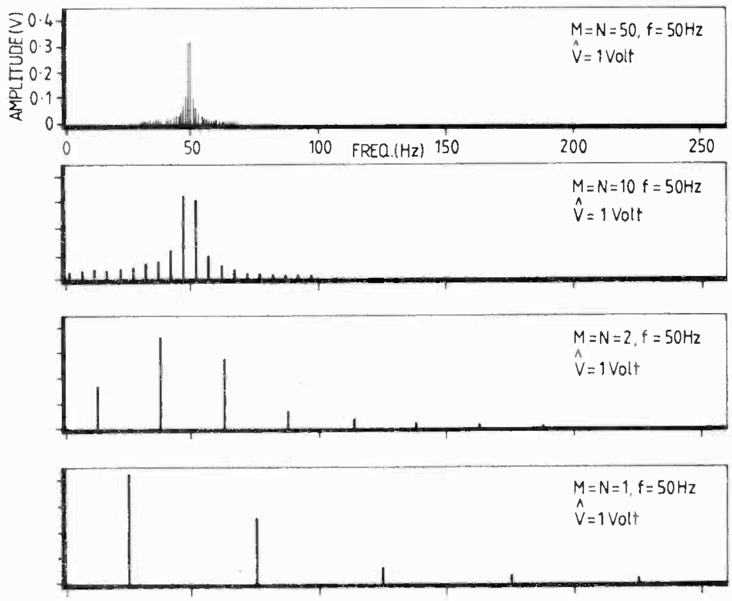

Fig. 6. Spectral components up to 250Hz with various ratios of M:N.

It is also useful to note that the control circuit is completely isolated from the mains supply and is this quite safe when making adjustments, oscilloscope connections, etc. Finally, the replacement of the d.i.l. switch system by voltage-actuated c.m.o.s. switches would enable the computer control of the r.m.s. output voltage to be achieved.

Next month

Behind the micro. A survey for users who want to progress beyond computer games and use their machines as tools for practical experimentation.

PAL decoding. David Read analyses the cause of dot-patterning and cross-colour effects in colour tv receivers in the first of a new series. Later parts discuss decoder design and how to reduce defects, colour tube limitations and a practical decoder design with wide luminance bandwidth.

Energy saver. Instead of the bang-bang' mode of operation usually to be found in central-heating boilers, where the boiler works flat out until stopped dead by the thermostat, Jim McHarg's unit pulses the boiler, reducing the excursions of temperature and saving fuel.

Microcomputer robot control. Morris Driels describes an interface to control non-servo robotic devices by means of a Rockwell 6522 v.i.a. and SAA1027 stepper motor drive chip.

On sale November 16

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Is this year really the centenary of electronics?

by James Franklin

Supporters of Thomas A. Edison would certainly claim that 1983 is the true centenary of electronics as a technology. It was a hundred years ago that this prolific inventor discovered "the Edison Effect", later to be known as thermionic emission. He had discovered that the discoloration of the inside of a carbon-filament electric light bulb was reduced in the plane of the filament, but only on one side of the bulb, and that on the side of the filament which was connected to the positive pole of the supply. He reasoned that the positive half of the U-shaped filament was casting a 'shadow' between the negative half and the glass. Later, he found that if he put a tinfoil coating on part of the inside of the evacuated glass bulb, a current could be made to flow across the empty space between the hot filament and the tinfoil coating. He noted the fact – later to have such practical importance – that this current would flow in one direction only.

But although the electron had been postulated (as the minimum amount of charge carried by an ion) and named as such by Johnstone Stoney in 1874, the idea of this particle of negative electric charge moving about and constituting an electric current was not yet known to the practical experimenters of the 1880s. So it did not occur to Edison that the one-way current he had observed was in fact the result of any such entities travelling through the empty space in his lamp. It was a great mystery to him and the Edison Effect remained a scientific curiosity for a while.

A decade or more had to pass before J. J. Thomson found that it was possible to validate the existence of the electron by measurement. He measured the charge/mass ratio of the electrons constituting the cathode rays that had been investigated by William Crookes and others in the 1870s. From this work arose, about 1897, the Thomson concept of the atom as a positively charged mass with a lot of small negatively charged electrons embedded in it – sufficient for the atom as a whole to have no net charge. Thomson also studied the Edison Effect at about this time and established that the current flowing through the empty space was in fact a stream of electrons.

In the present story the old saw that the British make discoveries and inventions which the Americans then turn into successful products is manifestly the inverse of the truth. It was J. A. Fleming who not only experimented with the Edison Effect but showed an awareness of its practical possibilities when he wrote to Guglielo Marconi: "I have not mentioned this to anyone yet as it may become very useful."

Fleming's crucial work resulting in the invention of the thermionic diode as a practical device for use in wireless telegraphy was not done until 1904. Is this, then, the true date of birth of electronics technology? The retrospective account which Fleming gave in his book "Fifty Years of Electricity" (published by *Wireless World* in the 1920s) may help one to think about it. He recalls:

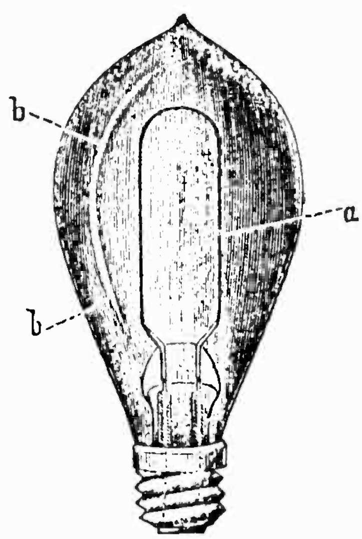
"The author had carefully studied in 1883 and 1896 . . . the so-called "Edison effect" in glow lamps discovered by Edison in 1883, and by 1904, as a consequence of the researches of Sir J. J. Thomson, it was well known that an incandescent filament of carbon in a high vacuum was giving off torrents of electrons or particles of negative electricity. Also, it had been found by the author that the space in a high vacuum between an incandescent cathode and a cold anode could conduct negative electricity from the hot to the cold electrode, but not in the reverse direction. It was not at all obvious, however, that a carbon filament incandescent lamp with a plate sealed into the bulb could be used to rectify high-frequency alternating currents; that is, to convert them into continuous or direct currents. Mr Edison had made no such use of his "Edison effect" lamps, nor had it occurred to anyone, until the author pointed it out, that such a lamp, having a metal cylinder surrounding the filament and carried on a wire sealed through the bulb, could be used to rectify high frequency currents and, therefore, as a detector of electric waves in wireless telegraphy.

"The author, however, constructed in 1904 some carbon filament incandescent lamps in which the filament was surrounded by a metal cylinder carried on a platinum wire sealed through the bulb. These lamps had their filaments made incandescent by a six-cell storage battery, and they were connected . . . with the receiving circuit of a wireless telegraph apparatus . . .

"It was at once found that this thermionic valve gave us a very simple, easily managed detector of electric waves in radiotelegraphy."

All praise to Fleming for inventing the thermionic diode – from which, of course came Lee de Forest's triode, modern radio technology and eventually electronics. (The triode oscillator was used in an early electronic instrument for measuring mechanical displacement by capacitance variation only a few years after the invention of this type of valve.) But whether Fleming in 1904 or Edison in 1883 was the true founder of electronics as a technology will probably remain a matter for historical interpretation.

FIG. 1.



Glow-lamp, having the glass bulb blackened by deposit of carbon, showing the molecular scattering which has taken place from the point *a* on the filament, and the shadow or line of no deposit produced at *b*.

Based on a diagram taken from Proceedings of the Royal Institution, *February 14, 1890, which illustrated a paper by Prof. J. A. Fleming, 'Problems in the Physics of an Electric Lamp'.*

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LETTERS

LOGIC AND ELECTRONIC SYMBOL STANDARDIZATION

It is with a certain sense of bewilderment that I view the differing symbols used in the electronics magazines which I read: these range from the otherwise excellent, but often symbolically and artistically abysmal, recent computer magazines to your own (I feel) leading journal.

British Standards perhaps need taking to task for their lack of guidance and unhelpful 'black boxes': can you – anyone – kick them into a "non-sitting-on-it" situation?

'Mil' standards please those of us who deal with them on a daily basis, naturally, but what is needed is a workable standard which also allows for an individual style, as exhibited in *WW* for so long.

G. Beard
Wandsworth

ELECTRONIC WEIGHING SCALE

I have read with interest J. L. Hood's design for an electronic weighing machine in your October issue. Obviously, I am very pleased to see he has used as the 199.9mV d.p.m. our own DPM 200 which is particularly suitable as it has the kg symbols available on the display.

However, I should point out that whilst we cannot comment regarding the rest of the circuit, there is an error regarding the driving of these symbols. To avoid 'burn in' an l.c.d. should be driven by an a.c. source and such a source is available on our meter labelled 'XDP'. Your circuit shows the symbol and the decimal point connected directly to ground which could damage the meter.

Should any of your readers require full data sheets for this product we would be delighted to supply one. Could I also mention that besides ourselves, the DPM 200 is available from the following distributors: RS Components Ltd, BICC Verospeed Ltd and Farnell Components Ltd.

S. P. Wyre
Lascar Electronics
Module House, Whiteparish
Wilts

CALL SIGN

Keith Ellis's letter in October brought back two amateur radio memories, one very painful, of over 60 years ago.

As 2MT's QTH at Writtle, Essex was the next village to my home at Widford, his signals were devastating when listened to on a home-built set under the permission of my Experimental Receiving Licence of December 1920. Capt Eckersley kindly put up with "instant" visits from three of us hot and sticky off our cycles even before he had put his telephone microphone mouthpiece down at the end of a transmission.

At St John's School, Leatherhead, where I was a Founder Member of the School Wireless Society I once skipped Prayers between two evening preps to listen to a special transmission on a receiver equipped with several French R valves. As the set was temporarily housed in a basement room under the Masters' Common Room I put a cloth over the valves to conceal my presence, but sadly I was spotted by a Master entering the building from the outside. At the end of the second Prep, all were released to bed except Thurlow 1 who, after confession, had to pay a painful visit to his Housemaster for six of the best.

What was done for amateur radio!

Richard Thurlow G3WW
March
Cambridgeshire

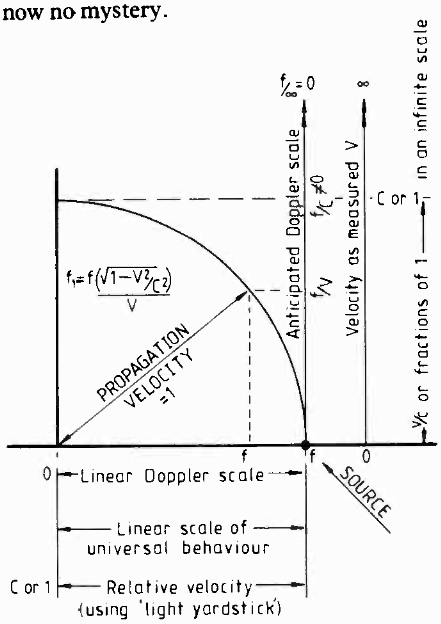
ELECTROMAGNETIC DOPPLER

So now S. J. Hobson chooses to join Kennaugh and the rest in the demonstration of failure to understand basic principles (September Letters.)

The terms C + V and C – V are potentially infinite and it is quite wrong even to imagine that they might be used to discuss events in an orderly universe in which events happen linearly in a scale which ends abruptly at C. Let j_v be the Lorentz transform. V is as we measure and we see that

$V.j_v$ = a linear proportion of the scale C.

Knowing this, we can use the diagram for all of our experimental results leaving mass, length and time invariant: there is now no mystery.



S.T.R. was the miscegenation of a man who did not understand that apples must not be mixed up, mathematically, with pears.

Finally, to change the subject, could someone remind Catt and Co. that when a short wire is statically charged, the charge migrates half to each end and there remains until let out. Might this not have something to do with the cause of the step being half as high and twice as long?

A. Jones
Alderney, CI

SINE WAVES, HARMONICS AND SIDEBANDS

The simplest and most fundamental form of repetitive motion can be represented by a sine wave. To mix metaphors, one coud say it is the the "lowest level" of repetitive motion and all other types tend to "gravitate" towards it. The waves of the sea, the swing of a pendulum, the vibration in a piece of solid material all tend towards a sine wave. Mathematically the sine wave has the unique property that the representation of the rate at which it changes (its differential) is another sine wave.

In electronics it has the property of being the only kind of electro magnetic radiation which occupies one spot frequency, and apart from indicating its existence conveys *no* other information whatever.

Immediately the shape of the wave changes from a pure sine form other frequencies appear. And this is where a certain amount of confusion can arise. On the one hand we learn that a repetitive waveform which is not a sine wave always contains harmonics. On the other we learn that a sine wave, modulated by another wave at a lower frequency always results in the production of sidebands. But what is not so often realised is that harmonics and sidebands are exactly the same. The reason why this is not realised seems to stem from the fact that we tend to think of a modulated sine wave as a sine wave which is varying – usually rather slowly – in amplitude. Actually it is nothing of the kind, because a 'sine wave' which is varying in amplitude is no longer a sine wave. No matter how slow the change each half cycle, for example, must be a little greater or smaller in amplitude than the previous one and we have in effect a distorted sine wave. Now suppose we increase the modulating frequency until it is the same as the modulated frequency. The distortion becomes more and more obvious until, when they are equal, every cycle suffers the same amount of distortion and we have a repetitive, non sinusoidal wave form. And of course, the sideband offset frequency is now the same as the modulated frequency – in other words we have a harmonic.

Understanding, as opposed to the mechanical acquisition of unrelated facts, arises from our ability to make a coherent pattern out of the information we receive. And the realisation that harmonics are only a specific kind of sideband can help to give a clearer picture of the general process of modulation.

Roy Hartkopf
Alphington
Victoria
Australia

INADEQUATE MATHEMATICS?

I have been very interested to read the series of challenging articles and letters on basic physics in *Wireless World*; however I must say that Professor Jennison's article and his description of a machine for stopping a travelling wave have all the appearance of being an elaborate hoax. He produces a stationary field and asks "Where are the charges that produce it?" It is obvious to me where the charges are – they are moving up and down (or more precisely, in his circular configuration, inwards and outwards) in the

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LETTERS

capacitors of his looped waveguide. Could it be that Professor Jennison has made the mistake that my students commonly make – that of confusing the mathematical description with the real thing? The fact that one can write the same equations for two phenomena does not mean that the two phenomena are the same. In using an artificial waveguide, Professor Jennison has, in effect, localized his wave with respect to specific points in his construction, i.e. his capacitors; there is, as far as I know, no evidence to suggest that an electromagnetic wave travelling in a closed loop of waveguide would be so localized with respect to any specific point in the guide. It may be argued that it is so localized due to the reflective effect of electrons in the metal of the guide, but then, of course, we are back to electrons.

The method described of getting a stationary field from a travelling wave is not new; in a rotor-fed 3-phase induction motor, a magnetic wave is produced which travels round the airgap at a speed equal to the difference between the synchrononous speed and the rotor speed. If one couples a d.c. motor to the shaft and forces the rotor speed up to be equal to the synchronous speed, the field becomes stationary. This is an experiment which is easily carried out and the result checked simply by connecting an oscilloscope across a stator winding.

It is not that I favour any particular theory of electromagnetic phenomena – it is just that in Professor Jennison's article my attention focused itself on his assumption that the wave in his machine is the same sort of thing as the wave in his theoretical waveguide, presumably because the equations are the same. In fact in recent years I have come to consider that the mathematics we use are inadequate to describe the phenomena we encounter, and are frequently a source of confusion to students.

A. H. Freeborn
Managua
Nicaragua

DESIGN COMPETITION

It should be possible to reduce a microphone's pick-up of unwanted background noise (D. Wattson – Letters, September). One would need two microphones placed back to back so that one of them picks up more signal energy from the source than the other.

By combining their outputs in anti-phase the background noise could be reduced by means of a balance control. Such a circuit could also be used with advantage for those useless microphones which are built on the cases of cassette recorders. They also pick up the recorder's motor noise. An internal anti-phase mike near the motor would reduce this defect.

A. H. Winterflood
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CLOSED LOOPS

I was delighted to note Mr Winterflood's enjoyment of *WW*'s "Physics Section" and Letters: your excellent magazine is becoming rather like the House of Commons where protagonists and antagonists agonise without much hope of convincing each other, it being the interested onlooker who wins by seeing the most as if he were watching a game of chess. Such is the function of debate, and most interesting it can be. But it is also extremely valuable because it helps brains to tick conceptually and we could do with a lot more of that, in a digital world of disintegration, Deus being very much ex Machina even if Machina can not see it. That must remain Machina's problem.

If I may, I would like to put it to Mr Winterflood that the mummy of the closed loops is the concept of mass-energy-mass-energy interchange, where mass is perceivable (from one side) and energy is deduced to exist because mass demonstrates a funny thing called behaviour which has to be explained somehow.

Similarly, the daddy of the closed loops is creation-catastrophe-creation - catastrophe whether looking at mass or imagining energy travelling in the opposite direction to mass. The unattainability of ultimate mass and zero energy appear to account for the finiteness of the universe.

The marriage of this daddy with that mummy is the essential marriage between method and means, Deus and Machina: if that marriage breaks down, so does the machine and the patent becomes void, but Deus lives on to create another day.

The only missing parameter is the causal factor for the outward acceleration of mass, and we can find *that* if we can put behind us the egotistic thought that in throwing a cricket ball we give it energy and accept that we dissipate energy in giving it movement, while the ball imbibes energy during the act of acceleration: the concept alters nothing in that it only amounts to a deeper analysis of how kinetic energy actually works, the point being that spatial energy would tend to constancy in any locality.

In cosmological scale, this would not imply constancy of spatial energy along any radial geodesic of outward acceleration: if there were an energy gradient, mass would climb up it and thus accelerate! Such a gradient is provided by the realisation that a mass approaching the speed of light would self-destruct just before getting there, becoming a dissociated collection of basic building blocks carrying away the energy of destruction in their violent spinning. Thus a high-energy state would exist at the catastrophic boundary of the universe, gradually dissipating to a greater state of entropy towards the centre – hence the energy gradient that causes the acceleration of the masses, so explaining the increasing relativistic energy state of mass in its evolution from basic building block to quasar (and perhaps black hole) with increasing distance.

In this concept, the Einsteinian curvature of space becomes an energy gradient, the fifth dimension, time being the fourth, the other three being well enough known to all but the flat-earthers, while in the commercial world the sixth dimension would be chepth, or cheapness!

Such an energy gradient would occur towards all masses in that they would attract energetic sub-massive building blocks around them, the carriers of spin energy: gravity then becomes a quarter wave with a pressure node centred around the mass in question.

If Professor Eric Laithwaite will now wave his mill-wheel about again as it spins on its axle, we might learn something, especially about the precession of gyroscopes, the inordinately rapid winking of extremely massive and dense pulsars at very great distances, quasars, and black holes. As he says, there has *got* to be something up there, and I happen to agree with him.

But now, what price the planetary electron? There is nothing to stop it from orbiting and its orbital velocity becomes a function of its distance from creation towards catastrophe: as the atom progresses outwards accelerating, so its nucleus becomes more massive and attractive. The electron appears to spiral more and more rapidly into the nucleus, does it not? Thus mass becomes denser and denser, ultimately becoming perhaps a black hole dissipating itself into energy, having been a quasar.

Macrocosm and microcosm are subject to the same laws: all we need to do is to recognise them, and to integrate them using our powers of mental conception, the building of a great spatial jig-saw puzzle.

James A. MacHarg
Wooler
Northumbria

FORTH COMPUTER

When choosing a computer to perform a particular function one evaluates its performance in terms of price, throughput and storage. Throughput is more dominated by the number of cycles it has to perform than by cycle time (at any given level of process technology). The number of cycles is determined both by the size of the task and by the degree of fit between the task and the computer's instruction set (i.e. the fit between the source language and the processor architecture). As with most engineering the old 80/20 rule applies; 20% of the source task will consume 80% of the processor activity. Thus to a first order approximation, all one needs to do when evaluating a processor in an application is to find out how the processor copes with the code fragments (20% of the total) which it will be executing for 80% of the time. Hence it is neither worthless nor misleading as Mr J. O'Connor (July Letters) asserts, to examine some small code fragments so long as they have been chosen with care. In the case of Forth, as I explained, the dominant code fragment is Next for it is used in all code routines which are used to emulate the Forth machine. Other code fragments (all of which incorporate Next) in decreasing order of usuage are those for subroutine nesting and denesting (Docol, Semis) and stack operations (DUP, SWAP, DROP, + etc). Hence the choice of code fragments (all duplicated from the relevant FIG models) published in May *W.W.* upon which I based my processor choice for my Forth computer.

Recent research into processor architecture has led to a new form. Spectacular performance claims are made for these Reduced Instruction Set Computers (fabricated as VLSI microprocessors), in that they will outperform both in terms of programme size (smaller) and task execution (faster) not only commercially available microprocessors but also commercially available mini and super-mini computers. Such results are claimed both by the original RISC workers David Patterson and Carlo Sequin (*IEEE Computer* Sept '82) and also by Inmos for their S14 processor which appears to be a research vehicle for the as yet unavailable Inmos

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Transputer. Patterson and Sequin found that just one code fragment – the procedure call/return for high level languages – accounted for a massive 40% of the processor memory accesses. So they concentrated their efforts upon designing a processor architecture which effectively tackled this problem. They produced with less design and layout effort a design that usually, with less instructions and with less transistors, outperforms most current computers.

Tables of relative performance (Manufacturer's figures)

	design+ layout effort man-months	relative to RISC code size	execution time
RISC	27	1.0	1.0
S14	na	na	na
M68000	170	0.9	3.5
Z8002	130	1.2	4.1
PDP 11/70	na	0.9	2.6
VAX 11/780	na	0.8	2.1

	# instructions, addr modes	relative to S14 code size	execution time
RISC	31,2	na	na
S14	48,na	1.0	1.0
M68000	61,14	4.3	2.2
Z8002	110,12	3.6	2.2
PDP 11/70	65,12	na	na
VAX 11/780	248,18	2.9	2.1

Obviously there is not a one-to-one correspondence between designing a processor architecture and choosing a microprocessor to run Forth on. However I maintain that they are similar in that by looking at what instruction sequences will consume most processor resources and then by analysing the fit of those few, one can make the correct choice.

I obviously failed to convey to the *W.W.* readership the fact that the Forth machine (emulated by the M6809) is a zero address machine. The only microprocessor that I know of that has zero address stack instructions is the INS16032. In a zero address machine, data operations always create and destroy items at the top of stack. The more common microprocessor architecture is a one [two] address machine where data operations occur between the [an] accumulator and some other (normally memory) location. For these reasons Mr J. O'Connor's code is not a suitable emulation of the Forth word '+' for it both fails to destroy one of the operands by adjusting the length of the data stack and it also leaves the result in the accumulator. Mr J. O'Connor points out that if BP (base pointer) has a fixed relationship towards SP (stack pointer) his code fragment can be shortened even further. The use of stack instructions relative to BP works fine for PASCAL-like languages with compile time evaluated offsets within stack frames but is impractical for Forth where there are no stack frames and the stack size is so dynamic. Forth avoids all the complications of stack frames (and so also of static and dynamic links) by keeping control information on the return stack. Therefore there is no appropriate place for the stack frame marker (BP) to point to. That is, in Forth there is no base other than stack top from which to evaluate at compile time a run time offset. Of the two processors under discussion (I8088, M6809) it is only the M6809 that allows just such addressing.

B. Woodroffe
Edinburgh

PREFERRED VALUES IN SERIES AND PARALLEL

A little acquaintance with the sequence of preferred values for resistors manufactured to a tolerance of 20% leads to the discovery that every resistor in the sequence is the approximate equivalent of two others connected in series. For example, the resistors ranging from 1 ohm to 10 ohm are

$$1, 1.5, 2.2, 3.3, 4.7, 6.8, 10$$

and

$$3.3 \simeq 1 + 2.2,$$

$$4.7 \simeq 1.5 + 3.3,$$

and so on.

Closer acquaintance yields the further discovery that every resistor is also the approximate equivalent of two others connected in parallel. For example,

$$\frac{1}{1.5} \simeq \frac{1}{2.2} + \frac{1}{4.7},$$

$$\frac{1}{2.2} \simeq \frac{1}{3.3} + \frac{1}{6.8},$$

and so on. At the expense therefore of some inconvenience one could avoid the expense of stocking half of the values in the 20% sequence.

A search for an exact basis for these two approximations would begin with the reminder that the preferred values are the rounded approximations of

$$1, r, r^2, r^3, r^4, r^5, r^6, \ldots$$

where r is determined by the requirement that $r^6 = 10$, and equals 1.468 to three decimal places. The next step would be to investigate a preferred sequence

$$1, x, x^2, x^3, x^4, x^5, x^6, \ldots$$

where x is determined, on the one hand, by the condition

$$x^3 = 1 + x^2,$$

and, on the other hand, by the condition

$$\frac{1}{x} = \frac{1}{x^2} + \frac{1}{x^4}.$$

Surprisingly, simplification of the second condition shows that it is identical with the first. In other words, if a preferred sequence possesses either the series property or the parallel property it will also possess the other.

Cause for greater surprise lies in the solution of the equation

$$x^3 = 1 + x^2.$$

A few trials with an electronic calculator will show that x is equal to 1.466 to three decimal places, a value fortuitously close to that obtained for r above.

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Australia

DEATH OF ELECTRIC CURRENT

Two quotations from *Wireless World*, September 1983:

1. M. G. Wellard's letter, quoting Hertz: "In [Weber's theory], conductors appear as the only bodies which take part in the propagation of electrical disturbances – non-conductors as bodies which oppose this propagation. According to our [Hertz's] conception . . . all propagation of electrical disturbances takes place through non-conductors; and conductors oppose this".
2. M. McLoughlin: "Current dumping review – 1": "Obviously high farce has effected an entry . . . A complex situation may sometimes be viewed quite validly in alternative ways. In this case the fullest understanding seems to be obtained when one has seen both explanations, seen that they are both valid, and grasped that they are complementary views of the same situation".

Need one say more?

R. Kennaway
Norwich

AERETICS

First, may I congratulate Dr Scott Murray and yourself on these articles and the courage displayed in attacking the 'Citadel'. Today's teachers know too little physics and have let the mathematics, of which they know a little, rule the whole field, often against the physical facts.

I would suggest there is an error in Part 2 (August) of the series, when the electric and magnetic fields are described as "the *first* instance when imagination is treated as truth". Surely the action of the gravitational field was the first. No one, so far as I know, expects the gravity field to act through intermediate bodies, so why should the electric field? No one looks for a gravity wind, so why seek an aether wind? The Michaelson-Morley experiment was quite irrelevant. It disproved nothing, not even an aether, if there is one.

Then in Part 3 (October) Dr Scott Murray breaks his own rule by accepting the photon as a fact. Perhaps the photon is a

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root trouble for modern physics. Arguments about the duality of particles and waves would cease without photons. What are they? The photon is a truly metaphysical object, being a particle which travels at the speed of light, and so has no depth, no volume, only an infinite area transverse to its direction of propagation, like the surface of an expanding balloon. It also has no mass, in fact it is a nothing which carries a packet of energy.

Photons were 'guessed-up' by Einstein who also *postulated* a constant velocity for light – but *only in a vacuum* (nowhere) We know that light travels more slowly in other dielectrics such as glass or water.

Before the electric telegraph, a blind man might have said that all velocity was limited to the speed of sound. Until some new medium is found the velocity of communication is limited to that of light or radio. If Spain (lat 40°, long−5°) and New Zealand (lat 175, long 175) both fired vertical rockets at 0.6c none of the astronaughts would believe the US and USSR reports, via radio, that the other ship existed, for they could neither see it nor hear its radio.

Can we start again? Are we looking at an energy packet from the wrong point: Planck (1901) was studying the photoelectric effect when he discovered the quanta, and he had probably barely assimilated the idea of an electron. He could not have known Bohr's atom (1913) and so came to the wrong conclusion? Is it the electron which requires an energy packet to acquire escape-velocity from the atom, and not the light that comes in packets? If a large missile hits a car head-on and one or two humans go through the windscreen, would one say that the missile energy is a discrete number of humans?

Let us start again from known facts. (1) Light is an electro-magnetic phenomenon: demonstrated by Faraday and Kerr. (2) Light is not a static problem: it is oscillatory (Hertz). (3) The electric and magnetic fields are at right-angles and *always* 90° out of phase. Some recent textbooks show these in-phase – an umpardonable error. Infortunately too few physicists know much about radio and, ever since Hertz, scientists have avoided the question of how a radio signal gets from point A to point B. This is an inadmissible question, likened by Bedford to the grin on the Cheshire Cat.

With sound waves, disregarding the Brownian movement or the wind, the vibrations of air molecules pass from one atom to another with no continuous linear motion of air molecules in the direction of propagation. Electromagnetic waves must also be conveyed by small displacements of electricity: electron vibrations induced from one to another by the electro-magnetic field, or action-at-a-distance. Are these free electrons? Unlikely, except in an ionised layer. So this brings us back to "What is a displacement current?"

The only good theory I can offer is that of Dr Moulin (JIEE 1941, V86 p113) who showed that the electron orbits of a dielectric appear to be displaced when a capacitor is charged. The orbits move towards the positive plate by an amount depending on the potential gradient and the construction (permittivity) of the atoms.

Consider hydrogen atoms between two charged plates. The electron's orbit is displaced towards the positive plate, the distance being kE, where k is the permittivity. The distance may also depend on the gas-pressure, which controls the breakdown voltage, but let us keep it simple. An alternating voltage (r.f.) on the plates will cause the electrons to move up and down while the slower, heavier, nucleus will scarcely move.

Now consider the same simple atoms near to a conductor carrying a direct current. The electrons moving in the wire will repel, and be repelled by (inductance), the electrons in the gas. So the orbiting electrons tend to move in a plane parallel to the wire, or the orbit tends to be warped to be at right-angles to the wire regardless of its original axis, giving a magnetic field. This will give a gyroscopic precession, but more about that later. The orbits of the atoms can be likened to a flattened chain-mesh, the amount of warp depending on the current in the wire and the permeability of the atoms. With an r.f. current, the warp will flatten the mesh first on one side and then on the other.

But there is another effect to be noted. Due to repulsion the orbit is not merely turning over, it also moves in the direction of flow in the wire, or the warp includes a voltage component. Similarly when the orbit moves in an electric field the spiralling up and down produces the equivalent of a warp, so there is a magnetic component.

Now consider the atoms around a dipole aerial. The orbital motion would now be: 'Up'; going down and warping forwards; losing warp until 'Down'; going upwards and warping backwards; losing warp until 'Up' again. It should be noted that the warp is greatest, most tilted, when the voltage passes through zero, or the maximum electric and magnetic components are 90° out of phase.

Then there is the gyroscopic precession which causes the warp to turn outwards also, always away from the aerial. (Fleming's Rule). So the full motion is: Horizontal-Up; downwards forwards and outwards; downwards forwards and inwards to Horizontal-Down; then upwards backwards and outwards, upwards backwards and inwards, to Horizontal-Up. The motion of any one orbit will induce similar motion in adjacent orbits giving radiation as a wave of electromagnetic energy.

Such a picture of orbital displacement requires no photons. It explains how a polarised electromagnetic wave can radiate outwards, to be propagated with any value of energy. The Planck quanta is only required to cause an electron to escape from its atom in a photo-cell. It will also explain most, perhaps all, the phenomena associated with radio propagation: refraction, scattering, Luxemburg effect, etc.

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Berks

MIXED LOGIC

Writing in reply to Mr Catt's letter 'Mixed Logic' in the August 1983 issue of Wireless World, his points shall be answered in the order in which they were made.

1. I agree with Mr Catt that the 'flag' or 'polarity indicator' is *not* a new symbol. Details of this symbol and also the 'small circle' symbol for the 'negation indicator' are covered in depth in British Standard 3939, Section 21, July 1977.

My use of the word 'new' was purely in the context of the article!

2. British Standard 3939, Section 21, July '77 is obviously in complete disagreement with Mr Catt's quotation from US MIL-STD-806B (26 February 1962), in that the British Standard (A.4.2.) describes the negation indicator (small circle) as indicating logic reversal, or Not operation.

A.5.1. of the same British Standard states that use of the 'polarity indicator' (flag) automatically involves the Mixed Logic convention, and defines which logic convention (voltage) is in force at the interconnection interface.

B.S. 3939 attributes completely different functions to the two symbols. How does US MIL-STD-806B define the 'flag' symbol?

3. Outright condemnation of the 'oblique slash' does appear to be a rather impulsive reaction!

It is agreed that an oblique slash is used to indicate multiple lines, but it is also associated with a digit to indicate the number of lines symbolized.

i.e. . . . 8/

The Not action 'slash' proposed does not have a digit appended, and is drawn with a thicker stroke.

i.e. . . . /

4. It was Mr Cassera's excellent article which prompted me to write my own; in an attempt to both reinforce his arguments and then to extend them.

The main thrust of my article was to promote adoption of 'Mixed Logic' principles, and to this end I can only give credit to British Standard 3939, Section 21, July '77. (Which I don't feel the need to supply at cost, as it is readily available!)

My only agreement with Mr Catt is in his point that this is an important and neglected subject.

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Essex

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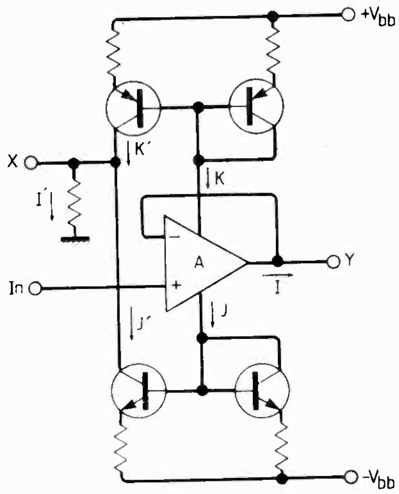
CIRCUIT IDEAS

Current sensor uses op-amp

Found convenient for measuring current without breaking a circuit, this sensor uses an op-amp and current mirrors. If the amplifier input impedance is high, output current, I=K−J, is the difference between the two supply currents, and current mirrors deliver I′∼I to Z. Accuracy of 99% is possible from 0Hz to a frequency limit set by the op-amp. This accuracy can be obtained even when the amplifier is overloaded, but the voltage at Y will not equal the input.

If Z is resistive, voltages at X and Y can be used to exhibit the I/V characteristic of any load between Y and ground; examples of loads are electromechanical transducers, thermistors, current limiters and non-linear reactances. When point X is connected to the input, the open-circuit system is stable with an impedance −Z from Y to ground and it is possible to design a signal source with a negative output impedance which can be used to improve the Q of a reactive load. For most applications, a 741 amplifier with 15V rails and a value of 100Ω for the four resistors is adequate, but higher power and frequency devices may be used.



F. N. H. Robinson
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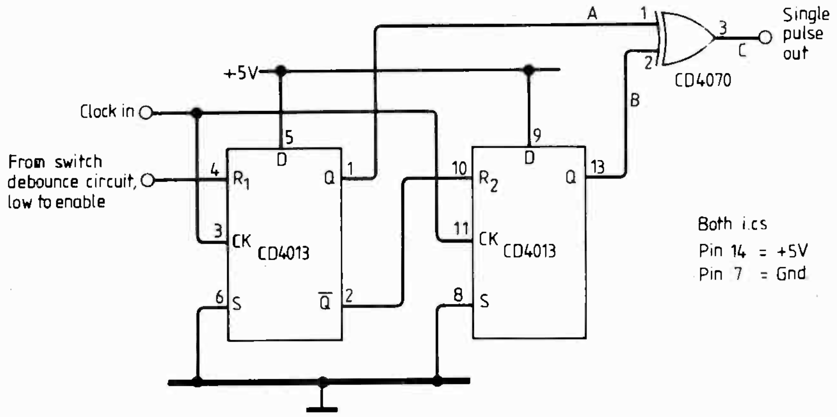
Precise single pulses

Gating to give single pulses whose width is exactly one clock cycle can be formed using only two i.cs – a dual D-type flip-flop and ¼ of a quad exclusive-or i.c. Debouncing is needed for a manual switch.

D. A. Haines
Bromley
Kent



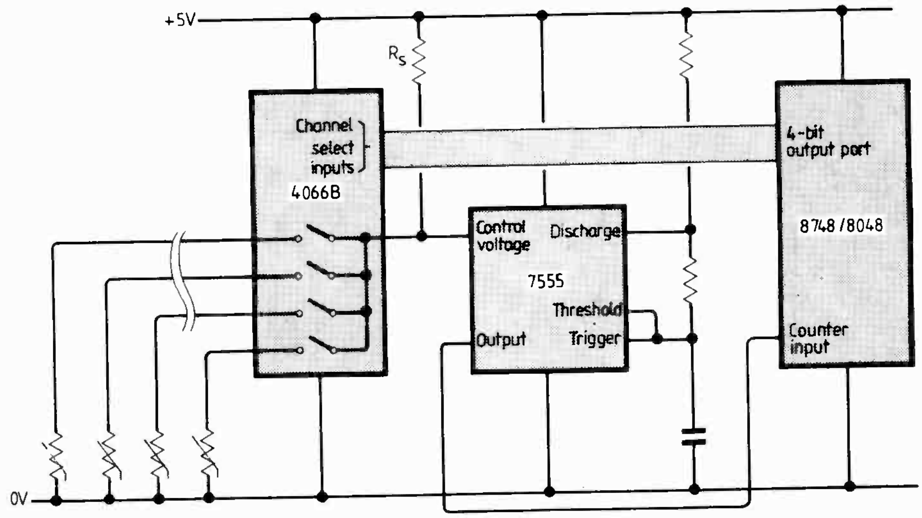
	CK	R_1	Q_1	$\bar{Q}_1$	R_2	Q_2	A	B	C
Clock n	↑	1	0	1	1	0	0	0	0
n+1	↑	0	1	0	0	0	1	0	1
n+2	↑	0	1	0	0	1	1	1	0
	X	1	0	1	1	0	0	0	0

X = don't care

Economical multi-channel measurement interface

Values of a number of thermistors – or other variable resistances – may be converted into digital form for reading by a microprocessor using this simple circuit. A cmos 555 timer oscillates at between 10 and 50kHz with a 100:1 to 20:1 mark-space ratio and its control voltage pin is grounded, through one of a number of resistors to be measured, by an analogue switch; these resistors are around 20kΩ, one of them forming a reference value. Resistor R_s acts as part of a potential divider and should be approximately equal to the reference resistor.

The microprocessor selects a channel through the analogue switch and counts timer oscillations over a given period. Resistance changes in a channel alter the mark period but the space period remains constant and a few thousand counts can be made in around 100ms, so all channels may be scanned in less than 1s. Use of a reference resistor allows frequency errors due to temperature, voltage and other changes to be cancelled by software. If the resistors are thermistors the circuit can resolve 0.1°, absolute accuracy depending only on stability of the reference resistor.



Unknown resistors are sensed using d.c., so connections may be long without radiating a.f. signals. Integration eliminates 50Hz interference if the count period is a multiple of 20ms and h.f. spikes merely add or subtract one or two counts in one or two thousand.

R. J. Milburn
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County Durham

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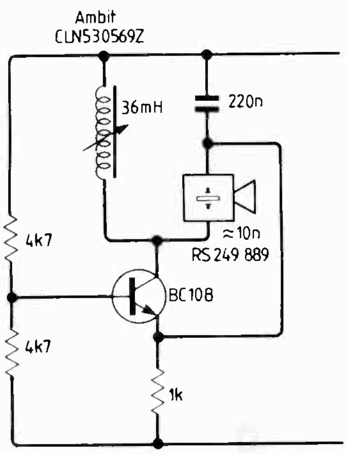
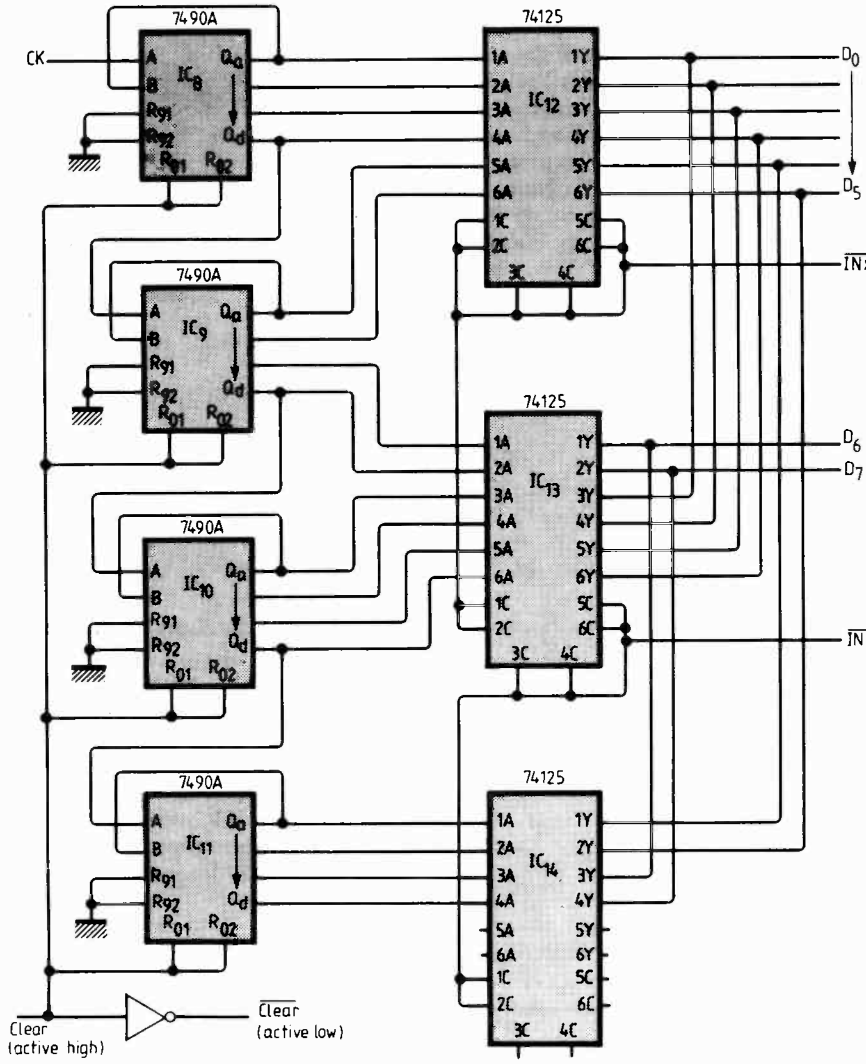
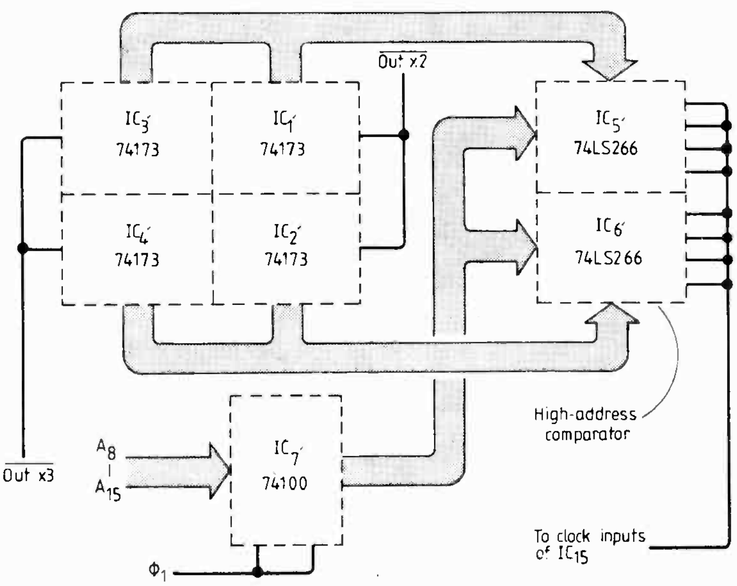
Low-power alarm

Here is a simple low-power sounder using an inductor to increase the voltage across a piezo-electric audible warning device. The circuit includes a Colpitts oscillator with a variable inductor, which is tuned to suit the sounder resonant frequency. Using the sounder as part of the tuned circuit means that the r.m.s. voltage across it is multiplied by the loaded Q of the tuned section and the resonant frequency pulls toward that of the sounder. These factors combine to give a piercing 5kHz whistle suitable for burglar alarms, etc., at supply voltages down to 4V with a current drain of 2.5mA. I included a simple latching arrangement to make the circuit suitable for burglar alarms, etc.

Steve Kirby
University of York
Yorkshire







Note: C,M,N, G1, G2 connections of IC1', IC2', IC3', IC4' are the same as for IC1, IC2, IC3, IC4 respectively

State/cycle counter for 8080 processors

Designed for 8080-based systems, this digital circuit accurately measures program or program-segment execution time by counting machine states and aids debugging by counting machine cycles. Initialization of the circuit occurs when the monitor loads 16-bit start and finish addresses of the program segment to be traced. Start and finish low-byte addresses are loaded from the accumulator into buffers $IC_{1,2}$ and $IC_{3,4}$ by executing say OUT x,0 and OUT x,1 instructions respectively. Executing OUT x,2 and OUT x,3 instructions will load high-byte start and finish addresses into buffers $IC_{1',2'}$ and $IC_{3',4'}$ respectively.

Buffers $IC_{7,7'}$ latch current low and high addresses from the address bus during each machine state. Both buffers are controlled by $\phi 1$ clock pulses, during which time the address on the address bus

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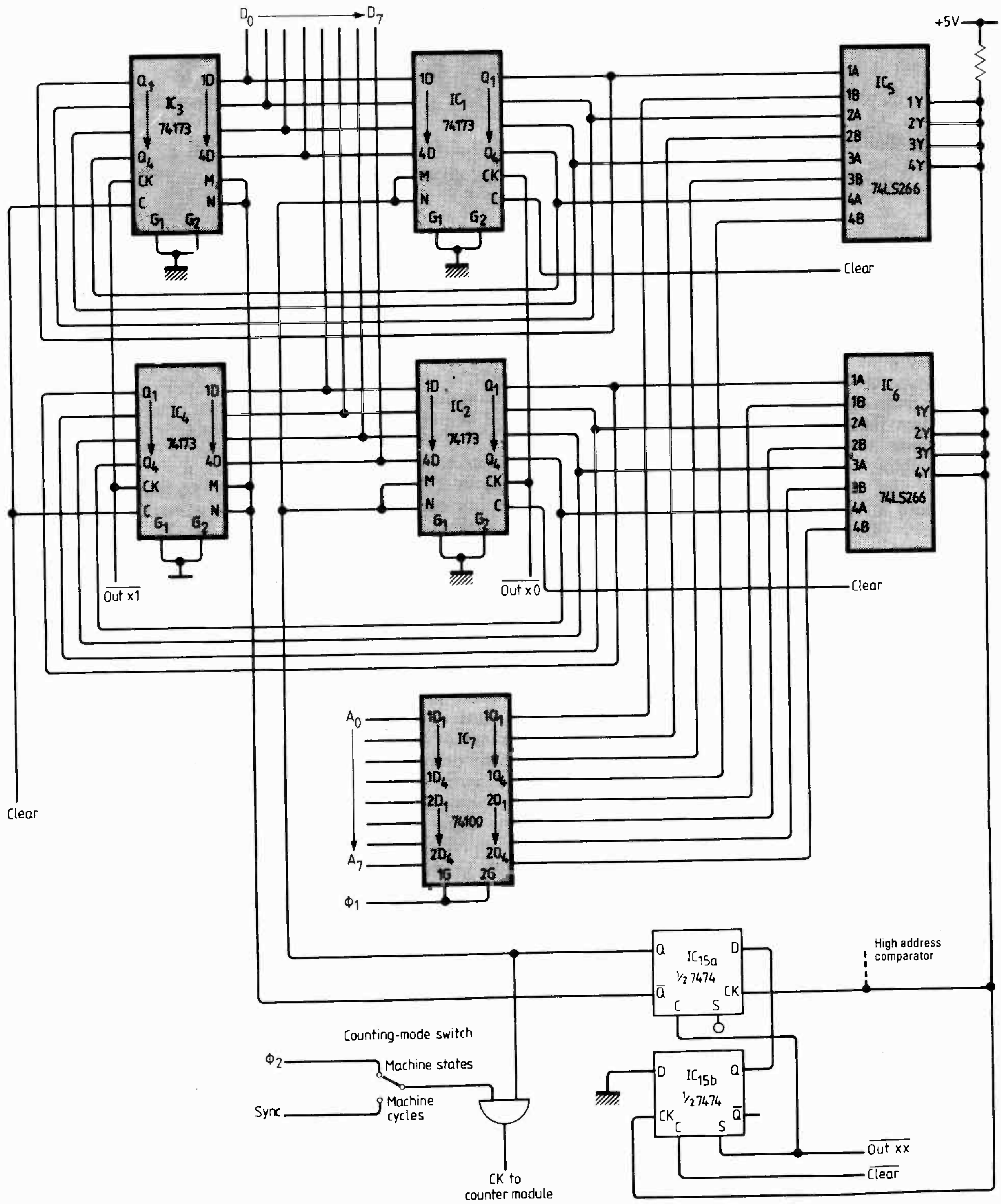

is stable. The latched address is continuously compared with the starting address using exclusive-nor gates of $IC_{5,6}$. When matching is detected the clock input of IC_{15a} goes high causing the flip-flop to reset which inhibits the counting operation of IC_8 to IC_{11}.

Reinitialization is required to repeat the counting operation; the clear line may be connected to the processor reset input to reset the counters, buffers and IC_{15b} when the system is reset or reinitialized. This inhibits the counter prior to initialization. When system control is returned to the monitor you can put counter data into the accumulator using say IN x,0 and IN x,1 instructions. This module can count 10 000 states or cycles but it can be expanded using tri-state drivers like IC_{12} to IC_{15} and software.

Any port number can be used for the OUT instruction. The inverted signal derived from this instruction is used during initialization to set the D input of IC_{15a} and reset its output which allows the starting-address matching process to begin. When machine-state mode is used, compensation should be made for the number of uncounted machine states in the final machine cycle detected.

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Heliopolis
Cairo

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16-line p.a.b.x with options

A flexible electronic/electromechanical p.a.b.x using i.cs wherever possible to provide quiet operation.

After successfully constructing L. D. Gunn's 10-line exchange (WW August 1980, pp 41-45) I felt that more facilities were necessary which led to the construction of this flexible private automatic branch exchange, p.a.b.x, with optional facilities and equipment status feedback. As some of the facilities are not directly related to the system they may be included or omitted as required.

To obtain flexibility each of up to 16 stations is in fact a full switchboard which eliminates the need for a centrally supervised switchboard. The block diagram shows the modular construction of the system which offers the following.

- internal conversation between each of the stations with full privacy.
- accepting incoming exchange calls at each station with automatic switching of the incoming call to the position taking the call.
- making of outgoing exchange calls from each station with the option of inhibiting out-dialling from selected stations as required.
- transfer of incoming or outgoing calls between any station.
- visual indication at each station signalling incoming exchange call, exchange line occupied and hold mode.
- line hold when transferring calls or when having private consultations with 'music-on-hold' option for party on line.
- optional timer or manually controlled ringer as an alternative to going off hook or unplugging when telephone intruders are not wanted. Visual indication and access to the exchange line are retained.
- optional connection of an outdoor telephone with electronic door opener.
- BT compatibility with full galvanic separation.
- one-person transfer, that is, put an incoming call on hold, replace handset and pick up the conversation from any other station.
- optional on/off switching of electrical equipment from any station both in continuous and pulse mode. The total number of stations and remote switches connected will however be limited to 16.

Finally, some features like hold and visual signalling of incoming calls facilities may be used separately, the latter being useful for the hard of hearing and those frequently using headphones. Relay contacts could be used to disconnect the headphones.

As outlined in the aforementioned

by J. H. Kuiper

original project, uniselectors and i.cs have their disadvantages. In this design, i.cs are used instead of relays wherever possible, which results in a relatively quiet electronic/electromechanical system. To make the diagrams easier to follow, only full details for connecting one station are given. Up to 16 further stations are connected to the main bus in the same way as the first. Details for modifying the telephones will be given. Each station connected requires an originator relay, O, having three contacts, a terminate relay, T, having two contacts and a ground relay, G, having four contacts. Six diodes per connected set are required in addition to one normally-closed contact on the K and Q relays. In the diagram only one internal-control K relay and one external-control Q relay are drawn. Ignoring these n.c. contacts, K and Q relays each have two contacts. Since the usual maximum number of contacts on a relay seems to be six, additional K and Q relays will be required, the number depending on the number of stations connected. These are connected in series or parallel with the first relays depending on the coil resistance of the relays used.

In the terminator, T relays are driven from the 4514 decoder using transistors. Table 1 lists the 16 outputs of the i.c. To simplify construction a driver i.c. is used. Since one array contains seven drivers the maximum of 16 stations would require two of these driver arrays and two discrete n-p-n transistors. Any combination of components can be selected as long as all emitters of the separate drivers are connected to pin eight of the arrays and

Table 1. Sixteen outputs of the 4514 decoder used in the terminator.

Output	Pin	Number
0	11	79
1	9	70
2	10	11
3	8	12
4	7	13
5	6	14
6	5	15
7	4	16
8	18	71
9	17	72
A	20	73
B	19	74
C	14	75
D	13	76
E	16	77
F	15	78

*Suggested dialling numbers for stations 11-16 and 70-79.

pin nine is connected to V_{dd}. Table 2 lists the seven in and outputs of the array. The array has internal diodes so T relays may be connected directly.

Operation

Internal conversation. Lifting the calling station handset completes a circuit from

System block diagram

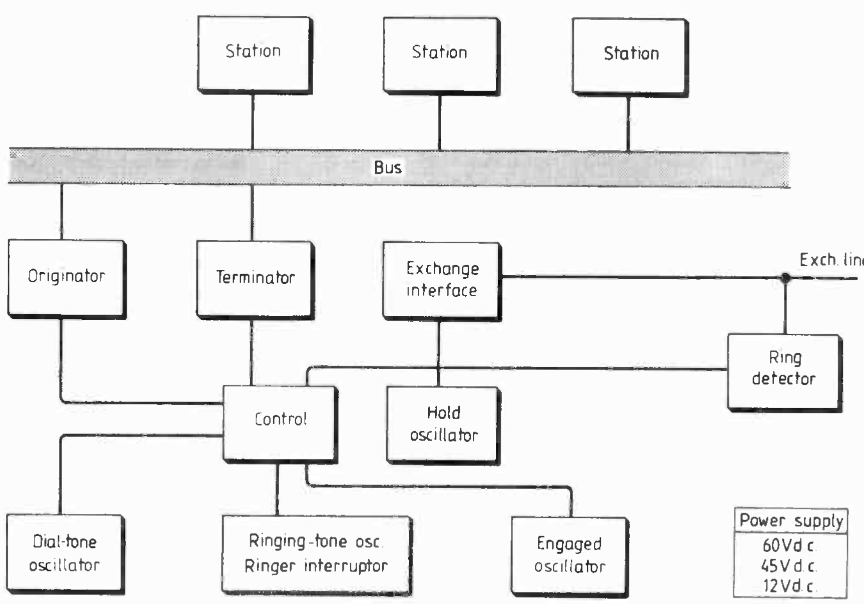

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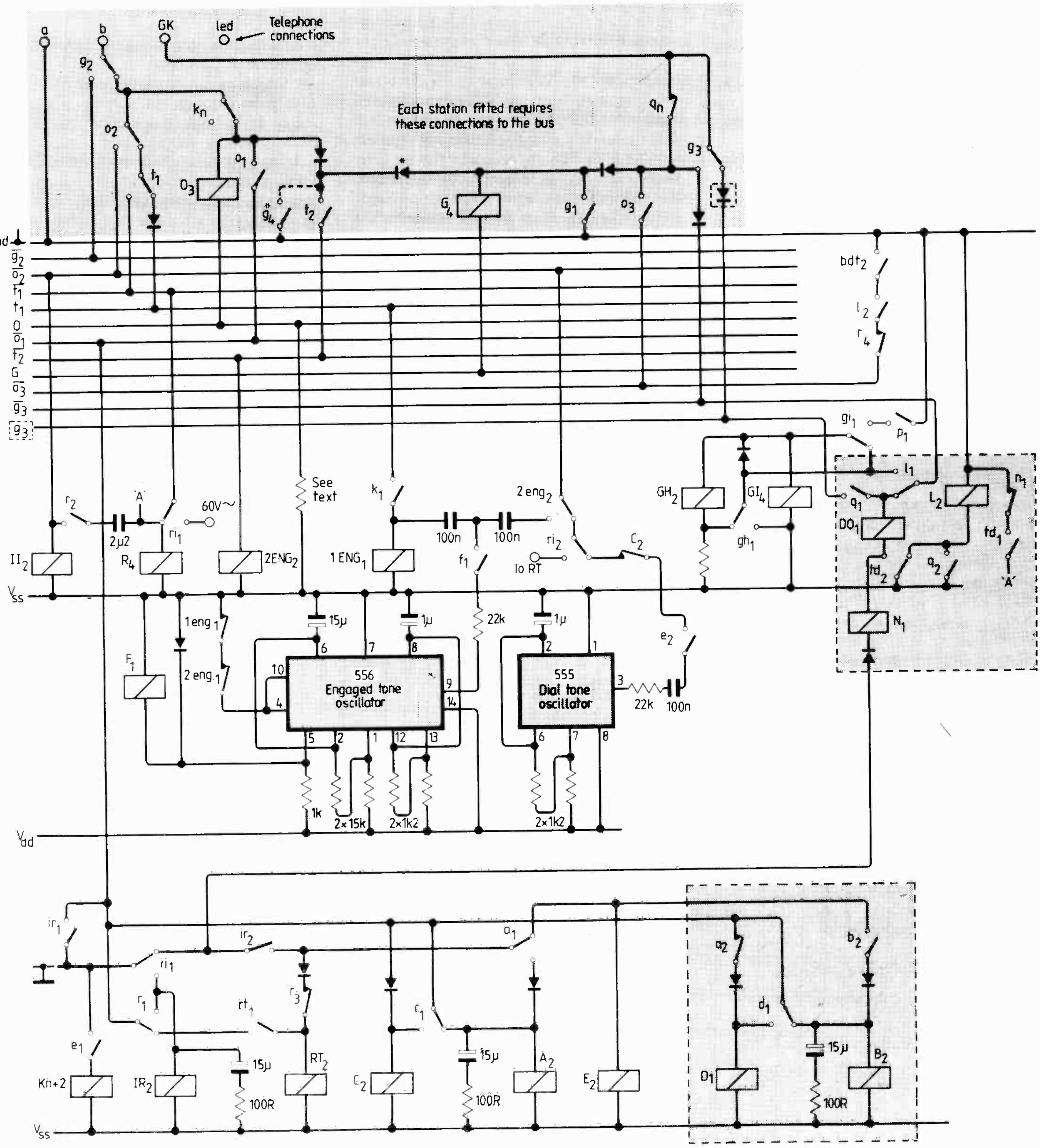
Table 2. Input/output pins of the ULN2003 driver i.c.

In	Out
1	16
2	15
3	14
4	13
5	12
6	11
7	10

Note ULN2003 equivalents are SN75468, XR2203 and RS307-109.

ground through the a line, telephone b line, the calling station g_2 and k contacts, the Q coil and back to V_{ss}. Contact o_1 prepares a holding path for O, o_2 operates internal-interrupter relay II and o_3 will be discussed later. Contact ii_2 in the terminator switches without effect due to b_2 still being closed while ii_1 operates reset relay IR in the internal control. An internal control path is set up by ir_2 and ir_1 holds relay O through o_1 and operates relays A B and E. Contact a_1 prepares an additional holding path for A, a_2 prevents D from switching, b_1 prepares a hold for B (all internal control) and b_2 in the terminator unlocks the terminator input bistable whose output is logical zero. Contact b_2 also partially enables the 40161 i.c., prevents T drivers from operating to disable the bell during dialling, and therefore inhibits the ringing-tone oscillator/interruptor. Contact e_1 powers the K coil and e_2 completes the dial-tone path from its oscillators through e_2, c_2, ri_2, $2eng_2$ and the calling station o_2 and g_2 relay contracts to inform the caller that origination is complete and dialling may start.

Dial-tone oscillator DT consists of a



Main switchboard circuit comprising originator, internal control, recall and engaged/dial-tone oscillator sections. The system can accept up to 16 stations but only one interface is shown for clarity. Each station connected to the bus requires an originator relay, a terminator relay, a ground relay and six diodes.

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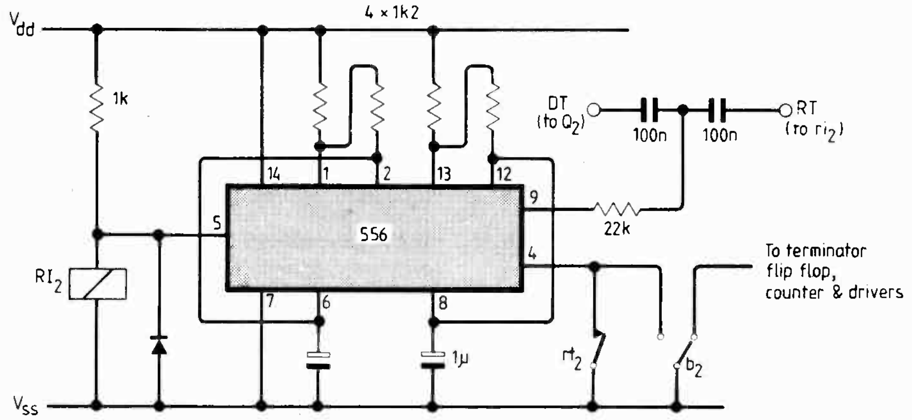
free-running 555 timer generating an internal dialling tone of around 400Hz. Relay(s) K, operated through e_1, switch the appropriate number of k contacts as follows. Contact k_1 prepares an operating path for the 1ENG relay while k_2 in the terminator keeps completes enabling of the 40161 counter and allows the 4514 decoder to operate. Further k contacts disconnect all sets from their respective originator relays, the coil of the calling set being held as explained above. Any further handset lifted from this point on will cause the 1ENG relay to operate by making a path through ground, the a line, the station wanting to make the call, the b line, its g_2, o_2, and t_1 contacts, k_1 and 1ENG to V_{ss}. Contact leng_1 now starts the 556 engaged oscillator which produces a high-pitched tone interrupted at 2Hz intervals by relay F. Through an attenuator, f_1 and a decoupling capacitor, this busy signal passes to the second caller by means of t_1, o_2 and g_2 contacts. Contact o_2 prevents the original caller from being disturbed by the busy signal.

Dialling takes place since internal interruptor relay II follows dial pulses sent from the originating station. Contact ii_1 switches RT through r_3 and C on the first pulse of the first digit. Following events

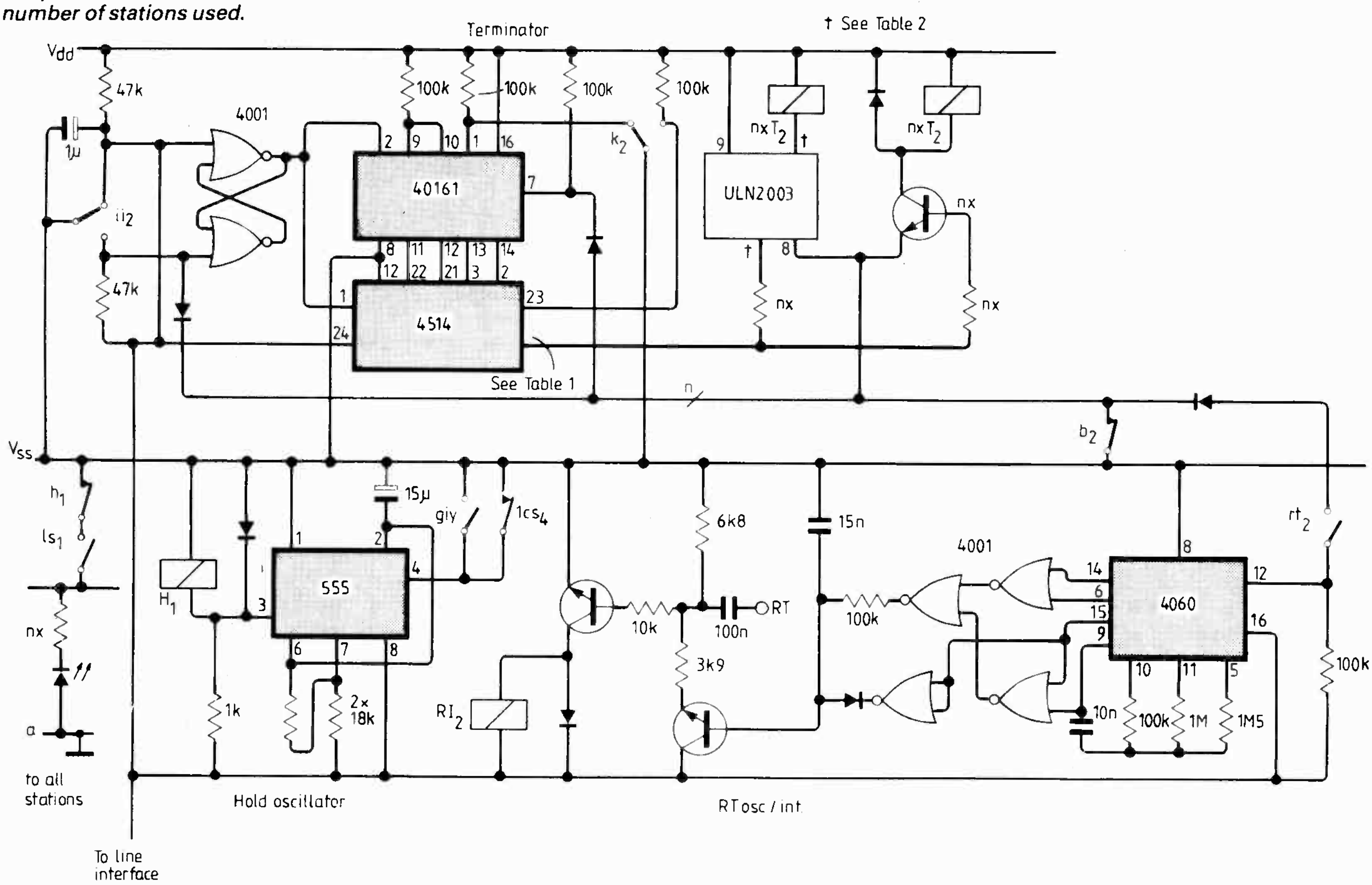


Alternative 556 dial-tone oscillator/interruptor. Resistors connected to i.c. pins 1, 2 and 6 are selected to give the desired ring-interruption period.

caused by the switching of ii_1 first and looking at ii_2 later, rt_1 will hold relay RT energized through contacts r_1 and ir_1 will hold relay RT energized through contacts r_1 and ir_1 while rt_2 prepares the ringing-tone oscillator/interruptor for operation. In the internal-control section, c_1 holds relay C on through ir_1 and connects the initial operating path of relay A through ir_1 Relay A is slow to release because of its RC shunt and remains energized through a_1, ir_2 and ii_1 in spite of ii_1 switching on and off while following dial pulses. Meanwhile c_2 disconnects the dial tone from the calling station. Internal-reset relay IR also has an RC shunt slowing its release so pulsing through contacts ii_1 has no effect. After the final pulse of the frist digit dialled, ii_1 continues to hold IR for a while. Contacts ir_2 and a_1 set up an additional holding path through b_1 for relay B while a path for relay D is made through contacts ir_2, a_1 and a_2.

Dialling the second digit causes a similar action now involving relays D and B. Switching of ii_1 operates relay D on the first pulse through contacts ir_2, a_1 and a_2. Relay D is held by contacts ir_1 and d_1. Slow releasing relay B loses its previous holding path through d_1 but is energized as long as pulsing of contacts ii_1 continues through contacts ir_2, a_1 and b_1. It disengages shortly after the last pulse of the second digit dialled. Breaking of contact B_1 and previous opening of contact a_1 prevents further dialling pulses from having effect since relays C and D remain powered. Finally, b_2 in the terminator closes. Blocking diodes ensure that only the required relays operate and eliminate bounce effects from contacts ii_1.

How the system manipulates incoming and outgoing calls is described in the next section.



In the terminator, positive-going edges of pulses produced by contact ii_2 operate the 4016 counter. Negative-going edges operate the 4514 decoder/latch connected to the counter output and latch output drives the selected relay coil through a buffer transistor in the ULN2003 array. If sixteen stations are used, two array. If sixteen stations are used, two arrays and two discrete transistors are required. Unspecified values are selected to suit the number of stations used.

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Forth language

Selecting a processor to suit the language, and control structures are subjects of Brian Woodroffe's second article illustrating why he designed his computer around Forth.

by B. Woodroffe

Forth's speed is directly related to how efficiently the computer can execute the NEXT operation. The Table shows how NEXT is coded for some popular eight-bit microprocessors; the 6809 processor executes the operation quickly so a NEXT operation may be included at the end of code routine. This improves performance since the 'JMP NEXT' operation needed for most processors is avoided – in stark contrast to conclusions drawn from one manufacturer's benchmark tests[7].

NEXT is the virtual-machine instruction fetch so the choice of a processor to run Forth on should be dominated by speed and memory costs of the NEXT operation. Further, 6809 registers exactly match those required for Forth as can be seen in List 2. Machine code in the host computer represents the Forth machine, the Y register taking on the role of the Forth program counter. Following examples of simulating the virtual machine, in 6809 machine code, confirm that this processor is well suited to Forth.

The stack

So far, only the control mechanism by which Forth transfers control from one word to the next has been described, but the language must also control and manipulate data. This, too, is done by means of a stack, but this storage area is known as a data stack, as opposed to the one previously described which is known as the 'return' or 'control' stack. Separation of the stacks simplifies things; normally, data and control operations use the same stack. The stack is further broken down into 'frames' with markers to denote which part is what. In Forth all operators, such as the words + and AND, may remove instructions from the stack, destroy them, manipulate them and push results back onto the stack many times. This has the advantage that operators need not be told where their operands are, which results in less code. A computer operating this form of addressing is known as a zero-address machine, for operand addresses are implicit in the instruction. These words may be in the machine code of the target computer or determined using words already defined.

List 2. Registers of the 6809 suit Forth requirements.

6809 register		Forth usage	
S	stack pointer	RP	return stack pointer
U	user stack pointer	SP	data stack pointer
Y	index register	IP	instruction pointer
X	index register	W	current c.f.a.
D	accumulator	–	accumulator

Using a stack avoids problems caused by parentheses and operator precedence. As far as the computer is concerned the problem is solved, List 3, but programmers used to infix notation may find postfix notation (reverse-Polish notation) difficult, e.g.

Postfix	Infix
34+56+×	(3+4)×(5+6)

Table. Coding and performance analysis of the Forth NEXT operation for popular eight-bit microprocessors.

Processor	6809	6800	Z80/8085	8088	6502

Code	LDX 0,Y++
	JMP [0,X]
		JMP NEXT
		LDX IP
		INX
		INX
		STX IP
		LDX 0,X
		STX W
		LDX 0,X
		JMP 0,X
			JMP NEXT
			LDAX B
			INX B
			MOV L,A
			LDAX B
			INX B
			MOV H,A
			MOV E,M
			INX H
			MOV D,M
			XCHG
			PCHL
				JMP NEXT
				LODS AX
				MOV BX,AX
				MOV DX,BX
				INC DX
				JMP WORD PTR [BX]
					JMP NEXT
					LDY #1
					LDY [IP],Y
					STA W+1
					DEY
					LDY [IP],Y
					STA W
					CLC
					LDA IP
					ADC #2
					STA IP
					BCC L
					INC IP+1
					L JMP W−1

Memory bytes	4	17	14	11	28
Processor clock cycles	14	44	60	58	43
Normal cycle time (μs)	1	1	0.25	0.2	1
Total time (μs)	14	44	15	11.6	43
Memory-access (ns)	695	530	250(Z80)	450	650
Time for 450ns-access memory (μs)	9	37	27	11.6	29.7
Speed relative to 6800*	4.11	1	1.37	3.19	1.25

*Value rises proportional to speed.

List 3. Some 6809-code arithmetic routines including add, subtract and two's complement.

```
"+"     FDB $+2
        PULU D
        ADDD 0,U
        STD 0,U
        NEXT
MINUS   FDB $+2
        LDD #0
        SUBD 0,U
        NEXT
@       FDB $+2 (fetch)
        LDD [0,U]
        STD 0,U
        NEXT
!       FDB $+2 (store)
        PULU X
        PULU D
        STD 0,X
        NEXT
DUP     FDB $+2
        LDD 0,U
        PSHU D
        NEXT
OVER    FDB $+2
        LDD 2,U
        PSHU D
        NEXT
SWAP    FDB $+2
        PULU D,X
        EXG D,X
        PSHU D,X
        NEXT
DROP    FDB $+2
        LEAU 2,U
        NEXT
```

NEXT is defined as a macro instruction.

Parameters are also passed between separate lists using the stack. The word consumes as many stack elements as required and pushes back its results. Some defined Forth words for subtracting and doubling the top of the stack respectively are

```
"–"FDB DOCOL      "2*"FDB DOCOL
   FDB MINUS          FDB DUP
   FDB ADD            FDB PLUS
   FDB SEMIS          FDB SEMIS.
```

Language control structures

As has been shown, Forth passes control from one item in a word to the next and results are calculated. These words can be either machine-code words or pointers to other words. How control may be diverted to form if-then-else or repeat-until structures is the following subject, starting with an explanation of how Forth tests for true or false conditions by simply considering a non-zero value at the top of the data stack as a true condition. Examples of conditions that create these flags are '0=', '0<', '=' and '<' in the form of code words or Forth words, as appropriate, Lists 4, 5. Diversion of control is carried out by Forth

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List 4. Code routines leaving a flag at stack top.

```
0EQUAL  FDB $+2
        LDD #1      assume true (i.e.
                    zero)
        LDX 0,U++   get operand, set
                    6809 flags
        BEQ 0E1
        DECB        was <>0 so set
                    Forth flag
0E1     STD 0,U     put back Forth flag
        NEXT
0LESS   FDB $+2
        LDB #1      prepare true
        LDA 0,U     get sign to A
        BMI 0L1     -?
        CLRB        no, leave false
0L1:    CLRA
        STD 0,U
        NEXT
```

List 5. Forth routines leaving a flag.

```
"="     FDB DOCOL
        FDB SUB
        FDB 0EQUAL
        FDB SEMIS
"<"     FDB DOCOL
        FDB SUB
        FDB 0LESS
        FDB SEMIS
">"     FDB DOCOL
        FDB SWAP
        FDB LESS
        FDB SEMIS
```

words BRANCH and 0BRANCH, the former taking the next storage cell as a branch offset and the latter branching or not depending on the value at the top of the stack. If the flag is false, the threaded-code instruction pointer, ip, is incremented by the offset value contained in the next program storage cell. When the flag is true, this offset is skipped and execution continues with the next word. Controlled loops may also be constructed. Using 'begin . . . until' structures, statements between are executed so long as the flag at the top of the stack remains false. Iterative loop type structures such as '100 TIMES DO' are handled by taking initial and limit loop indexes off the data stack and storing them on the control stack. At the potential end of the loop the current index is incremented and compared with the limit. If the limit is exceeded a branch is executed as described above, otherwise the indexes are deleted and the offset skipped to continue execution, List 6.

List 6. Code for diverting control flow if the flag at the top of the stack is false.

```
0BRANCH: FDB $+2     6809 code
         LDD ,U++    test and delete
                     Forth flag
         BNE 0B1     <>0, branch if true
         LDX 0,Y     get jump offset in
                     X
         LEAY Y,X    add offset
         NEXT
0B1:     LEAY 2,Y    skip over offset
         NEXT
BRANCH   FDB $+2
         LDX 0,Y
         LEAY Y,X
         NEXT
```

```
: ROOTS                 ( stack ..c b a start defining new word 'ROOTS' )
   SWAP MINUS           (       ..c a -b )
   OVER                 (       ..c a -b a )
   DUP +                (       ..c a -b 2a quicker than 2* )
   /                    (       ..c a -b/2a )
   ROT ROT              (       ..-b/2a c a save -b/2a )
   /                    (       ..-b/2a c/a )
   OVER DUP*            (       ..-b/2a c/a -b/2a*-b/2a )
   +                    (       ..-b/2a b**2/4a-a/c )
   DUP 0<               ( is top less than 0, ie imaginary roots? )
   IF                   ( test flag )
     DROP DROP          ( delete partial results, send <cr><lf> to terminal )
     CR ." imaginary roots" ( and print message )
   ELSE
     CR                 ( real roots, send <crc><lf> to terminal )
     0                  ( convert 16-bit positive number to 32 bits )
     SQRT               ( get back square root )
     OVER OVER +        ( duplicate both parts of answer and get 1st result )
     ." roots are" .    ( print message and first answer )
     ." , and" - .      ( print message and other answer )
   ENDIF                ( continue execution )
   CR ;                 ( send <cr><lf> and stop compiling return to execution )
```

List 7. Forth code used to calculate the roots of a quadratic equation. The stack is represented across the page with the top of the stack at the right.

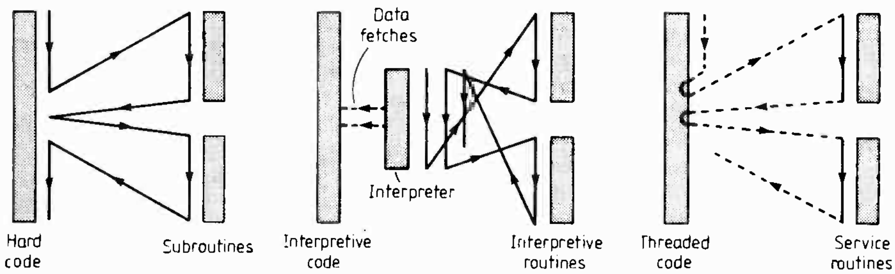
Using Forth

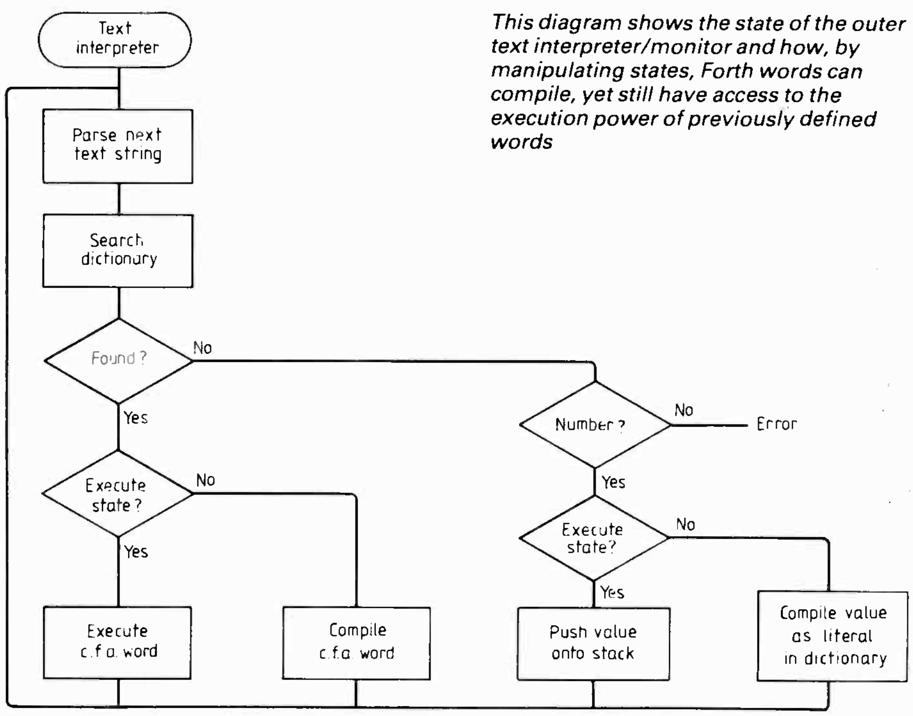
List 7 is an example of a Forth routine for calculating the roots of a quadratic equation, given that the indexes are on the stack. Forth has the shortcoming that it only handles integer arithmetic so non-integer results will be incorrect. The program example illustrates a number of Forth concepts, e.g., stack manipulation, passing parameters and terminal output. Words used in the program are explained in the next article, as are the dictionary and compiler.

Reference

7. Intel iAPX88 Book, July 1981, appendix pp. 20-36.

Three flow diagrams compare, from left to right, hard code, interpretive code and threaded code.





This diagram shows the state of the outer text interpreter/monitor and how, by manipulating states, Forth words can compile, yet still have access to the execution power of previously defined words

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Digital filter design techniques

A survey of the most widely used techniques for the design and implementation of digital filters, with comparisons based on the authors experimental work.

by R. N. Gorgui-Naguib and K. M. Henein

Digital filters are classified into two categories based on finite and infinite impulse response. Finite response or non-recursive filters have a finite duration impulse response, while infinite response filters have an impulse response of infinite duration due to their recursive structure. This fundamental difference in structure dictates different design approaches to be adopted for the two types of digital filter.

Finite response filters can have linear phase and may be designed by several techniques, of which the following are considered:

- frequency sampling
- window method
- optimal design methods.

For the design of infinite response filters, however, there are two different approaches. The first is a direct approach in which the coefficients of the digital filter are determined by some computational alogorithm directly from the filter specifications. The second, indirect, approach is to determine the coefficients from the corresponding analogue filter transfer function. The following methods based on these concepts are compared:

- numerical methods
- impulse invariance method
- bilinear transformation.

FIR filter design

Finite impulse response filters have two distinct properties: they are always stable, and second, if they are not causal, they can always be made to be causal by introducing finite delays. Because of these two properties, the design of f.i.r. filters can be simplified. The system functions can be expressed as

$$H(z)=\sum_{n=0}^{N-1} h(n).z^{-n}$$

where h(n) is the N-point impulse response of the f.i.r. filter and H(z) is the z-transform of the sequence evaluated on the unit circle. Such a filter can be implemented as a set of taps and delay blocks leading to the general f.i.r. filter structure shown in Fig. 1. The most important of the various techniques for design of these filters are discussed in detail.

Frequency sampling technique

A finite-duration sequence can be represented by its discrete Fourier transform. Considering the equation given earlier, h(n) can be obtained merely by taking the inverse discrete Fourier transform:

$$h(n)=\frac{1}{N}\sum_{n=0}^{N-1} H(k).e^{j2\pi kn/N}$$

so that

$$H(z)=\sum_{n=0}^{N-1}\frac{1}{N}\sum_{k=0}^{N-1} H(k).e^{j2\pi kn/N}.z^{-n}$$

which ultimately can be written in the form

$$H(z)=\frac{1-z^{-N}}{N}\sum_{k=0}^{N-1}\frac{H(k)}{1-e^{j2\pi k/N}.z^{-1}}.$$

This equation is the basis of the frequency sampling realisation of an f.i.r. filter. Substituting $z=e^{j\omega}$ in the above equation and using some trigonometric identities gives

$$H(e^{j\omega})=\frac{e^{-j\omega(N-1)/2}}{N}\sum_{k=0}^{N-1} H(k).I_{\omega,k}$$

where

$$I_{\omega,k}=e^{j\pi k(1-1/N)}.\frac{\sin\{N(\omega-2\pi k/N)/2\}}{\sin\{(\omega-2\pi k/N)/2\}}$$

and is called the frequency interpolating function. In other words, the filter is specified in terms of samples of one period of the desired frequency response, and the interpolation is used to complement or fill-in the gaps of the function. The interpolation effect, however, can be a serious drawback because passband and stopband oscillation develops due to the slow convergence of the Fourier series, caused by the discontinuity at the passband-stopband border. This peak at the transition point is known as Gibb's phenomenon.

Window method

The window method overcomes the problems described by some approximating techniques which consist essentially in preconditioning the impulse response h(n) using a class of time-domain functions, or 'window functions', w(n). These functions modify h(n) to get the desired truncated response h'(n) as follows:

$$h'(n)=h(n).w(n) \text{ for } 0\leqslant n\leqslant N-1$$
$$=0 \text{ otherwise.}$$

Using the window method means that

- discontinuities in $H(e^{j\omega})$ become transition bands between values on either side of the discontinuity
- the width of this transition band is inversely proportional to the energy under the main lobe
- side lobes of the window function produce unwanted ripple in the filter stopband.

In an attempt to reach the ideal window, several were proposed among which the following are most important.

Rectangular window. The rectangular window has the function

$$w(n)=1 \text{ for } 0\leqslant n\leqslant n-1$$
$$=0 \text{ otherwise.}$$

It has two serious drawbacks: the side lobes produce large ripple in the stopband and the Gibb's phenomenon problem remains unsolved. To overcome this, it is necessary to 'taper' the ends of the window, considered next.

Generalized Hamming and Hanning windows. Hamming and Hanning windows can be derived from the generalized Hamming window function:

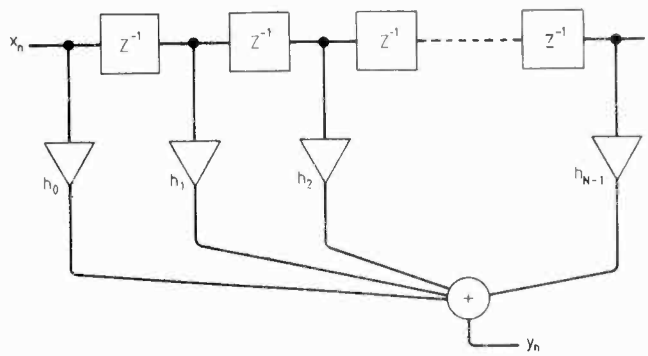

Fig. 1. General finite impulse-response filter structure with input X_n and output $Y_n.z^{-1}$ represents a delay block while h_n is the nth impulse response.

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$$w(n)=\alpha+(1-\alpha)\cos\frac{2\pi n}{N}$$

$$\text{for } -\left(\frac{N-1}{2}\right)\leq n\leq\frac{N-1}{2}$$

$$=0 \text{ otherwise.}$$

In the case of the Hamming window, $\alpha=0.54$, while in the Hanning window $\alpha=0.5$. These two windows, differing only in the choice of α, present trade-offs between the width of the main lobe and the ripple cancellation.

Blackman window. This window presents an improvement in ripple performance over the Hamming window due to the introduction of an extra cosine term in the function, giving

$$w(n)=0.42+0.5\cos\frac{2\pi n}{N}+0.08\cos\frac{4\pi n}{N}$$

$$\text{for } -\left(\frac{N-1}{2}\right)\leq n\leq\left(\frac{N-1}{2}\right)$$

$$=0 \text{ otherwise.}$$

This last term leads to a further reduction in the amplitude of the oscillation due to Gibb's phenomenon. The effect of applying this window is an increase in transition region width and a decrease in ripple level.

Kaiser window. The attractive property of this window is that it offers two variable parameters which can be adjusted to control the transition region width and the ripple performance. The Kaiser window is

$$w(n)=\frac{I_0\left(\alpha\sqrt{1-\left(\frac{2n}{N-1}\right)^2}\right)}{I_0(\alpha)}$$

$$\text{for } -\left(\frac{N-1}{2}\right)\leq n\leq\frac{N-1}{2}$$

$$=0 \text{ otherwise}$$

where $I_0(x)$ is the zero-order Bessel function of the first kind. In the equation, the value of α controls the ripple ratio and N determines the main lobe width. Unfortunately, this adaptivity gained is at the expense of increasing complexity in computation. Fig. 2 shows the performance of the Kaiser and Hamming windows for the same number of samples.

Computer optimization methods

Optimal design methods are the most accurate and most complex ways for designing f.i.r. filters. Several authors suggest varying the number of frequency samples to improve the filter frequency response by minimizing the maximum deviation between this response and the desired one over the frequency range of interest.

Computer optimization techniques can select the transition points and calculate the maximum out-of-band response as a function of the transition values. Then, the frequency response is interpolated to a predetermined degree of accuracy using the fast Fourier transform.

An algorithm which can be adopted to obtain the solution to the approximation problem is the Remez exchange algorithm, a flowchart of which is given in Fig. 3. In this algorithm, the weighted error function $E(e^{j\omega})$ is minimized so that a unique solution (best solution) is obtained to approximate the required frequency response $H_{DN}(e^{j\omega})$:

$$E(e^{j\omega})=W_N(e^{j\omega})\ .\ \{H_{DN}(e^{j\omega})-P(e^{j\omega})\}$$

and $P(e^{j\omega})$ is the Lagrange interpolation function on r points. $E(e^{j\omega})$ is then compared to a specific resolution, δ, until the optimal approximation is reached.

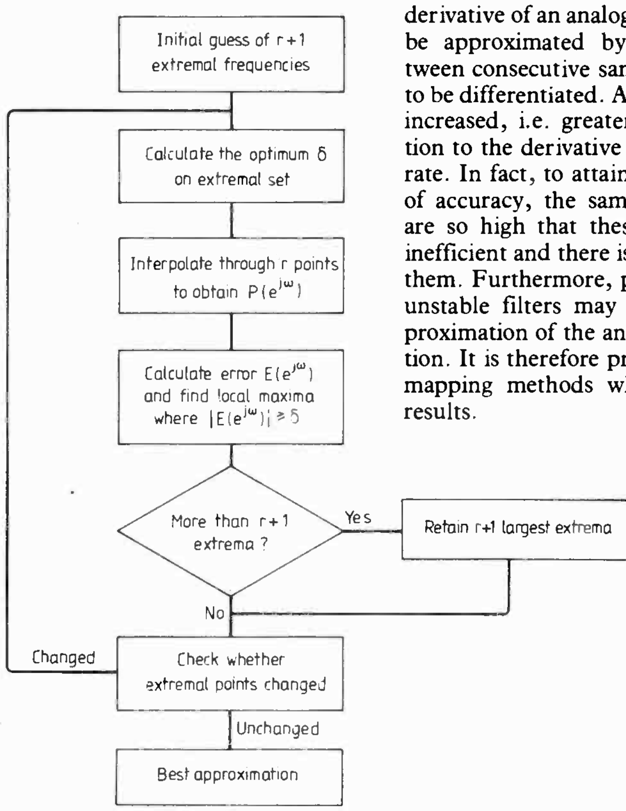

Fig.3. Flowchart of the Remez exchange algorithm shows how it can be used to obtain the solution to the approximation problem. Starting with an initial guess of r+1 extremal frequencies, the error function is forced to have a magnitude δ with alternating signs, then the Lagrange interpolation formula is applied to interpolate P(e^jw) on the r points until the best approximation is obtained.

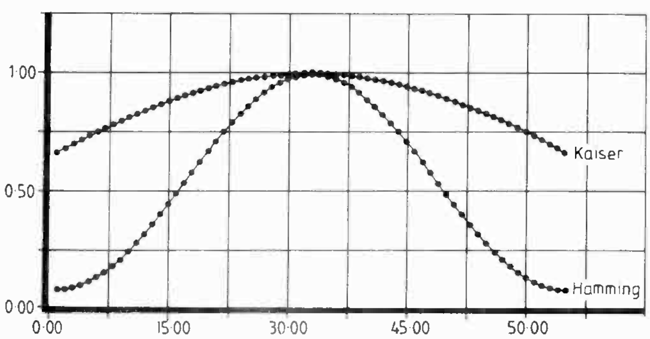

Fig.2. Plot showing the behaviour of Kaiser and Hamming windows (number of samples = 65) for the same cut-off frequency.

Infinite impulse response filter design

The different structure and transfer function of infinite impulse response filters from the previously considered f.i.r. filters dictates different design approaches.

The general i.i.r. filter transfer function is

$$H(z)=\frac{\sum_{n=0}^{N} a_n.z^{-n}}{1+\sum_{m=1}^{M} b_m.z^{-m}}$$

and the problem in the design of such filters is to determine the filter coefficients a_n and b_m so that the filter specifications are satisfied. For this purpose, the following techniques are based on direct and indirect approaches are presented. It should be mentioned that i.i.r. filter design methods relying on the indirect approach are simple to realize as they are based on simple closed-form analogue formulae.

Numerical methods

Some numerical approximation techniques are based on the intuitive notion that the derivative of an analogue time function can be approximated by the difference between consecutive samples of the function to be differentiated. As the sampling rate is increased, i.e. greater N, the approximation to the derivative becomes more accurate. In fact, to attain a reasonable degree of accuracy, the sampling rates required are so high that these methods are very inefficient and there is little to recommend them. Furthermore, problems can arise as unstable filters may result from the approximation of the analogue transfer function. It is therefore preferable to use other mapping methods which produce better results.

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Impulse invariance method

In transforming the analogue transfer function to a digital one, h(n) or H(z) must be first obtained. This requires a mapping from the s-domain to the z-domain. The requirements are:

1. The imaginary axis of the s-plane maps on the circumference of the unit circle of the z-plane.
2. Strips of $2\pi/T$ on the surface of the left hand part of the s-plane map into the unit circle of the z-plane, Fig. 4.

In practical cases, however, the analogue filter is not band-limited. This creates aliasing between successive terms, i.e. the sampling process will be affected by the interference between the spectra and the response of the digital filter will not be identical to the original analogue frequency response.

Bilinear transformation

The advantage of the bilinear transformation over the previous method is that the aliasing problem is overcome. This is done by mapping the entire left-hand half of the s-plane into the unit circle of the z-plane, Fig. 5. The transformation can be derived from the notion that it is required to obtain a stable function, G(z), of the form

$$G(z)=\frac{\sum_{n=0}^{N} a_n . z^{-n}}{1+\sum_{m=1}^{M} b_m . z^{-m}}.$$

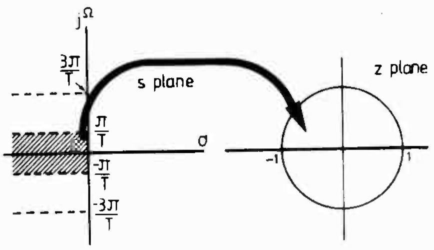

Fig.4. Mapping from the s-plane to the z-plane using the impulse invariance method. Shaded area shows a strip of $2\pi/T$ on the surface of the left-hand half of the s-plane being mapped onto the unit circle of the z-plane.

As G(z) is real, rational and stable in z^{-1}, we need a transformation function, f(z), of the form

$$f(z)=\frac{a+bz^{-1}}{c+dz^{-1}}.$$

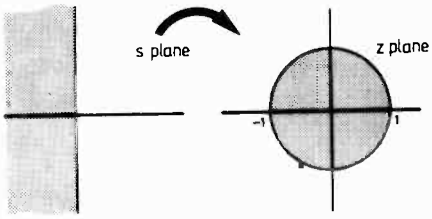

Fig.5. Mapping from the s-plane to the z-plane using the bilinear transformation. Here, the entire left half of the s-plane is mapped onto the unit circle of the z-plane thus solving the aliasing problem occurring in the case of the impulse invariance method.

Applying the mapping conditions yields

$$a=-b$$

and $$c=d$$

and so f(z) can be rewritten as

$$f(z)=\left(\frac{a}{c}\right)\frac{1-z^{-1}}{1+z^{-1}}$$

or $$j\Omega_c=\left(\frac{a}{c}\right)\frac{1-e^{-j\omega_c T}}{1+e^{-j\omega_c T}}$$

which gives

$$\Omega_c=\left(\frac{a}{c}\right)\tan\left(\frac{\omega_c T}{2}\right).$$

This is the non-linear (warped) bilinear transformation which maps the entire left-half of the s-plane into the unit circle of the z-plane.

Summary

Various design techniques can be applied to each type of filter. In f.i.r. filters, the methods are based on the approximation or truncation of the impulse response, and a trade-off between accuracy and complexity has always to be made. Both the frequency sampling technique and the window method have proved to be simple to implement. The first-mentioned method, however, suffers from the effect of interpolation and Gibb's phenomenon, while the last does not provide a defined criterion for optimum design. Optimal methods, on the other hand, are very accurate but too complicated to implement.

In i.i.r. filter design, the methods essentially rely on digitizing some existing analogue transfer function. Numerical methods are ineffective as they require a large number of samples and a very high sampling rate. Moreover, unstable digital filters can result from stable analogue ones due to the approximation of the analogue transfer function.

The impulse invariance method, which relies on getting the z-transform of an H(s) transfer function and maps a portion of the left-half of the s-plane into the z-plane unit circle, results in aliasing. Conversely, in the bilinear transformation, a mapping of the entire left half of the s-plane onto the z-plane unit circle overcomes aliasing and stability problems but is non-linear thus requiring compensation, or pre-warping, operations to be performed which may not be possible for all functions. WW

Further reading

Digital Filters: Analysis and Design by A. Antoniou. McGraw-Hill, 1976.
Digital and Kalman Filtering by S. M. Bozic. E. Arnold, 1979.
Digital Filters and their Applications by V. Cappellini, A. G. Constantinides, P. Emiliani. Academic Press, 1978.
One-Dimensional Digital Signal Processing by C. T. Chen. Marcel Dekker, 1979.
Digital Filtering and Signal Processing by D. Childers and A. Burling. West Publishing Co., 1975.
Digital Filters (experimental report) by K. M. Henein. Imperial College of Science and Technology, December 1982.
Digital Signal Processing by A. V. Oppenheim and R. W. Schafer. Prentice Hall, 1975.
Theory and Application of Digital Signal Processing by L. R. Rabiner and B. Gold. Prentice Hall, 1975.
Digital filter design, by B. M. G. Cheetham and P. M. Hughes. *Wireless World*, May, June, August 1982.

R. N. Gorgui-Naguib, left, who obtained a B.Sc. in electronics and communications from Cairo University in 1979 and the Diploma of Imperial College in computing science in 1982, and K. M. Henein who got his first degree in electronic engineering from the university of Essex in 1982, are both studying for M.Sc. degrees in communications engineering at Imperial College, University of London.

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Using the 68008

Having 32-bit architecture, Motorola's 68008 can run in existing eight-bit microcomputer systems

By Andy Barth

This article demonstrates the ease with which the Motorola MC68008 can replace conventional eight-bit microprocessors in existing microcomputer systems to provide a quick and ready means of producing a 68008-based system with minimal design effort. The Motorola Micromodule 19 chosen (M68MM19A) is typical of many existing eight-bit systems, comprising a single p.c. board, an 2MHz 6809 m.p.u., 16kbytes of rom, 2kbytes of static ram, an asynchronous serial data port (using MC68B50 ACIA) with RS232C/422/423 interface, a parallel printer interface port (using a MC68B21 PIA), three 16-bit counters (using a MC68B40 PTM), and external address, data and control bus buffers. The interface logic is designed primarily to interface to the M68MM19A, although in principle it should work with most 6809-based systems. No bus arbitration logic has been included, and this will need to be added if dynamic memory or other potential bus masters – such as d.m.a. devices – are used. The bus arbitration schemes of the 6809 and 68008 are similar and should not require much additional hardware.

MC68008 overview

The MC68008 has the same internal architecture as, and is fully software-compatible with, the 68000 m.p.u., but has an eight-bit external data bus. It therefore allows the design of cost-effective systems using eight-bit non-multiplexed data buses, simultaneously providing the benefits of a 32-bit microprocessor architecture, Fig. 1. It provides 17 general-purpose 32-bit registers, 56 basic instruction types and 14 basic addressing modes with many more sub-modes, Fig. 2. The combination of these instruction types, data types and addressing modes provides thousands of useful instructions. The 1Mbyte non-segmented linear address space allows modular programs to be developed and executed efficiently. It interfaces to memory and peripherals through non-multiplexed asynchronous address and data buses.

Interfacing

In normal operation the 68008 makes data transfers to or from memory and peripherals in an asynchronous fashion. Handshake control lines, address strobe (AS), data strobe (DS), read/write (R/W), and data transfer acknowledge (DTACK), enable the data transfer rate to be optimised for the particular device being accessed. Once a bus cycle has begun the

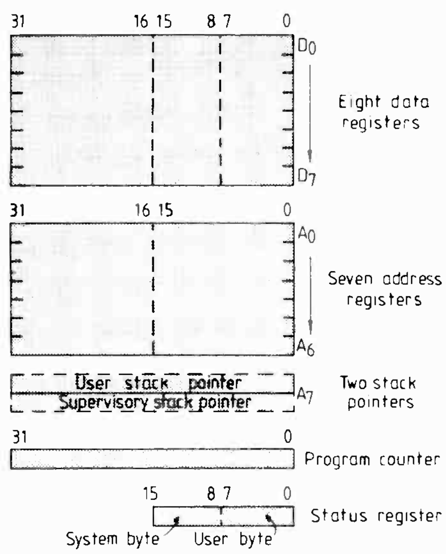

Fig. 2. MC68008 programming model shows eight general-purpose registers, for 8, 16 and 32-bit data operations, seven address registers, and two system stack pointers for software stack pointers and base address registers. All registers may be used as index registers.

Andrew Barth is a senior staff engineer with Motorola's systems engineering group in East Kilbride. He graduated in physics from Leeds University and since 1976 has worked in microprocessor systems design in Germany and the USA, as well as in the UK.

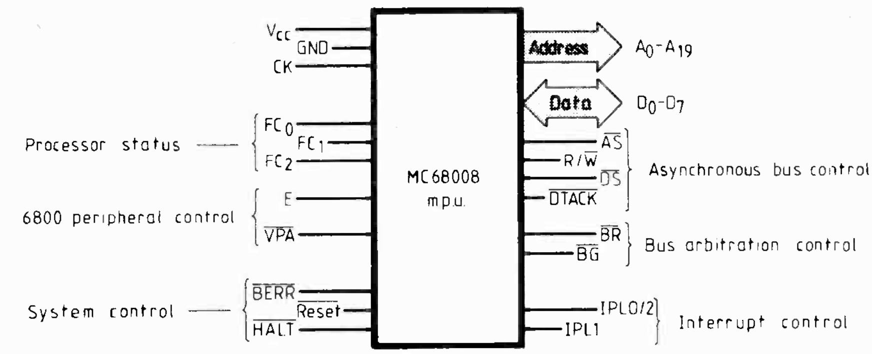

Fig. 1. MC68008 signal lines. The designer can now use a high-performance microprocessor with a 32-bit architecture in small cost-effective systems using an 8-bit data bus. With non-multiplexed buses and 1 megabyte address space the 68008 comes in a 48-pin package at two-thirds of the price of a 68000.

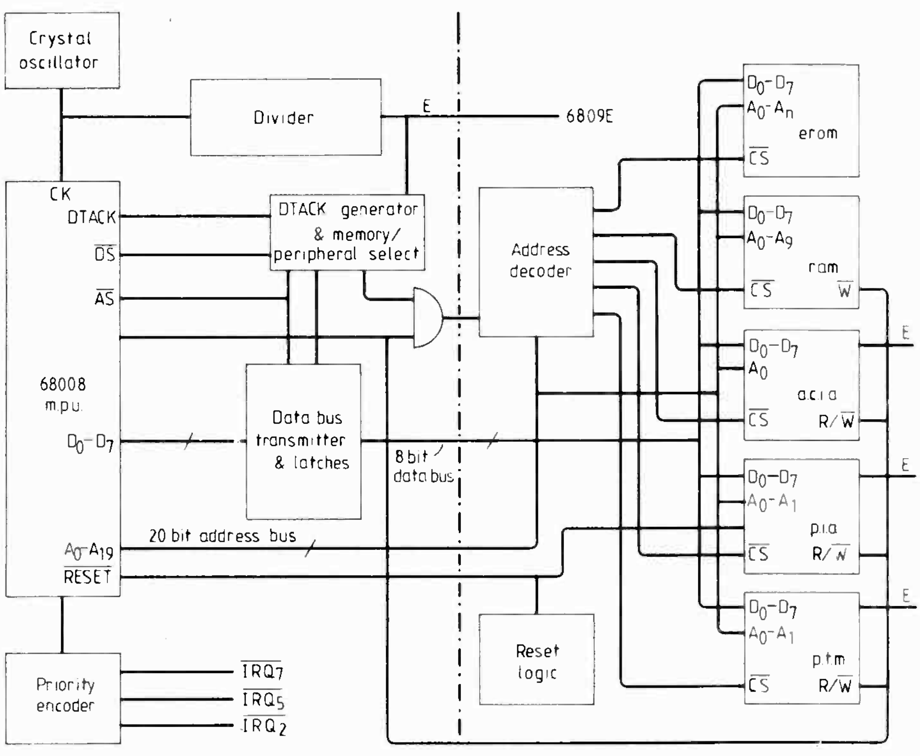

Fig. 3. In the 68008-M68MM19 combination the right-hand side of the line could be any 6809-based system. Such systems provide a ready means of producing a 68008-based computer with minimal design effort.

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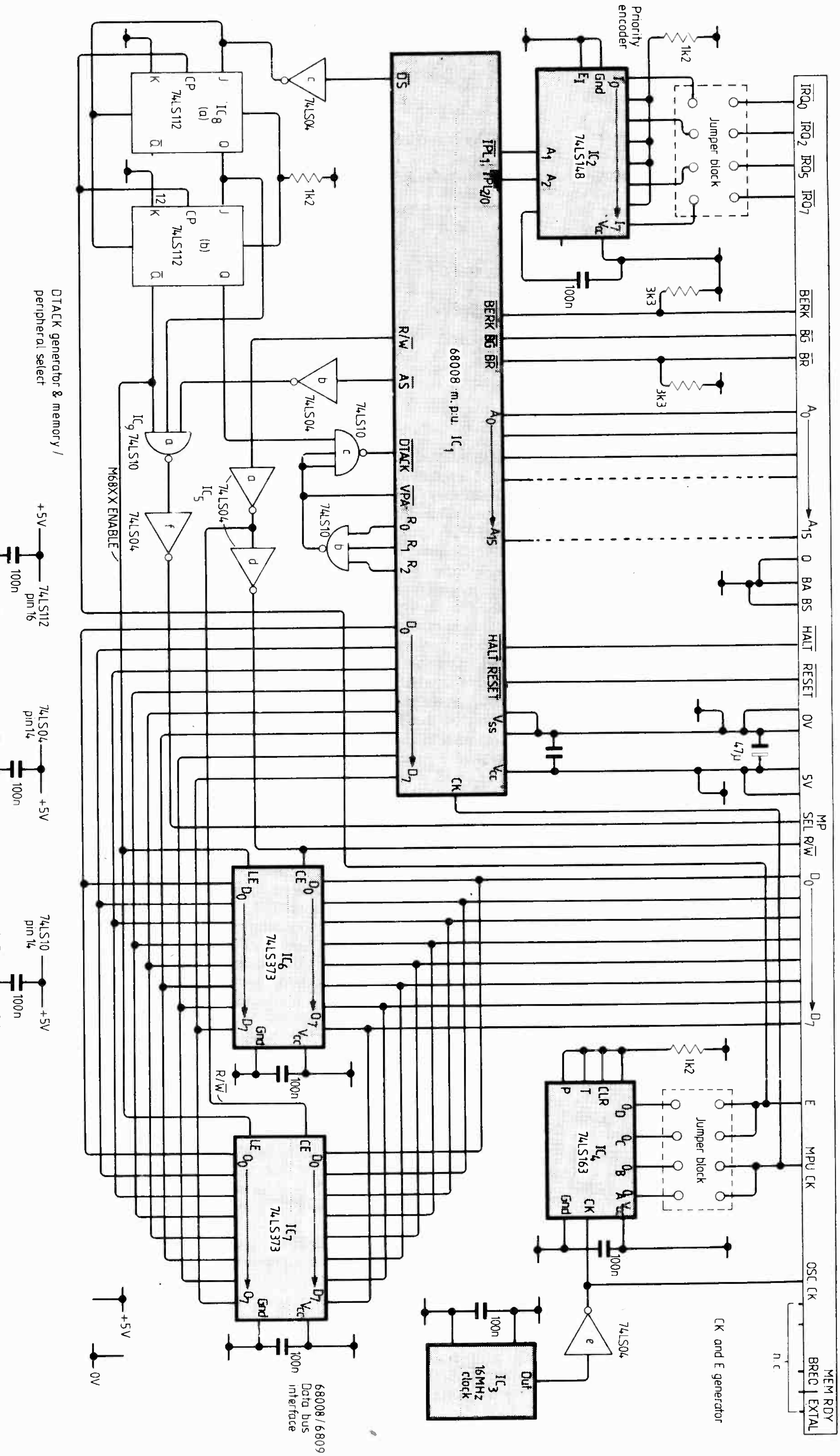

Fig. 4. *68008 and eight t.t.l. interface devices fit easily onto a single Eurocard. Ribbon cable and 40-pin d.i.l. leader could connect the board to the target system.*

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memory ir peripheral device notifies the m.p.u. that it is ready to receive or transmit data by issuing the DTACK signal. The timing of DTACK within a given bus cycle is tailored to the data access time of the device. For a slow device the 68008 inserts wait states until DTACK is received. In new designs this technique is used to maximize system throughout and minimize the external logic required. In a synchronous system, like that using a 6809, the data is expected to be valid after a certain time into the bus cycle. For a 6809 system this is on the falling edge of the E clock.

There are two methods of interfacing to a synchronous system: the 68008 itself running synchronously, and also running asynchronously.

Synchronous mode. The 68008 has 6800 peripheral control signals (E, VPA) which enable it to execute a 6800-type synchronous bus cycle. The peripheral device issues VPA instead of DTACK during the bus cycle to indicate this to the m.p.u. The E clock output runs at one tenth of the 68008 clock (CLK) so that, for example, if the m.p.u. uses an 8MHz clock, the peripheral will be clocked at 800kHz. This provides an easy method of interfacing synchronous peripheral devices with the minimal external logic. There is no reason why all memory (including program memory) and peripherals shouldn't be controlled in this way, so that every bus cycle is executed synchronously. While this is very easy to implement, it does mean all bus cycles, including instruction fetch and execute cycles, contain large numbers of wait states.

Asynchronous mode. Here the 68000-type peripherals can be clocked at their highest operating frequency (2MHz) using an externally generated E clock. The m.p.u. runs asynchronously and the DTACK signal is generated synchronously with the 'new E' clock. This reduces the number of wait states per bus cycle. This approach requires more circuit components but results in increased system throughput, and is the scheme used in this article.

Circuit description

Figure 3 is the block diagram of the 68008/68MM19A combination, and Fig. 4 shows the detailed circuit of the interface logic. Signals on the connector pins are connected to the 6809 d.i.l. socket on the M68MM19A board. The 68008 data bus and 68MM19A data bus are connected via a pair of 74LS373 octal latches (IC_6 and IC_7) joined back-to-back. Their enable outputs are controlled by the m.p.u. R/W so that one latch (IC_7) is enables for a m.p.u. read and the other (IC_6) is enabled for a m.p.u. write. The latches are normally in the transparent mode but became latched as the memory/peripheral is deselected. They remain latched until DTACK is negated in the 68008 bus cycle state S_7. The MC68008 data sheet explains bus cycle states.

The DTACK signal is generated by the 74LS112 JK flip-flops ($IC_{8a,b}$) from DS and E. Note that E is derived from the clock oscillator K1148 (IC_3) via the

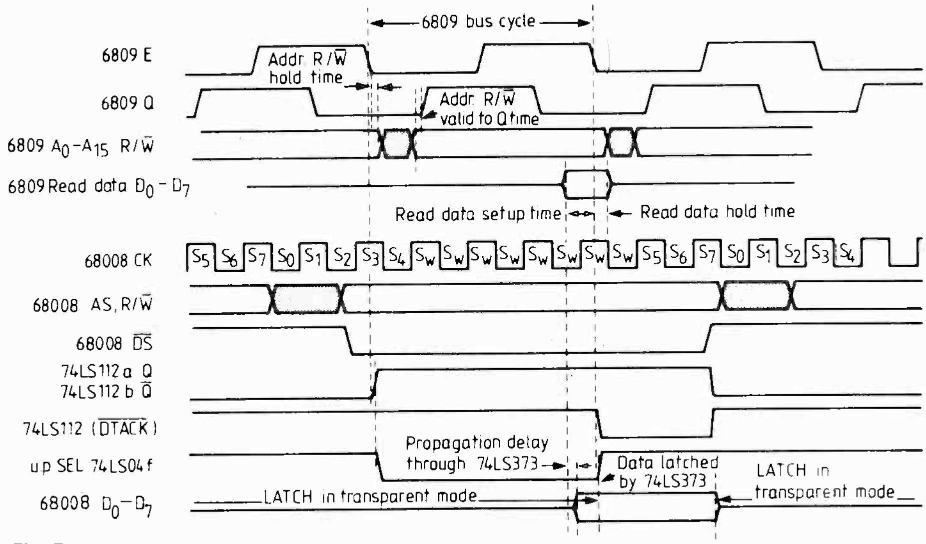

Fig. 5.

74LS163 counter (IC_4) and that the 68008 E-output is ignored. DTACK is fed to the m.p.u. on every bus cycle except during interrupt acknowledge (IACK) cycles. During IACK cycles the interrupting peripheral must issue DTACK (if the m.p.u. is to perform a vectored interrupt sequence) in which case the peripheral must provide the interrupt vector number on the data bus, ot it must issue VPA (for the m.p.u. to perform an auto-vector sequence). As none of the 68MM19A peripherals are capable of generating their own interrupt vector numbers, DTACK must be supressed during an IACK cycle and VPA asserted in its place. The IACK state is indicated by the 68008 function codes, $FC_0=FC_1=FC_2=1$. Nand gates IC_{9b} and IC_{9c}, generate VPA and inhibit DTACK.

Signal MPSEL from 74LS04 inverter IC_{5f} enables the 68MM19A address decoder logic for the memory and peripheral devices. Fig. 5 shows the relationship between 6809 and 68008 bus timings for a m.p.u. read operation. Signal MPSEL is asserted during state S_3 corresponding to the beginning of a 6809 cycle (A_0-A_{19}, AS, R/W and DS having been set up in states S_0-S_2). Data from the memory or peripheral device becomes valid prior to the next falling edge of E at which time the data is latched by IC_7 and DTACK is asserted at the m.p.u. During S_6 the 68008 reads the data from the latch IC_7, and the bus cycle terminates at the end of S_7.

Similarly, during a m.p.u. write operation, data from the m.p.u. becomes valid in S_2 and DS in S_3. Data is latched by the memory or peripheral device on the next falling edge of E. Signal DTACK is asserted and the m.p.u. proceeds to terminate the bus cycle.

Counter IC_4 and the jumper block enable the m.p.u. and memory/peripherals to operate at several clock rates, i.e. 4 or 8MHz 68008 and 1 or 2MHz memory/peripherals. The 74LS148 priority encoder IC_2, and jumper block determine the relative priority of the peripheral interrupts. Unlike the 68000 which has three interrupt priority level inputs (IPL_0, IPL_1 and IPL_2), the 48-pin 68008 has only two, $IPL_{0/2}$ and IPL_1; IPL_0 and IPL_2 are connected internally. Consequently only four of the eight interrupt levels 0, 2, 5 and 7 are usable.

Comparisons

Eight t.t.l. devices are required to interface the 68008 to the synchronous 68MM19A microcomputer. This is more than the 68008 synchronous scheme but does yield improved system throughout. The components can easily be accommodated on a single Eurocard. Connections between the 68008 board and the 68MM19A would be via the connector (say, a 3M Scotchflex 50-way header) on the 68008 board and the 6809 socket on the 68MM19A. As shown in Fig. 4, signals on the pins replace those of the ousted 6809 on a one-to-one basis (except pin 39, the MPSEL signal which is used to enable the address decoder).

By reprogramming the field programmable array address decoder on the 68MM19A to suit the differing requirements of the 68008 (e.g. 68008 has its RESET and other vectors in low-order memory; 6809 in high-order memory) many applications become possible. For example, I made minor modifications to MEX68KECB Tutor (a 68000byte debug monitor program with assembler/disassembler) to suit the memory mapping of the 68MM19A, thereby creating a simple 68008 development/educational tool from the 68008-68MM19A combination.

Benchmark tests were conducted comparing the unmodified 68MM19A with 2MHz 6809 with the 68008-68MM19A system, last-mentioned showing typically a three to four-fold speed improvement over the first. This is not a fair indication of the true performance of the 68008 because it is the 2MHz 68MM19A that governs the maximum system throughout here, not the 68008. The m.p.u. is inserting wait states until the 68MM19A is able to transfer data. In a new design where both m.p.u. and memory/peripherals are running asynchronously it is possible to have zero states in a bus cycle and maximum data transfer rates are obtained. On such systems a four to five-fold speed improvement may be seen. Ten and 12.5MHz versions of the 68008 are planned for the future. WW

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German radio show

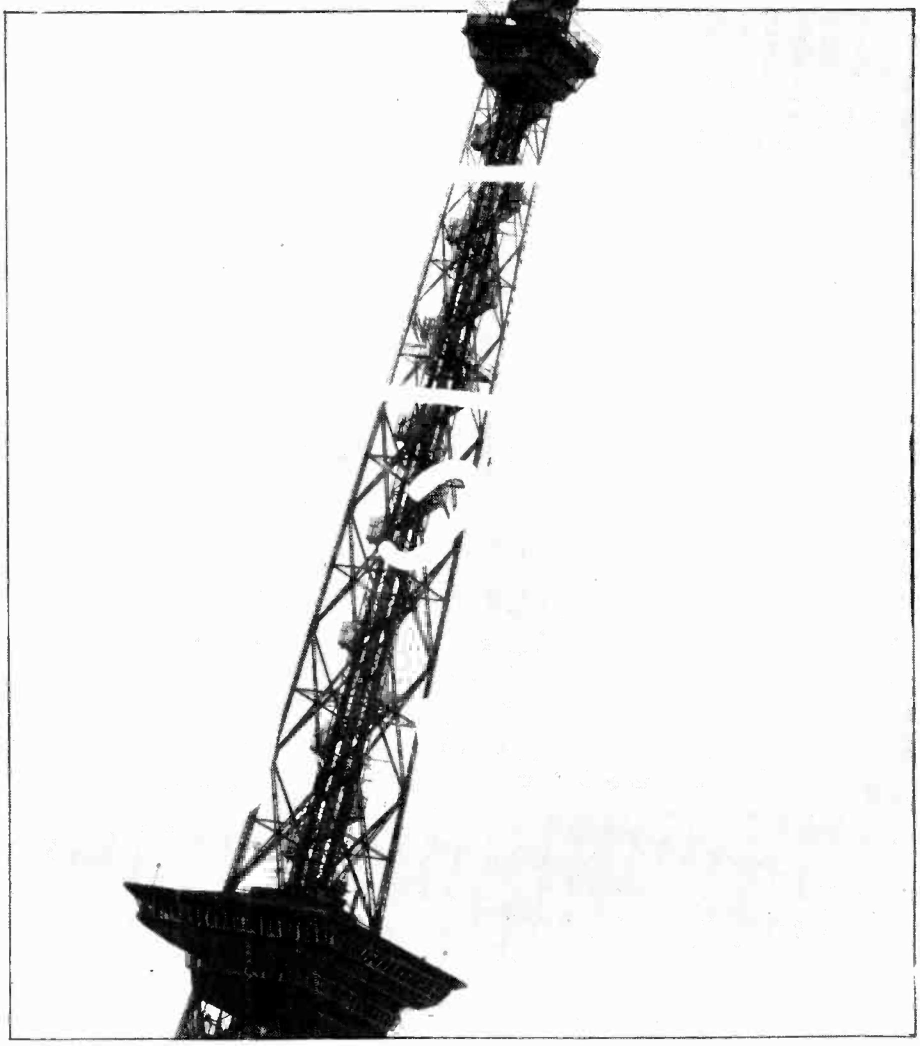
The International Audio and Video Fair, also known as the German radio exhibition or Funkausstellung, continues to be held in Berlin. Geoffrey Shorter paid a lightning visit.

Embarrassment accompanied the start of Bildschirmtext or Btx, Germany's national viewdata service, officially inaugurated by the new Federal Minister for Posts Dr Christian Schwarz-Schilling at the 34th Funkausstellung. The service, on trial in Berlin and Düsseldorf for the last three years, was not able to go nation-wide on schedule because of difficulties in the construction of the central computers, said to hinge on "software problems" of IBM's Series 1 and 4300-based system. Three firms tendered for the 1981 Btx contract, IBM, GEC and SEL, and as the lowest bidder IBM were given the job, thought to be worth $22.5 million. But to avoid losing face a further, Berlin-only, contract was placed with – ironically – GEC Computers, suppliers of the original Prestel-type system, and the full service postponed until May next year. And as if to rub salt into the wound, Austria's parallel Btx service was off to a flying start – using GEC's system.

Prestel-type experiments started back in 1977, followed by the formal field trial in 1979 (*WW* Berlin reports, November 1977, 1979) using British technology. But the limited Prestel character set was not originated with multinational alphabets in mind, and it was this, together with limitations in graphical capability, that led to the European post administrations (CEPT) agreeing a new international standard (*WW* Berlin report Nov 1981). Surprise has often been shown at BT's attempts to push Prestel as a serious proposal for international working, and certainly many Europeans thought the UK wouldn't get as far as it did in promoting its system overseas.

It was quickly realised that to be widely successful many information providers would need to be attracted. To do this has meant allowing the data processing systems of the suppliers to interwork with the system: banks, mail-order houses, tour operators, computer centres, for example, which required new software, later sold back (*sic*) to Britain. And having sold the idea to commerce and the 'semi-professional' areas there would be more to offer private users. But as our last report hinted the new CEPT decoders could be expensive – Loewe Opta decoders now cost DM1000 – at any rate until a new chip made by the Philips subsidiary Valvo brings price down to DM300,500 next year. (For the Berlin and Düsseldorf trials the Bundespost placed 8,000 Prestel-type decoders with subscribers, free of charge, with the understanding that a new standard was under way.)

But despite the delayed start, the Bundespost is confident of its forecast of a million Btx users by 1986 – 600,000 sets in businesses and 400,000 in private homes – and three million by the end of the decade.



Coaxial cable systems have been given a big push by the country's new government, through its Minister for Posts. Dr Christian Schwärz-Schilling increased spending to DM1 billion for 1983 alone – a big increase from the original DM400 million budget, and which drew press comment earlier in the year because of alleged previous cable interests. Up until then, spending on cable tv had been restricted to situations of difficult aerial reception, largely as a result of a lack of social-democratic enthusiasm for letting commercial/private interests into the cable networks.

The christian-democratic takeover at the election allows the CDU-oriented publishers into the cable tv business, who are pushing for coaxial systems that can be installed now. A copper network is argued to cost DM3,400 million, compared with DM100 billion for a glass fibre network. Although several Länder, which have responsibility for broadcasting, have become aligned with the CDU since 1975 when cable systems were first recommended, a federal CDU influence in favour of cable was needed to initiate investment through the Bundespost, which has responsibility for cable networks up to the consumer interface. What the Länder have to do now is to sort out the legal problems – what to do about sex, violence, block advertising, press rights – by consensus.

Bigfon* – an acronym for wideband integrated fibre optic telecommunication network – is still some way off. The trials announced at the last show are only just beginning and won't be completed until 1987. But in a special one-year assessment of transmission techniques to commence

*Breitbandig integriertes Glasfaser-Fernmelde-Ortsnetz

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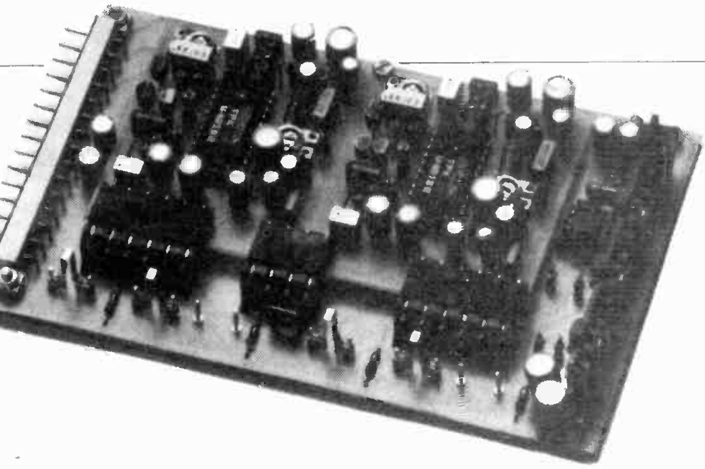

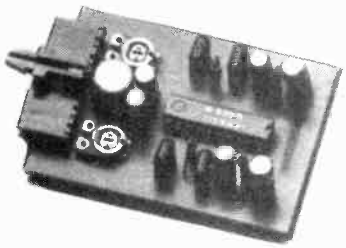

Significant size and price reduction in Telefunken's High Com circuit make this decoder-only circuit suitable for portable cassette players and car radio, as well as for decoding likely High Com-encoded f.m. broadcasts.

mid-1984 five systems are to be tested, including an analogue proposal by Fuba & Blaupunkt, hybrid schemes by SEL and Siemens, and a completely digital system proposed by Telefunken.

The tests need a new kind of receiver, for which Telefunken have received DM2 million in development money over the last two years, that will decode 32 stereo p.c.m. channels with a quality much superior to that obtainable from f.m. and cable systems. (And there is the potential to transmit compact discs or p.c.m. tapes directly.) Telefunken's prototype receiver comprised circuitry using 80 i.cs including error detection, with performance values for dynamic range and crosstalk of between 75 and 80dB, distortion below 0.05%, and all interference suppressed. Engineers at Telefunken say they are confident that Germany will have p.c.m. radio by the end of the eighties.

In a parallel programme, valued at between DM6 and 7 million over three years, Telefunken has developed the first p.c.m. tuner for direct satellite broadcasts. One of the channels allocated for direct tv broadcasting when the German service starts in 1985 will be dedicated to a raster of 32 digital radio channels, using 14bit linear coding and a sampling rate of 32kHz. Elaborate error detecting circuitry – 30% of the signal is taken up with error protection – ensures that not more than one fault an hour will be audible, even under difficult reception conditions. Because the satellite field strengths have been chosen to suit analogue transmission, p.c.m. will obviously allow reception with smaller antennae – a 60cm dish will be suitable over most of Europe – or else an increase in catchment area. Despite the relative simplicity of the front end (the h.f. part is fixed-tuned on account of the digital coding), overall complexity is such that 180 i.cs are used in the prototype. Cost will be around DM800 by the time the circuits have been further integrated down to three i.cs in 1986. It seems very likely that programme identification will be integral feature.

Video conferencing experiments have been given the go-ahead in Germany. Bundespost trials starting in 1984, announced at the exhibition, will offer a limited quality b/w service through existing facilities, and digital colour transmissions will have to wait for optical networks to be installed. An EEC standard will be adopted for the scheme as international compatibility is of paramount importance, and a codec design already agreed has been made in small quantities for the experiments. (Similar 2Mbit/s codecs for the COST 211 programme are made in the UK by McMichael under a BT development contract.)

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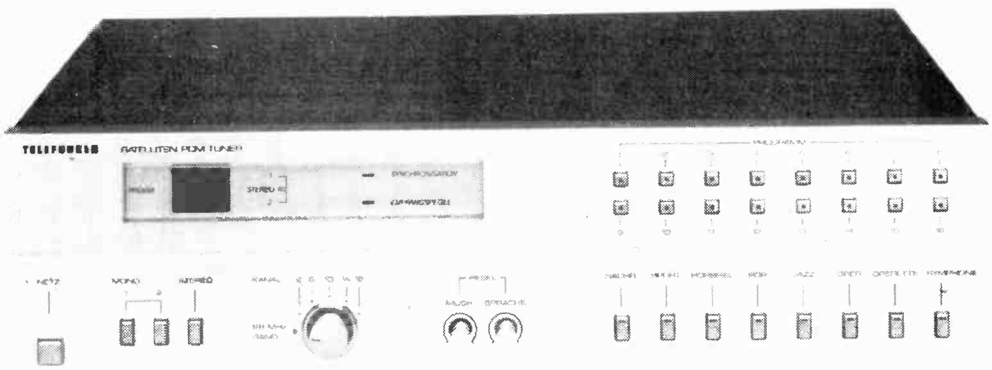
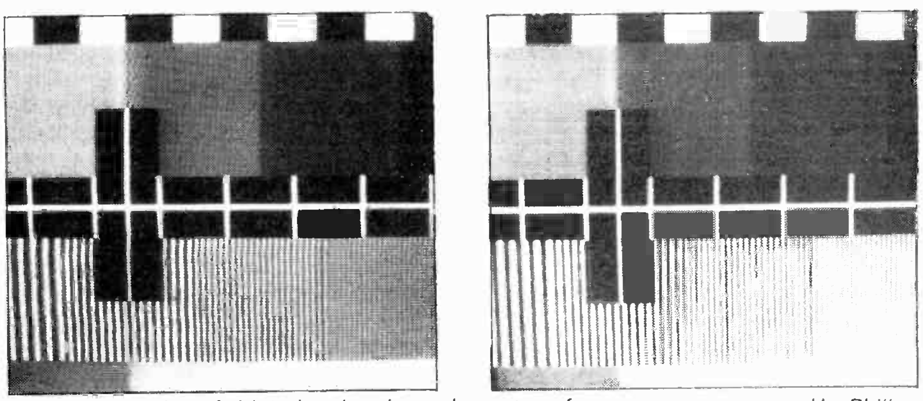
Many tv sets include digitized circuitry nowadays but the ITT Digivision set is the first to digitize all circuits following demodulation. Since the five-chip v.l.s.i. circuits were announced at the last Berlin show three more circuits have been added to the set – two to enhance chrominance and luminance processing for NTSC sets and a third is a low-cost teletext decoder. The original circuits were conceived in 1977 and breadboard verification over a period of three years resulted in the first 3µm integrations being made and tested in 40MHz n-mos two years ago (the video codec is bipolar however). Since then, ITT have signed up a good proportion of set makers who are gradually announcing digital chassis'. ITT's sets now on sale in Germany are priced at DM2600, with the teletext decoder built in. Other makers using these chips – which cost around \$30-40 – include Grundig, Sony, Sanyo, Sharp, Telefunken and Zenith now that the automatic picture control processor circuit is available. Meanwhile other i.c. makers – Philips' subsidiary Valvo, Motorola, maybe RCA – will try and interest set makers in other approaches.

To improve the quality of the tv picture without having to modify transmission standards requires a reasonably inexpensive memory that can store at least the information contained in one television field. For standard pal and secam signals the required sampling frequency for the brightness signal is 12MHz and for the two



Satellite p.c.m. tuner developed for Germany's TV-Sat permits high quality reception of 16 stereo or 32 mono sound channels with automatic programme identification. Selector knob shown will switch between various satellites and cable (118MHz).



Digital processing of video signals using a charge transfer memory, as proposed by Philips, can reduce effects of crosstalk between colour and luminance signals as shown on colour edges (left), increasing picture quality (right).

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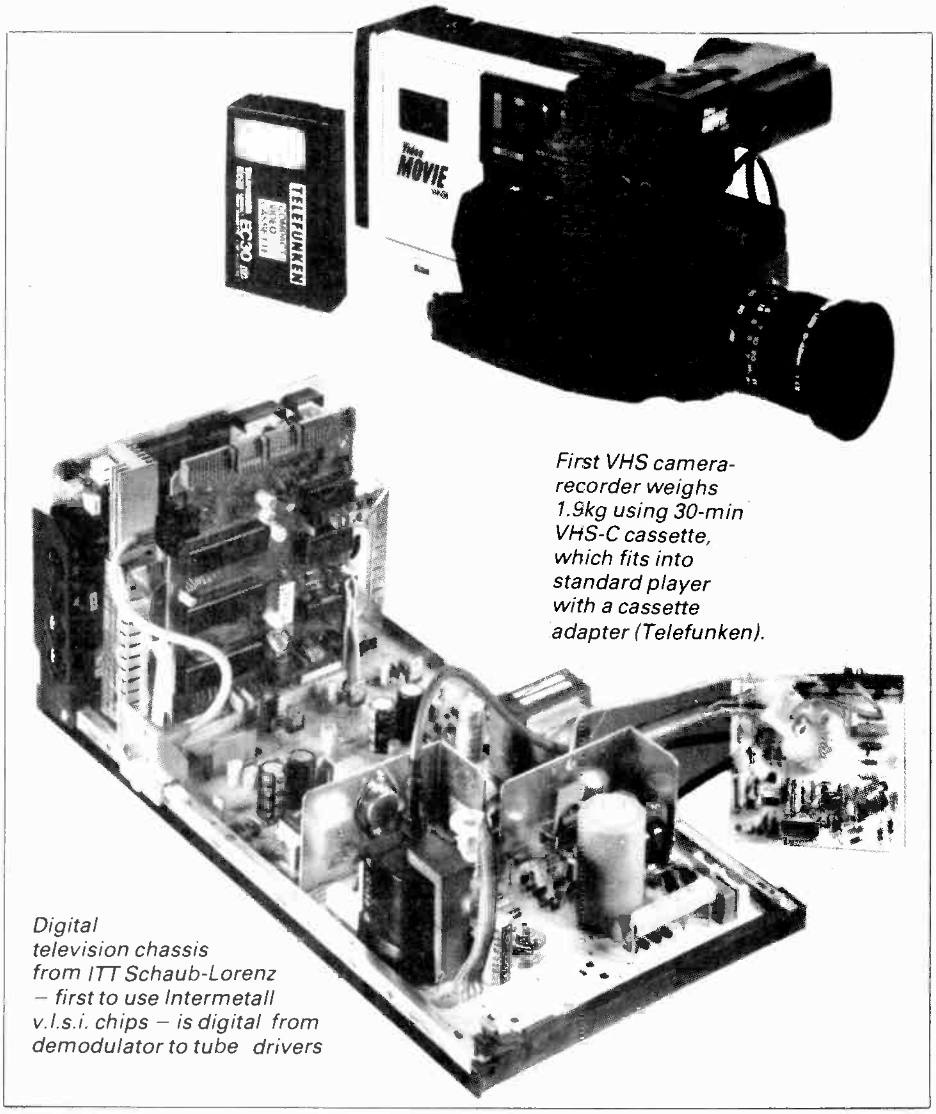

First VHS camera-recorder weighs 1.9kg using 30-min VHS-C cassette, which fits into standard player with a cassette adapter (Telefunken).

Digital television chassis from ITT Schaub-Lorenz – first to use Intermetall v.l.s.i. chips – is digital from demodulator to tube drivers

colour signals 3MHz, and together with a seven-bit quantization of the sampled values this gives an information content of 2.2Mbit per field. As the information to be stored arrives sequentially and only needs to be read out sequentially, a charge transfer device is sufficient, with a transfer rate that allows information becoming available in one field period (20ms) to be read out twice in succession within 10ms, as required when the field frequency is to be doubled. The purely sequential character of the memory makes the control and layout of the circuit much simpler, and the chip area required per bit is only about a third of that needed in ram.

Engineers at Philips Research Laboratories in Eindhoven have developed such a memory chip using a 2μm n-mos process on which one of the bits from a digitized television field can be stored, so the total field information, quantized in seven bits, can be stored using seven such chips. Each stores 308 lines of 1024bits with a surface area of $7.4\times4.7mm^2$. (Only seven connections are needed per chip: data in, data out, two clock signals and three supply lines. As normal encapsulations have ten connections, three can be used for introducing delay-offset of 0-7 bits.)

The final result – a 308Kbit video memory with control logic on a chip area of $34.8mm^2$ – is two to three times smaller than the same amount of ram, making it easier to design and less costly to produce, say Philips. Effective field frequency could be increased from 50 to 100Hz in either of two ways. In the first, the information in the even lines which is transmitted within 20ms can be stored in memory and reproduced twice by reading out from the memory twice in succession in 10ms. This is then repeated for the odd lines. Brightness flicker is eliminated by this process, but interline flicker remains. The other method, which on still pictures will eliminate both interline flicker and brightness flicker, reproduces the odd and even lines alternately, also in 10ms, but requires a larger memory than the first method because the information for a complete picture has to be stored for 40ms.

Moving pictures still cause problems at present because of the continual jumping back to a previous field, but the problems are now being studied. The use of a memory in colour decoding can also reduce noise and the effects of colour and luminance interaction, as well as including stationary pictures, magnifying picture details, reducing waiting times on teletext pages, and resynchronizing video signals originating from different sources.

In Sony's NTSC sets circuitry similar to ITT's doubles the number of scan lines to give a non-interlaced display. Processing starts with comb filtering to reduce false colour effects and dot patterning, in which three lines of composite video – 910 samples by eight bits per line – are stored in static ram. A line can be read out twice to produce 525 lines per field, this interpolation being suggested for character display. Alternatively, the interpolation can be the averaged of two adjacent lines, this being preferable for pictorial display. Either way, clock rate must be twice that of the input lock and horizontal scan rate must be doubled. Sony's digital PAL receiver will implement a single field memory in dynamic ram to double the field frequency and reduce large-area flicker.

Using the ITT chips as a starting point, Matsushita incorporate a 64K ram to display a 96×64 dot colour picture within the main frame, which they like to call "monitor in television". No doubt they would like to make their own digital tv i.cs, for their television division recently described a digital signal processor that could be integrated into a very large scale circuit. Analogue to digital and d-to-a converters, luminance and colour signal separation, colour controller, system clock generator, luminance signal controller, PAL/NTSC decoders and matrix have been implemented with about 10,000 t.t.l. gates and 8K rams. Integrated into a v.l.s. circuit, this would take the place of two of the ITT chips.

★ ★ ★

For two weeks around the time of the Funkausstellung Sender Freies Berlin was broadcasting its second programme on 92.4MHz encoded with a noise reduction system. That was Telefunken's High Com, a wideband compander offering a noise reduction of about 20dB in cassette recorders (see November 1979 report, page 49). But although Telefunken argue that this is better than the 15dB of Dolby C (A-weighted), it has proved difficult to market against Dolby, and not many licencees have adopted it in cassette machines. So for the last two or three years they have been experimenting with a version for f.m. radio to improve noise performance in fringe areas and increase service area.

Because it is essential in this application that the encoded signal is received by conventional sets compatibly, the amount of noise reduction has needed to be reduced: starting with 9dB, they went up to 15 – with adverse effects – and then down through 12 to 10dB. Encoded broadcasts by Westdeutscher Rundfunk have not produced any complaints so far, so compatibility seems proven, say Telefunken. But before the scheme can be adopted nationwide there must be a consensus of the Länder broadcasting organisations and so further field tests are planned for next March. By the end of 1984 a new i.c. will be available which because it is 'single-ended' (decode-only) is simpler, smaller and cheaper than its predecessor, and can be used in car radio and portable cassette players as well. The resulting o.e.m. price reduction from DM10 to DM3 should help to establish High-Com-FM despite the advance of digital noise-free radio in Germany. The idea is also being discussed in France (Telefunken's parent company is Thomson Brandt) and in Austria. WW

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NEW PRODUCTS

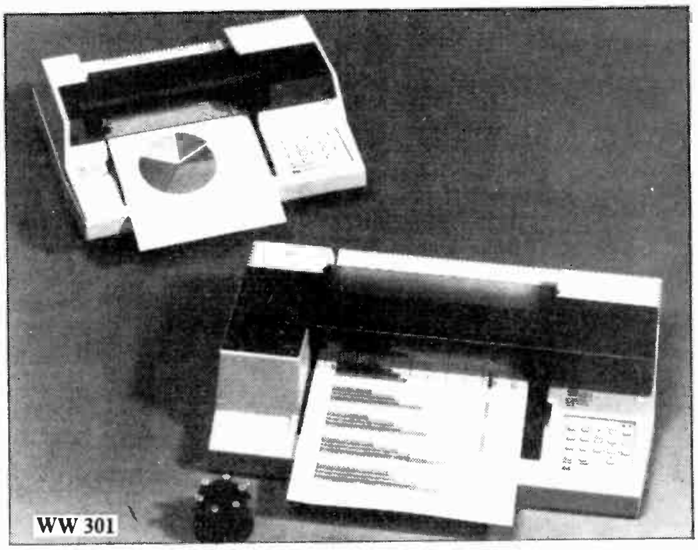
at TESTME

TEST AND MEASURE

The good thing about such exhibitions as Testmex is that their specialization ensures that a visitor is likely to find something of interest. Such a visitor is only likely to be there if concerned with test and measurement equipment. We present here those products which were actually launched at the exhibition.

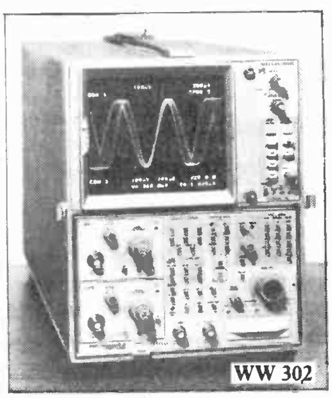
PLOT THICKENS

A new six-pen colour graphics plotter for use with engineering and scientific personal computers has been introduced by Hewlett-Packard. At the same time the earlier two-pen plotter has been reduced in price by 30%. The plotters are compatible with a number of computers including Apple, IBM PC and, of course, the HP models. Software is available to make them appeal to a wide range of users. They can even be used with a range of 'smart' instruments and an external controller may be bought separately to interface the plotters with other instruments. The new plotter (HP 7475A) can accept A3-size paper or transparent film to produce a variety of graphs, charts and histograms. Hewlett-Packard Ltd, Nine Mile Road, Easthampstead, Wokingham, Berks RG11 3LL.
WW 301


WW 301

SCOPE FOR ADD-ONS

In addition to a very neat portable digital storage 'scope, the 336, Tektronix were showing some digitizer plug-in units for their 7000 range of oscilloscopes which would turn them into digital storage 'scopes, the 7D20 add-on can accurately measure the amplitude of a 5ns-wide transient. Dual samplers simultaneously acquire the measurements from two channels as if it were a dual-beam oscilloscope. Signal averaging, pre-trigger and storage for six independent waveforms are provided, as is user prompting and menu displays to make it easy to use, The programming facilities make it suitable for fully automated testing and measurement. A high proportion of these facilities are also available on the 336 portable 'scope which weighs only 5kg. Tektronix UK Ltd, PO Box 69, Harpenden, Herts AL5 4UP.
WW 302


WW 302

INSTRUMENT CONTROLLER

Making its debut on the Fluke stand was the 1722A Industrial Instrument Controller, designed for controlling instrumentation systems in factories or labs. It features an interactive touch-sensitive screen, has IEEE and RS232 interfaces and a choice of memory storage; floppy disc, hard disc or bubble memory. Based around a 16-bit 99000 processor, the instrument offers wide facilities in automated testing and remote control. Fluke (GB) Ltd, Colonial Way, Watford, Herts WD2 4TT.
WW 303

TEST AND REPAIR ANALYSIS

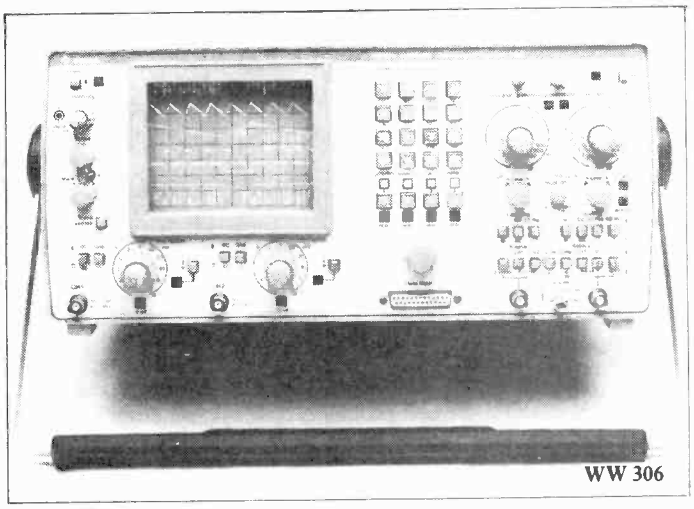
Incorporated into the display of the GenRad test and repair analysis/control system, or TRACS, were a number of new in-circuit board and component testers, including the 2274 circuit board test system. It was claimed to be low cost and flexible enough to meet the needs of both the small electronics manufacturer and the high-volume producer. The 1734 and 1735 component testers were capable of being configured to exercise a virtually unlimited variety of digital and analogue devices. GenRad Ltd, Norreys Drive, Maidenhead, Berks SL6 4BP.
WW 304

FAST FOURIER TRANSFORMATION

Bruel and Kjaer had a new FFT dual channel analyser with 800-line resolution, many functions and made a special point about its ease of use. They were also proud of their 2644 line driver amplifier which could be used to extend the communications lines between transducers and the measurement equipment. Bruel and Kjaer (UK) Ltd, Cross Lances Road, Hounslow, Middlesex TW3 2AE.
WW 305

INTELLIGENT 'SCOPE

A microprocessor-based, 100MHz oscilloscope with a built-in IEEE-488 interface can easily be incorporated into an automatic test system. It is the OS5110 from Gould which offers very comprehensive triggering facilities, Automatic measurements of many waveforms parameters carried out using a menu selection control system with full display of control settings, centre line voltages and measurement results. The built-in digital storage system provides waveform storage to the full 100MHz bandwidth of the instrument and transient storage at a sample rate of up to 1MHz. Gould Instruments Ltd, Roebuck Road, Hainault, Essex IG6 3UE.
WW 306


WW 306

SHORT-CIRCUIT LOCATION

Fast and easy location of short circuits on p.c.b.s was being demonstrated on the Omnitest stand using their Hy-trak instrument. They were also showing a disc-drive exerciser, the AVA 103D, for the alignment of magnetic heads in flexible and hard disc drives. Omnitest Ltd, Highcliffe House, 411 Lymington Road, Highcliffe, Christchurch, Dorset BH23 5EN.
WW 307

LOW-COST LOGIC ANALYSER . . .

. . . is provided as an add-on to a Commodore computer as part of a range of logic analysers and other Kontron equipment supplied by Elex Systems Ltd, John Scott House, Market Street, Bracknell, Berks RG12 1JB.
WW 308

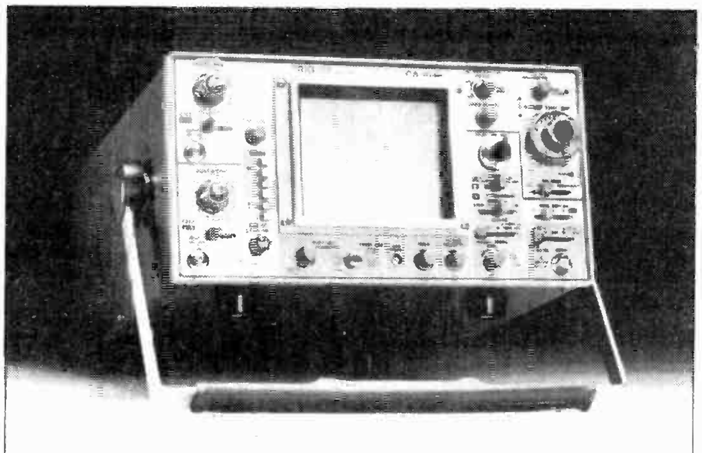
www.americanradiohistory.com

THREE-CHANNEL 'SCOPES

On display for the first time at Testmex were two Trio three-channel, dual timebase oscilloscipes. CS-1040 and CS-1060 have respective bandwidths of 40 and 60MHz. The use of a highly linear c.r.t. ensures that waveforms remain accurate and undistorted anywhere on the screen. Vertical axis 'sensitivity' is continuously adjustable between 1mV/cm and 5mV/cm. Part of the signal is diverted and sent to an outlet for use with frequency counters or other instruments. Alternate delayed sweep allows the display of a window section of the waveform at the same time as the original and as this can be done on all three channels, this can give six traces at the same time. There is a wide choice of sweep times and delays. There is provision for the display of video signals with a video-clamp function. House of Instruments, Clifton Chambers, 62 High Street, Saffron Walden, Essex CB10 1EE.
WW 309

ANALYSER WITH PERSONALITY

Z80, 6809 and 8085 options are the first of a series of personality modules which may be added to a Thandar TA2160 logic analyser. Each module enhances the facilities of the analyser and permits easy connection between circuits incorporating the microprocessor and the analyser. Complete address, data and contrul bus information is multiplexed by the unit into 16 channels for the TA2160. Switches on the units select the types of cycle captured and once stored the cycles may be displayed on the screen as wave forms or disassembled as mnemonics. An RS232 interface is provided to connect a printer. Thandar Electronics Ltd, London Road, St Ives, Huntingdon, Cambs PE17 4HJ.
WW 310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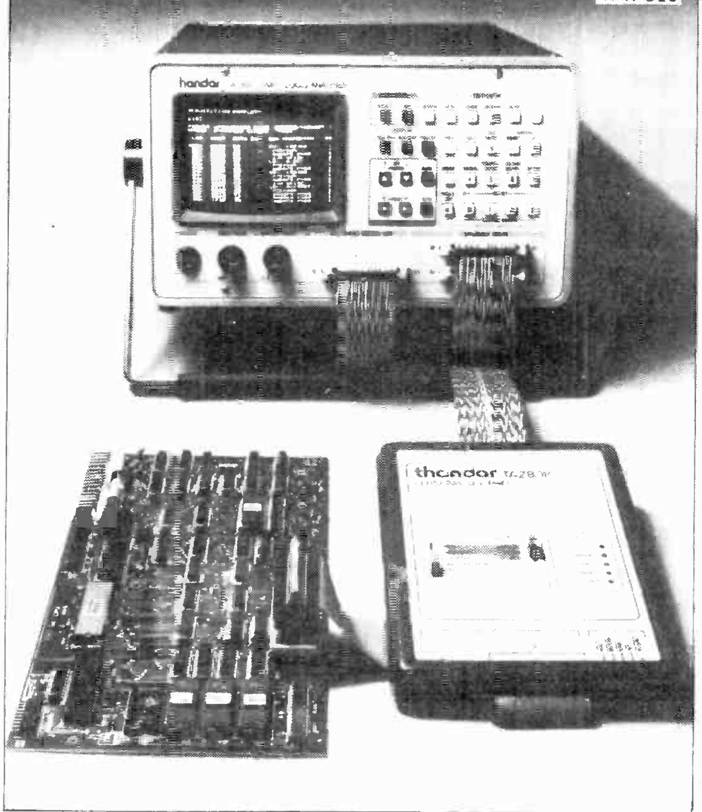
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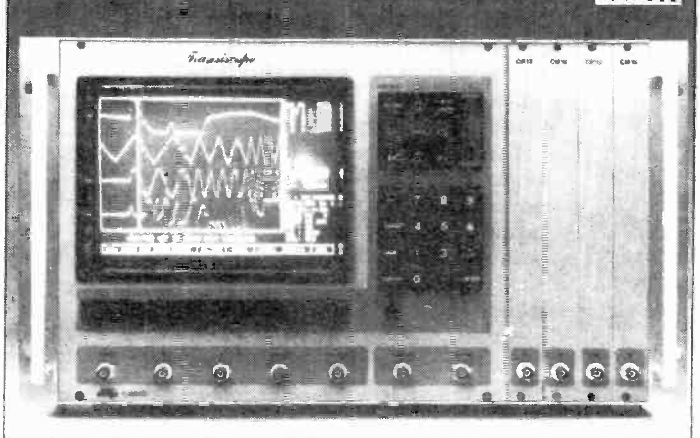
WW 311

WAVES RECORDED AND ANALYSED

With up to 16 channels available and a memory capacity of 64K by 12-bit words per channel, the Difa Transiscope can be used to study short transient signals, to an accuracy of 0.15%, or record over 170 hours of long-period waveforms. When the waveform has been stored, built in processors can be used to analyse and display them. Software is provided to allow many parameters to be calculated, with options for scalar, vector and fast Fourier transform computations. Guiding menus and controls labelled on the nine-inch data and scope display allow for ease of operation. Complex programmes can be downloaded through the GPIB port. Used in conjunction with a data recorder the instrument can analyse very rapid events in such applications as destructive testing or ballistics research. Racal Recorders Ltd, Hardkey Industrial Estate, Hythe, Southampton, Hants SO4 6ZH.
WW 311

TESTING ANY DEVICE

A single system which may be used to test virtually any component was the 2200 Device Test System, from Deltest. Plug-in packages area available for linear i.cs, digital i.cs, data converters, diodes and transistors, and other components. Turnkey systems are available for testing complete systems. Deltest Systems Ltd, PO Box 24, Pottery Road, Poole, Dorset BH14 8RQ.
WW 312

HARD COPY SPECIALISTS

In their first appearance at Testmex, Gulton were showing off their wide range of chart recorders. They have launched two multi-channel devices, the Supertrak 4100 and Computrak 6100 which are controlled by microprocessors to give programmable chart speeds, automatically generated grid patterns, automatic channel identification and many more features. Gulton Ltd, Maple Works, Old Shoreham Road, Hove, Sussex BN3 7EY.
WW 313

FAULT TRACERS

In addition to their established range of fault locators and current tracers, Antron were exhibiting a unit developed for in-circuit testing to be used for displaying impedance signature of devices. This uses a built-in oscilloscope display but another unit with the same facilities could be used with a separate scope to provide the display. Both units can switch between, and compare, known working circuits and the test circuit and can display semi-conductor curve characteristics for selection and matching. Antron Electronics Ltd, 39 Kings Road, Haslemere, Surrey GU27 2QA.
WW 314

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RANDOM ECHOES

By Chirp

THUNDERSTRUCK

The trouble with intelligent office machines is their tendency to get silly ideas at the most inconvenient times.

Take our IBM electronic typewriter for example. It has a solid state memory capable of retaining several pages of typing, but it can't do the clever things that a fully fledged word processor can do. And I'm sure it has an inferiority complex that makes it show off.

Because of its limitations we rarely use its full memory, and most of the information stored is rather dull – addresses and similar short items. It is only on the infrequent occasions when we wish to send a number of personalized but otherwise identical letters that the full memory capability is used. So, every now and then it decides to remember an entire report or similar document and stores it away with a contact's address until you are ready to write to him.

We have grown accustomed to these idiosyncrasies and know how to deal with them; but one Monday morning last month it took the opposite action and refused to function at all. Usually, when it is switched on it gives a little performance in a rather bossy way with the golf-ball typing head charging up and down the carriage before stopping at the margin setting, with the machine purring gently to show it is ready to get to work.

But on that Monday it refused to move. It made its purring noise to show that the drive motor was running, but it ignored operation of any of the keys and sat sulking on the desk doing nothing. Naturally we telephoned IBM, and they said they would ask the appropriate service engineer to contact us as soon as possible. He phoned the following morning and I explained that our electronic typewriter seemed to have developed a mechanical fault.

I was quite wrong. I should explain that the machine has a volatile memory, so that although one switches off the power to the operational circuits, the internal microcomputer remains connected. Our engineer thought that a thunderstorm during the weekend had caused a "spike" on the mains which put wrong data in the operational memory and stopped the machine working.

I can see why they are called intelligent machines – but "cunning" would be a better word.

TICKER-TALK

I suspect that the real car buff prefers five cylinders, electronic ignition and a turbo charger to the Maestro's talking dashboard. But it was the talking car that hit the headlines; cars that just go faster are pretty ordinary in terms of news value.

Electronic devices that talk or listen are now the fashionable technological magic. So I was not surprised to read about a talking wrist watch on the *Financial Times* Technology page just before they went on strike. It was produced by those clever Japanese who got a photograph of their wrist watch television set on the *FT* front page. I wrote about it in the July issue.

The talking wrist watch is not quite what you might expect. It is a normal digital watch, but with an all-solid-state memory system that can store up to eight seconds of speech and trot it out whenever you press the button. It is intended for use as an oral (or aural) electronic memo instead of one of these miniature cassette recorders.

I'm surprised that they can even accommodate the microphone and loudspeaker in a wrist watch case, and I'm bound to admire the ingenuity of the designers. But an eight-second capacity seems a bit small. I think it would just about accommodate the manufacturer's international address – spoken in English.

I was a bit disappointed, however, when I read the description. When I first saw the headline I assumed that a talking and listening wrist watch would tell you the time when you ask it. But perhaps one shouldn't expect the magic to be useful as well.

THE ALL ELECTRONIC SHOW-OFF

Do you remember when the term "electronic" was generally associated with radio, radar and similar kinds of magic that are now regarded as a bit dull and ordinary?

It's all different now, of course, with microchips all over the place, space invaders and that sort of thing. And it seems that no modern home is complete without an all-electronic kitchen – electronic washing machine, food mixer, cooker and steam iron – all programmable naturally.

I was a bit surprised, however, when I began to make some enquiries about a home video cassette machine. We're a little behind the times at our house. I started with that knowledgeable chap in the radio shop opposite our office. He recommended that I should be sure to get an electronic one.

"Is there some other kind?" I asked.

"Well, not now sir," he told me, with that knowing smile the expert gives when he thinks he's been caught out, "But the older models had mechanical push-button switches instead of these touch controls."

We had a similar experience with the telly. A few drops of water spilled into it when it was only a few days old and it stopped working immediately. We dried it out with the hair dryer and complained to the supplier, who repaired it under guarantee.

"These electronic sets do have teething troubles," the shop manager told me when I reported the fault.

"They are all electronic," I said.

"No sir, yours has electronic remote control," he explained.

I didn't argue. We live and learn. I always believed that our old valve colour telly was electronic, but it took more than a drop of water to put that one out of action.

LOGICAL CONCLUSION

There is a computer news journal on my side table with a survey of "Semi-custom logic" that goes on for page after page. Of course, I could discover what it means by reading the article, but that seems like cheating, so I looked up the words in my old dictionary.

The meaning of "logic" is given as reasoned argument; and the only adjectival meaning given for the word "custom" is custom design – designed to the customer's individual requirements. So semi-custom logic must mean that the product is half-designed to the customer's reasoned argument. Well, we're quite used to that.

One of the facts of life that an old dictionary brings to notice is the brief time since all this computer jargon became part of the language. My old dictionary is a 1954 edition. Less than twenty years old, but it gives the meaning of the verb "compute" as – count, reckon, assess; and the noun "computer" is, naturally, one who computes. So, with digits defined as fingers or toes, a digital computer is, logically, someone who counts on his fingers.

In my old dictionary the word "programme" is a noun pure and simple. A programme is a plan of intended proceedings, and no other meaning is given.

I have a press release on my desk announcing a "programmed socket". It says that if your second-source i.c. device has the wrong pin outs for your p.c. layout, you can simply instal the Programmed Socket instead of the i.c. and then the i.c. into the Programmed Socket. I think I know what all that means. I go through a similar procedure to drive my electric shaver from a 3-pin 13-amp socket.

What will they think of next – programmed soap for electronic washing machines?

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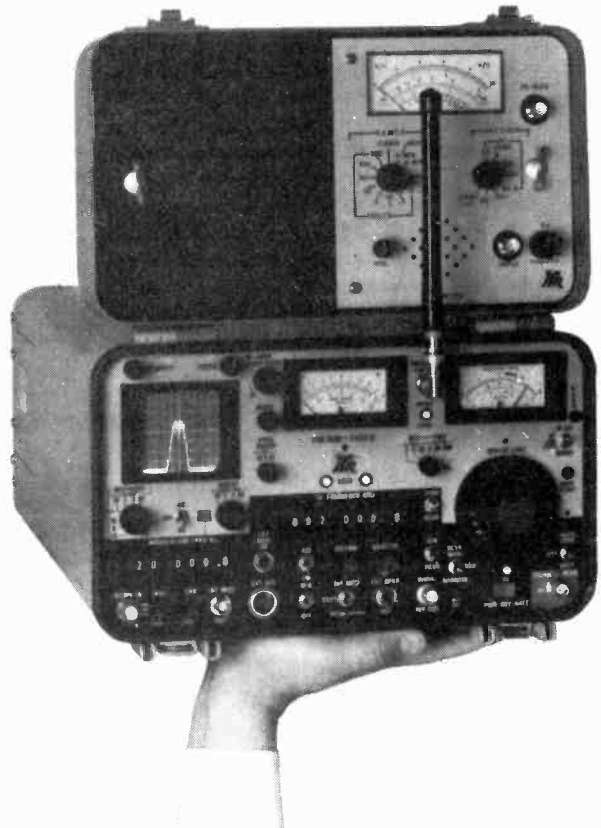

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WW – 012 FOR FURTHER DETAILS

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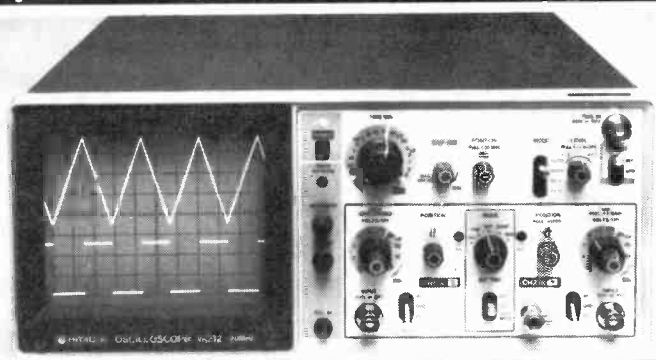

New from Hitachi are three low-cost bench 'scopes with bigger screens and extra features in a new slimline ultra-lightweight format.
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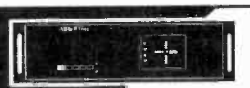

HF/SSB
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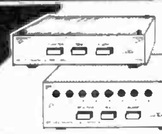

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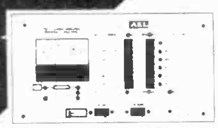
Linear Amplifiers



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WW – 009 FOR FURTHER DETAILS

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Discover the Microcomputer Age

Come along to The Northern Computer Fair and discover for yourself the excitement of the microcomputer age. All you need to know about personal computers, home computers and microcomputer systems for business will be on display at Belle Vue, Manchester from November 24-26. All your questions will be answered at the North's premier personal computer exhibition.

Enthusiasts can see the latest software and hardware technology in action, and for those new to the world of computers this show is a great introduction. Being sponsored by Practical Computing and Your Computer, the leading microcomputing magazines, you can be sure of value for money at £3 a ticket for Adults and £2 for Children under 16.

Travelling to the show is also easy as the organisers have arranged special reduced-price tickets with British Rail which include the cost of admission. For further information ring British Rail Enquiry Bureau on 061-832-8353 before November 11.

The Northern Computer Fair is open between 10.00 am and 6.00 pm every day so come along and bring the microcomputer age alive for you.

For special party rates and further information contact:
The Exhibition Manager,
The Northern Computer Fair,
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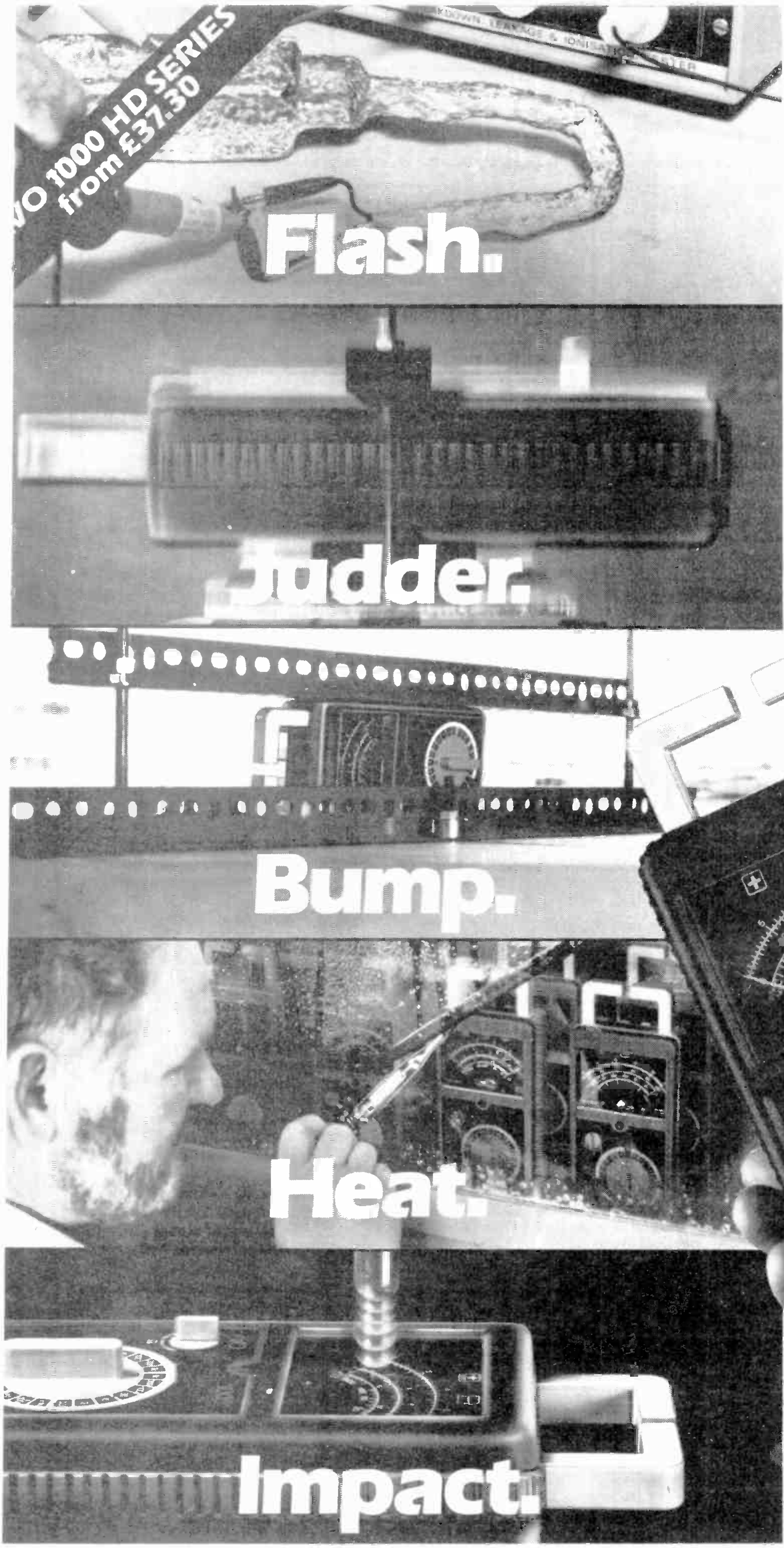


The heavy duty versions of the Avo 1000 Series have to pass a lot of tests that aren't electrical.

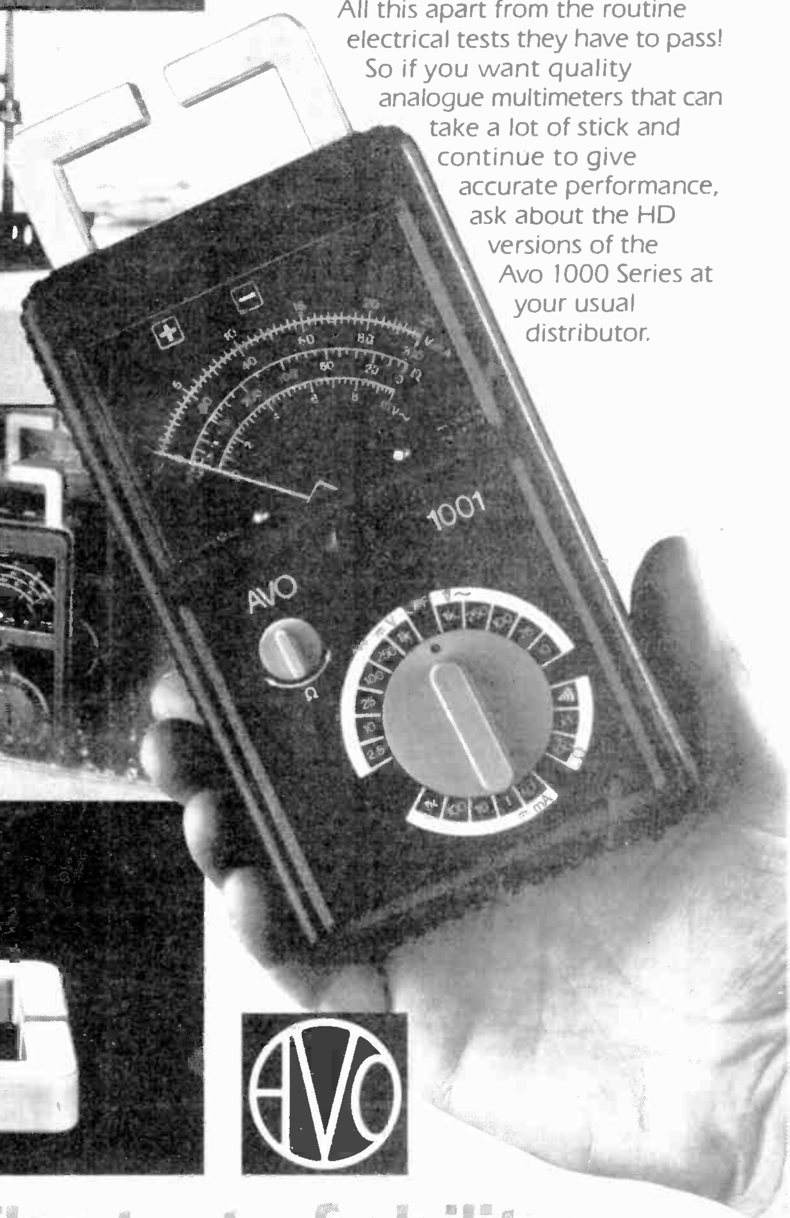
Under normal operating conditions, you can depend on the Avo 1000 Series to give long and reliable performance. However, we appreciate that a lot of users subject their test instruments to treatment that is far from normal. They drop them into their toolkits, throw pliers onto them or take them into hot and sticky boiler rooms.

So to make a tough range of instruments even tougher, we have developed a special rubberised coating which is moulded directly onto the casing.

We put all our instruments through a series of tests that make normal rough treatment look like delicate handling. We flash test them, we subject them to intense vibration, bump them up and down for hours, make them sit in difficult climatic conditions and drop a heavy metal rod on them from a substantial height.

All this apart from the routine electrical tests they have to pass!

So if you want quality analogue multimeters that can take a lot of stick and continue to give accurate performance, ask about the HD versions of the Avo 1000 Series at your usual distributor.



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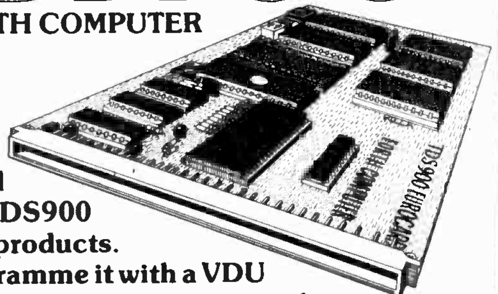
TDS900

FORTH COMPUTER



Build the TDS900 into products. Programme it with a VDU and your forecasts become fact.

Software costs are significant in all industrial applications of microprocessors. They cannot be amortised over the large quantities associated with personal computers and electronic games. This C-MOS embedded computer card aims at resolving this problem by including FORTH high level language programming and developmental facilities. The software can be written quickly and made to work correctly at lowest possible expense. Using a high level programming language rather than assembler gives a fast reaction time to market opportunities. Production products use the same board as employed in the prototypes.

No microprocessor development system is needed since the card contains a screen editor working with simple visual display units (VDUs). It also has the compiler for the FORTH source code. Debugging is inherent in the FORTH language and once the code is working, this can be output to a PROM programmer.

Use of C-MOS throughout has brought the power consumption down to 28mA, making the TDS900 especially suitable for portable and battery-driven applications.

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Visitors to our laboratories at are welcome by appointment

WW – 072 FOR FURTHER DETAILS

MANUFACTURERS & DISTRIBUTORS

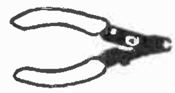
BERG low profile 14 pin dual in line IC Socket manufactured from glass-filled polyester to UL94V-0. **£7** for 100, **£31** for 500, **£56** for 1,000, **£256** for 5,000, **£460** for 10,000, **£2,100** for 50,000, **£3,700** for 100,000. Sample 10 sent for **£1.20** + 30p P&P (£1.37 inc. VAT).

BERG low profile 16 pin dual in line IC Socket as above **£8** for 100, **£36** for 500, **£65** for 1,000, **£295** for 5,000, **£530** for 10,000, **£2,390** for 50,000, **£4,300** for 100,000. Sample 10 sent for **£1.40** + 30p P&P (£1.96 inc. VAT).

(For larger quantities telephone for special quotation)

HIGH POWER SILICON BRIDGE RECTIFIERS. 25 amp 600v. Single hole fixing 250 (¼in) push-on connector terminals, manufactured by IR. **£20** for 10, **£90** for 50, **£175** for 100, **£800** for 500, **£1,450** for 1,000. Special quotation for larger quantities. Sample sent for **£2.50** + 25p P&P (£3.16 inc. VAT).

ZENER DIODES manufactured by **Thompson C.F.** all bandoliered BZX79 C18-BZX79C20-BZX83-C18-BZX83-C20. **£12** per 1,000 of one type, **£15** per 1,000 assorted sample, 100 sent for **£3** + 25p P&P (£3.74 inc. VAT).



WIRE CUTTER & STRIPPER, tempered steel blades spring loaded with moulded red PVC handles. Cutting and stripping adjustable up to 6.0mm². Overall length 135mm. Weight 64 grms. 10 for **£15**, 25 for **£34**, 50 for **£63**, 100 for **£116**, 500 for **£525**, 1,000 for **£1,000**. Sample pair sent for **£1.75** + P&P (£2.60 inc. VAT).

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ROUND RED NEON INDICATOR 240V AC 0.3W MT Hole dia. approx. 9.5mm. Bezel dia. aprox. 12.5mm. Complete with heat resistant leads approx. 500mm in length fitted with 250 (¼") push-on terminals. **£14** for 50, **£26** for 100, **£117** for 500, **£215** for 1,000, **£967** for 5,000. Sample 10 sent for **£3** + 50p P&P (£4.03 inc. VAT).

METAL FILM RESISTOR TYPE FZ4 manufactured by C.G.S. semi-precision with a standard tolrance of ± 2% and a temperature co-efficient of better than 100 ppm/°C. We have a full range in stock from 100R to 1 MO. All bandoliered. **£2.50** per 1,000, any one value.

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WW – 073 FOR FURTHER DETAILS

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Accurate Digital Multimeters at Exceptional Prices

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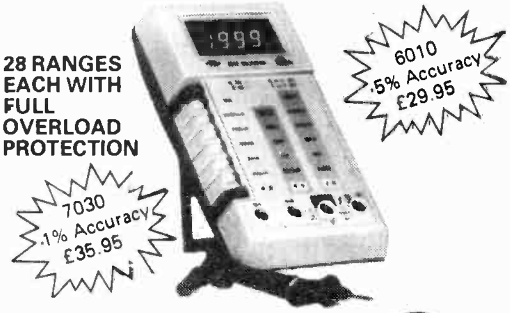

6010 & 7030 MODELS SPECIFICATION

- 10 amp AC/DC
- Battery: single 9V drycell. Life: 200 hrs
- Dimensions: 170 × 89 × 38mm.
- Weight: 400g inc. battery.
- Mode Select: Push Button
- AC DC Current: 200μA to 10A
- AC Voltage: 200mV to 750V
- DC Voltage: 200mV to 1000V
- Resistance: 200Ω to 20MΩ
- Input Impedance: 10MΩ
- Display: 3½ Digit 13mm LCD
- O/load Protection: All ranges

ANALOGUE HM102BZ WITH CONTINUITY BUZZER AND BATTERY SCALE

- DC Voltage: 0-25, 1, 2.5, 10, 25, 100, 250, 1000 volts 20,000 ohms/volt.
- AC Voltage: 0-10, 25, 100, 250, 1000 volts 10,000 ohms/volt.
- Decibels: -20 to +22dB
- DC Current: 0-50, 500μA, 0-5, 50, 500mA
- Ohmmeter: 0-6 Megohms in 4 ranges. 30 ohms Centre Scale.
- Power Supply: One 1.5V size 'A' battery (incl)
- Size & Weight: 135 × 91 × 39mm, 280gr.

OTHER features: Auto polarity, auto zero, battery low indicator, ABS plastic case with tilt stand, battery and test leads included, optional carrying case.

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WW – 022 FOR FURTHER DETAILS

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MSF CLOCK is ALWAYS CORRECT – never gains or loses, SELF SETTING at switch-on, 8 digits show Date, Hours, Minutes and Seconds, auto GMT/BST and leap year, parallel BCD (including Weekday) output for alarm, computer, etc, and audio to record and show time on playback, receives Rugby 60KHz atomic time signals, only 15x5x8 cm, built-in antenna, 1000Km range, GET the TIME RIGHT, £72.70.

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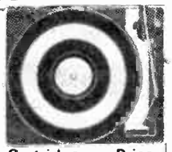
Large Turntables
240 volt AC. Post £2



Make	Model	Drive	Cartridge	Price
BSR	P170	Rim	Ceramic	£20
GARRARD	6200	Rim	Ceramic	£22
GARRARD	Delux	Belt	Magnetic	£40
GOLDRING	G102	Belt	Magnetic	£30
BSR	P232	12 volt	Magnetic	£24
AUTOCHANGERS 240 VOLT				
BSR	Budget	Rim	Ceramic	£16
BSR	Delux	Rim	Ceramic	£18
BSR	Delux	Rim	Magnetic	£26

MAINS PRE-AMP FOR MAGNETIC CARTRIDGES to low gain amplifier 10mv to ½ volt, mono **£5**, stereo **£7**. P&P £1.

HEAVY METAL PLINTHS
Post £1
Cut out for most Garrard decks. Black or silver grey finish. Size 16×13¾in. **£4**

DECCA TEAK VENEERED PLINTH. Post £1 **£5**
Superior finish with space and panel for small amplifier. Board is cut for B.S.R. 18¾in.×14¼in×4in. Black/chrome facia trim. Also with boards cut out for Garrard £3. **Tinted plastic cover £5**

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17⅞×13⅛×3¼in.	£5		
17¼×9⅜×3½in.	£3	18¼×12½×3in.	£5
16½×15×4½in.	£5	16⅝×13×4in.	£5
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22⅝×13⅞×3in.	£5	17¼×13¾×4⅛in.	£5
21½×14¼×2½in.	£5	21×13⅞×4⅛in.	£5
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Suitable for cassettes and all sizes of tape reels. AC mains 200/250V. Hand held size with switch and lead (120 volt to order). Will also demagnetise small tools and computer tapes.
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Stabilised output, 9 volt 400 m.a. U.K. made in plastic case with screw terminals. Safety overload cut out. Size 5×3¼×2½in. Transformer Rectifier Unit. Suitable Radios, Cassettes, models, £5. Post £1.

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All parts and instructions with Zener diode printed circuit, mains transformer 240V a.c. Output 6 or 7½ or 9 or 12V d.c. up to 100mA. Please state voltage required.

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TOGGLE SWITCHES SP **40p.** DPST **50p.** DPDT **60p.**
MINIATURE TOGGLES SP **40p.** DPDT **60p.**
RESISTORS. 10Ω to 10M. ¼W, ½W, 1W, **2p;** 2W **10p.**
Low ohm 1 watt 0.47 to 3.9 ohm **10p.**
HIGH STABILITY. ½w 2% 10 ohms to 1 meg. **10p.**
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt **20p.**
PICK-UP CARTRIDGES SONOTONE 9TAHC **£3.80.**
BSR Stereo Ceramic SC7 Medium Output **£2.** SC12 **£3.50.**
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STYLUS most Ceramic Acos, Sonotone, BSR, Garrard Philips,**£1.50** ea. Send old one for quote.
MAGNETIC STYLUS, Sony, JVC, Sanyo, Goldring, etc. **£4.**
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1P 12W; 2P 2W; 2P 6W; 3P 4W; 4P 2W; 4P 3W.
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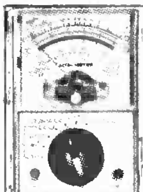
POTENTIOMETERS Carbon Track
5kΩ to 2MΩ. LOG or LIN. L/S **50p.** DP **90p.** Stereo L/S **£1.10.** DP **£1.30.** Edge Pot 5K. SP **45p.**

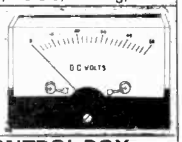
MINI-MULTI TESTER NEW



De luxe pocket size precision moving coil instrument. Impedance + Capacity – 4000 o.p.v. Battery included.
11 instant ranges measure:
DC volts 5.25, 250, 500.
AC volts 10, 50, 500, 1000.
DC amps 0-250μA, 0-250mA.
Resistance 0 to 600K ohms.
£7.50 Post 65p

De Luxe Range Doubler Model **£19.50**
50,000 o.p.v. 7×5×2in. Post £1
43 Ranges, 1,000V, AC-DC, 20 meg, etc.

PANEL METERS
50μa, 100μa, 500μa, 1ma, 5ma, 50ma, 100ma, 500ma, 1 amp, 2 amp, 25 volt, VU 2¼×2×1¼. Stereo VU 3¼×1⅝×1in. **£4.50** Post 50p



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Complete ready to use with cabinet size 9×3×5in. 3 channel, 1000 watt each. For home or disco **£27** Post £1
OR KIT OF PARTS £19.50

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200 Watt Rear Reflecting White Light Bulbs. Ideal for Disco Lights, Edison Screw. 6 for **£4,** or 12 for **£7.50.** Post £1.50. Suitable panel mounting holders **85p.**

RCS "MINOR" 10 watt AMPLIFIER KIT £14
This kit is suitable for record players, guitars, tape playback, electronic instruments or small PA systems. Two versions available: Mono, **£14;** Stereo, **£20.** Post £1
10W per channel; size 9½×3×2in. SAE details.
Full instructions supplied. 240V AC mains.

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Can be ganged to make multi-way stereo mixers Post 65p

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250-0-250V 80mA, 6.3V 3.5A, 6.3V 1A	£6.00	£2
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Tapped outputs available

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1 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£6.00	£2
2 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£10.50	£2
3 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£12.50	£2
5 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£16.00	£2

5-8-10-16V. ½ amp.	£2.50	£1	15-0-15V. 1 amp	£4.00	£1
6V. ½ amp.	£2.00	£1	15-0-15V. 2 amps	£4.50	£1
6-0-6V. 1½ amp	£3.50	£1	20V 1 amp	£4.00	£1
9V. 400ma.	£1.50	£1	20-0-20V 1 amp	£4.50	£1
9V 3 amp	£4.50	£1	20-40-60V 1 amp	£4.50	£2
9-0-9V. 50ma	£1.50	£1	25-0-25V 2 amps	£5.50	£2
9-0-9V. 1 amp	£3.50	£1	28V 1 amp Twice	£6.00	£2
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10-30-40V. 2 amps	£4.50	£1	30V 5 amp and 17-0-17 2a	£5.50	£2
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12-0-12V. 2 amps	£4.50	£1			

CHARGER TRANS	Post	RECTIFIERS	Post
6-12 volt 3a	£4.50+£2	6-12 volt 2a	£1.10+80p
6-12 volt 4a	£6.50+£2	6-12 volt 4a	£2.00+80p

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Post £2

TEAK VENEERED CABINET
11×8½×7in, 15 watts. 4, 8 or 16 ohm
OPUS TWO 15×10½×7¾in 25 watt 2-way system **£39 pair.** Post £3
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500mF 12V **15p;** 25V **20p;** 50V **30p.** 1200mF 76V **80p.**
1000mF 12V **20p;** 25V **35p;** 50V **50p;** 100V **£1.20p.**
2000mF 30V **42p;** 40V **60p;** 100V **£1.40;** 1500mF 100V **£1.20.**
2200mF 63V **90p.** 2500mF 50V **70p;** 3000mF 50V **65p;**
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NON POLARISED CAPACITORS – REVERSIBLE
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2/500V	45p	32+32+16/350V	90p	8+16/450V	75p
8/450V	45p	100+100/275V	50p	16+16/350V	80p
16/350V	45p	150+200/275V	50p	32+32/350V	85p
32/500V	95p	32+32+32/450V	95p	32+32/500V	£2
32/350V	50p	50+50+50/350V	95p	50+50/300V	50p
50/450V	95p	8+8/500V	£1	50+50/350V	80p

CAPACITORS WIRE END High Voltage
.001, .002, .003, .005, .01, .02, .03, .05 mfd 400V **10p.**
.1MF 400V **14p.** 600V **15p.** 1000V **25p.**
.22MF 350V **12p.** 600V **20p.** 1000V **30p.** 1750V **60p.**
.47MF 150V **10p.** 400V **25p.** 630V **30p.** 1000V **60p.**
TRIMMERS 30pF, 50pF, **10p.** 100pF, 150pF **20p.** 500pF **30p.**
MICROSWITCH SINGLE POLE CHANGEOVER 40p.
GEARED TWIN GANGS 365+365+25+25pF **£2.**
BRASS SPINDLE EXTENDERS 85p. Couplers **65p.**
VERNIER DRIVE DIALS, 36mm **£2.50,** 50mm **£3.**
SLOW MOTION DRIVE 6:1 £1.50. Reverse Vernier drive **90p.**
TWIN GANG 25+25pF or 120+120pF **£1**

HEATING ELEMENTS, WAFER THIN (Semi Flexible)
Size 11×9×⅛in. Operating voltage 240V, 250W approx. Suitable for Heating Pads, Food Warmers, Convector Heaters, Propagation, etc. Must be clamped between two sheets of metal or ceramic, etc.
ONLY **60p** EACH (FOUR FOR £2) POST 50p

NEW baker Star sound

High power full range quality loudspeakers. British made. Ideal for Hi-Fi, music P.A. or discotheques. These loudspeakers are recommended for high power quality.

MODEL	INCHES	OHMS	WATTS	TYPE	PRICE	POST
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SUPERB	12	8-16	30	HI-FI	£26	£2
AUDITORIUM	12	8-16	45	HI-FI	£24	£2
AUDITORIUM	15	8-16	60	HI-FI	£37	£2
GROUP 45	12	4-8-16	45	PA	£16	£2
DG 75	12	4-8-16	75	PA	£20	£2
GROUP 100	12	8-16	100	PA	£26	£2
DISCO 100	12	8-16	100	Disco	£26	£2
GROUP 100	15	8-16	100	PA	£35	£2
DISCO 100	15	8-16	100	Disco	£35	£2

BAKER AMPLIFIERS BRITISH MADE

NEW PA150 MICROPHONE PA AMPLIFIER £129
4 channel 8 inputs, dual impedance, 50K-600 ohm 4 channel mixing, volume, treble, bass. Presence controls, Master volume control, echo send return socket. Slave sockets. Post £3.

BAKER 150 Watt AMPLIFIER 4 Inputs £99
For Discotheque, Vocal, Public Address. Three speaker outlets for 4, 8 or 16 ohms. Four high gain inputs, 20 mv, 50K ohm. Individual volume controls "Four channel" mixing. 150 watts 8 ohms R.M.S. Music Power. Slave output 500 M.V. 25Kohm. Response 25 Hz – 20kHz ± 3dB. Integral Hi-Fi preamp separate Bass & Treble. Size – 16"×8"×5½". Wt – 14lb: Master volume control. British made. 12 months' guarantee. 240v A.C. mains or 120V to order. All transistor and solid state. Post £2.
100 Volt Line Model £114. MONO SLAVE 150 watt £80.
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BAKER MOBILE PA AMPLIFIER. All transistor, 60 watt RMS, 12v DC & 240v AC, 4 inputs 50k. Aux + 2 mics + 1 phono. Outputs 4-8-16 ohm + 100 volt line, **£89** p.p. £2

BAKER PORTABLE DISCO 150w. Twin console + amplifier + mike and headphones + twin speakers **£300.** 300 watt version Complete £399. Carriage £30. Console with pre-amp only **£107**

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MAKE	MODEL	SIZE	WATTS	OHMS	PRICE	POST
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PEERLESS	TWEETER	3¾in	60	8	£6.50	£1
AUDAX	TWEETER	4in	30	8	£6.50	£1
AUDAX	MID-RANGE	4in	50	8	£7.50	£1
SEAS	MID-RANGE	4½in	100	8	£14.50	£1
AUDAX	WOOFER	5½	25	8	£10	£1
GOODMANS	HIFAX	7½×4¼	100	4/8/16	£30	£2
GOODMANS	WOOFER	8in	25	4/8	£7.50	£1
GDODMANS	HB WOOFER	8in	60	8	£12.50	£1
WHARFEDALE	WOOFER	8in	30	8	£9.50	£2
CELESTION	DISCO/GROUP	10in	50	8/16	£19	£2
GOODMANS	HPG/GRDUP	12in	120	8/15	£29.50	£2
GOODMANS	GR12/GROUP	12in	90	8/15	£27.50	£2
GOODMANS	HPD/DISCO	12in	120	8/15	£29.50	£2
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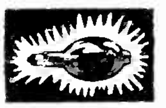
ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES



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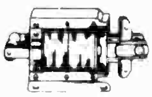

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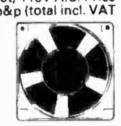
Powerful multi-stage dynamically balanced, totally enclosed 9" dia. Rotators, 3,500 rpm, 1½" I.D. inlet and outlet, 110V A.C. Price **£20.** Suitable transformer for 240V A.C. **£5** + £3 p&p (total incl. VAT **£32.20**) N.M.S.



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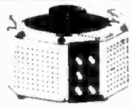

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Why waste money? Build your own EPROM ERASURE for a fraction of the price of a made-up unit. Complete kit of parts less case to include 12, 8 watt 2537 Angst Tube, Ballast unit, pair of bi-pin leads, Neon indicator, safety microswitch, on/off switch and circuit.
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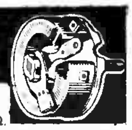

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Suitable **transformer** for above (**£10** p&p £1.50 (**£13.22** inc. VAT)

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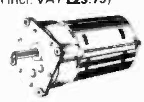

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AMPLIFIERS

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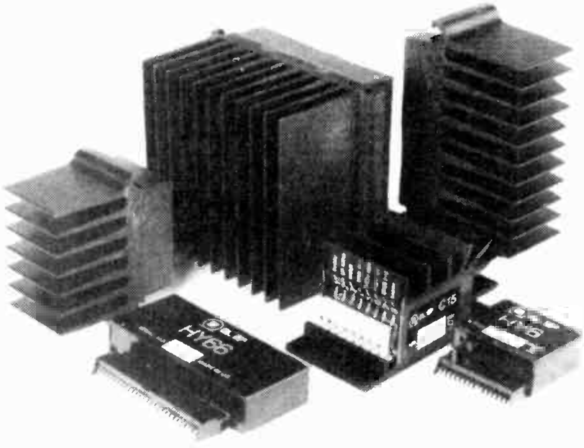
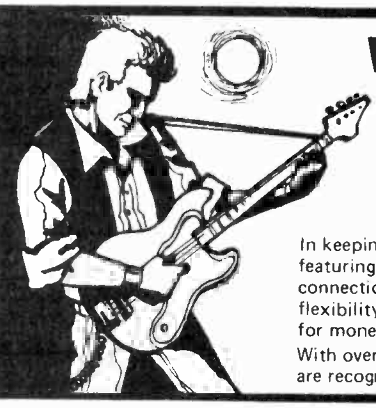


Over the last few years we have received feedback via the general public and industry that our products are from Taiwan, Singapore, Japan, etc... ILP are one of the few 'All British' electronics Companies manufacturing their own products in the United Kingdom. We have proved that we can compete in the world market during the past 12 years and currently export in excess of 60% of our production to over twenty different countries – including USA, Australia and Hong Kong. At the same time we are able to invest in research and development for the future, assuring security for the personnel, directly and indirectly, employed within the UK. We feel very proud of all this and hope you can reap some of our success.

I.L.Potts -- Chairman



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With over 10 years experience in audio amplifier technology ILP are recognised as world leaders.

BIPOLAR MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
HY30	15	4-8	0.015%	<0.006%	± 18	76 x 68 x 40	240	£8.40
HY60	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	£9.55
HY6060	30 + 30	4-8	0.015%	<0.006%	± 25	120 x 78 x 40	420	£18.69
HY124	60	4	0.01%	<0.006%	± 26	120 x 78 x 40	410	£20.75
HY128	60	8	0.01%	<0.006%	± 35	120 x 78 x 40	410	£20.75
HY244	120	4	0.01%	<0.006%	± 35	120 x 78 x 50	520	£25.47
HY248	120	8	0.01%	<0.006%	± 50	120 x 78 x 50	520	£25.47
HY364	180	4	0.01%	<0.006%	± 45	120 x 78 x 100	1030	£38.41
HY368	180	8	0.01%	<0.006%	± 60	120 x 78 x 100	1030	£38.41

Protection: Full load line. Slew Rate: 15v/μs. Risetime: 5μs. S/N ratio: 100db.
Frequency response (−3dB) 15Hz – 50KHz. Input sensitivity: 500mV rms.
Input Impedance: 100K Ω . Damping factor: 100Hz >400.

PRE-AMP SYSTEMS

Module Number	Module	Functions	Current Required	Price inc. VAT
HY6	Mono pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble	10mA	£7.60
HY66	Stereo pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble/Balance	20mA	£14.32
HY73	Guitar pre amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
HY78	Stereo pre amp	As HY66 less tone controls	20mA	£14.20

Most pre-amp modules can be driven by the PSU driving the main power amp. A separate PSU 30 is available purely for pre amp modules if required for £5.47 (inc. VAT). Pre-amp and mixing modules in 18 different variations. Please send for details.

Mounting Boards
For ease of construction we recommend the **B6** for modules HY6–HY13 £1.05 (inc. VAT) and the **B66** for modules HY66–HY78 £1.29 (inc. VAT).

MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
MOS 128	60	4-8	<0.005%	<0.006%	± 45	120 x 78 x 40	420	[illegible]
MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 x 78 x 80	850	[illegible]
MOS 364	180	4	<0.005%	<0.006%	± 55	120 x 78 x 100	1025	[illegible]

Protection. Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).
Slew rate: 20v/μs. Rise time 3μs. S/N ratio: 100db
Frequency response (−3dB) 15Hz – 100KHz. Input sensitivity 500mV rms
Input impedance: 100K Ω. Damping factor 100Hz >400.

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C15
Mono Power Booster Amplifier to increase the output of your existing car radio or cassette player to a nominal 15 watts rms

Very easy to use.

Robust construction. £9.14 (inc. VAT)

Mounts anywhere in car.

Automatic switch on.

Output power maximum 22w peak into 4Ω.
Frequency response (−3dB) 15Hz to 30KHz, T.H.D. 0.1% at 10w 1KHz
S/N ratio (DIN AUDIO) 80dB. Load Impedance 3Ω.
Input Sensitivity and impedance (selectable) 700mV rms into 15K Ω 3V rms into 8 Ω.
Size 95 x 48 x 50mm. Weight 256 gms.

C1515
Stereo version of C15 £17.19 (inc. VAT)
Size 95 x 40 x 80 Weight 410 gms.

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Model Number	For Use With	Price inc. VAT
PSU 21X	1 or 2 HY30	£11.93
PSU 41X	1 or 2 HY60, 1 x HY6060, 1 x HY124	£13.83
PSU 42X	1 x HY128	£15.90
PSU 43X	1 x MOS128	£16.70
PSU 51X	2 x HY128, 1 x HY244	£17.07

Model Number	For Use With	Price inc. VAT
PSU 52X	2 x HY124	£17.07
PSU 53X	2 x MOS128	£17.86
PSU 54X	1 x HY248	£17.86
PSU 55X	1 x MOS248	£19.52
PSU 71X	2 x HY244	£21.75

Model Number	For Use With	Price inc. VAT
PSU 72X	[illegible] HY248	[illegible]
PSU 73X	1 x HY364	[illegible]
PSU 74X	[illegible] HY368	[illegible]
[illegible]	[illegible]	[illegible]

Please note: X in part no. indicates primary voltage. Please insert "0" in place of X for 110V, "1" in place of X for 220V, and "2" in place of X for 240V.

ILP Electronics Ltd.

Graham Bell House, Roper Close
Canterbury CT2 7EP, Kent, England
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213	1.0	0.5	**3.19**	1.00
71	2	1	**4.25**	1.00
18	4	2	**4.91**	1.20
85	5	2.5	**6.78**	1.20
70	6	3	**7.69**	1.20
108	8	4	**8.98**	1.30
72	10	5	**9.82**	1.50
116	12	6	**10.89**	1.50
17	16	8	**12.97**	1.50
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Ref.	Amps	£	£
112	0.5	**3.19**	1.00
79	1.0	**4.32**	1.00
3	2.0	**6.99**	1.20
20	3.0	**8.10**	1.30
21	4.0	**9.67**	1.40
51	5.0	**11.95**	1.40
117	6.0	**13.52**	1.50
88	8.0	**18.10**	1.80
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90	12.0	**23.20**	4.00
91	15.0	**26.60**	4.00
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50 VOLT RANGE

Ref.	Amps	£	£
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103	1.0	**5.03**	1.10
104	2.0	**8.69**	1.30
105	3.0	**10.36**	1.50
106	4.0	**14.10**	1.60
107	6.0	**18.01**	1.70
118	8.0	**24.52**	2.00
119	10.0	**30.23**	4.00
109	12.0	**36.18**	4.00

60 VOLT RANGE

Ref.	Amps	£	£
124	0.5	**4.70**	1.20
126	1.0	**7.15**	1.20
127	2.0	**9.20**	1.40
125	3.0	**13.31**	1.50
123	4.0	**15.15**	1.70
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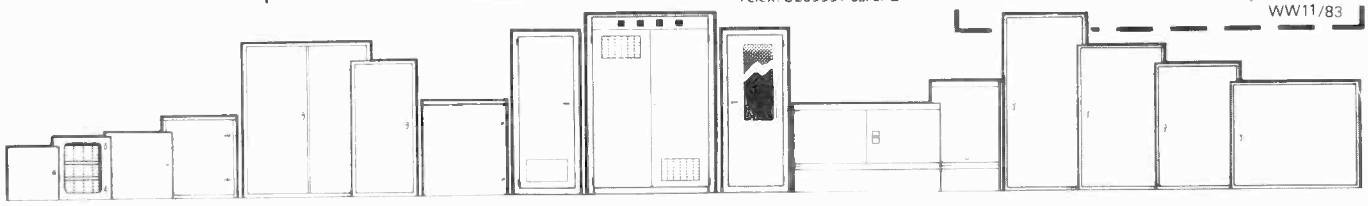

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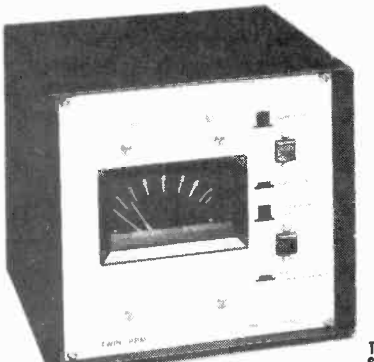

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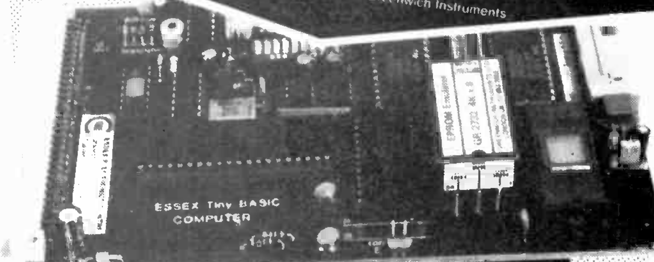

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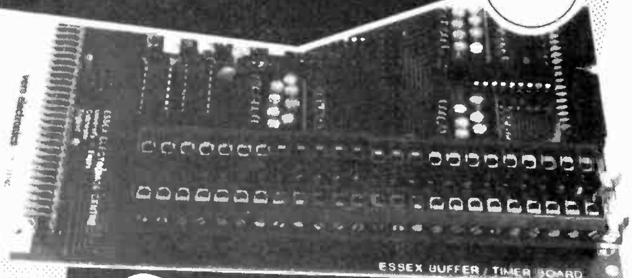

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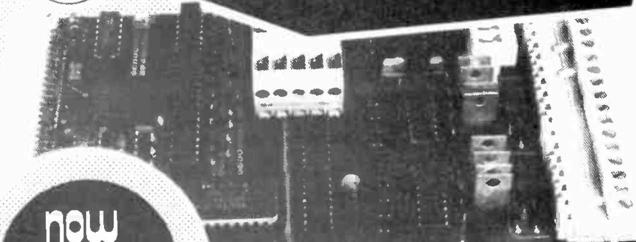

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SEMICONDUCTORS

AA119	0.10
AAY30	0.17
AAY30	0.17
AAZ13	0.15
AAZ15	0.15
AAZ17	0.15
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CY31	3.00
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C3JA	22.00
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DAF96	1.75
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E80CF	11.27
E80F	13.58
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E83CC	8.40
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E90CC	8.61
E90F	9.90
E91H	6.25
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PCF82	1.50
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PCF201	3.25
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XG5-500	26.60
XG2-6400	162.00
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ZM1020	9.00
ZM1021	9.00
ZM1022	9.00
ZM1023	9.00
ZM1040	19.36
ZM1041	16.66
ZM1042	17.77
1B3GT	3.00
1B24	25.00
1B35A	48.00
1B63	64.00
1R5	1.75
1S5	1.75
1T4	1.75
2AS15	11.50
2C39A	60.00
2C43	70.00
2D21	3.25
2E26	8.25
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2J70B	336.00
2K25	125.00
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3-500Z	85.00
3A5	3.00
3B24	11.00
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3B29	20.00
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3C45	24.50
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5R4GY	3.50
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5V4G	2.50
5Y3GT	2.50
5Z3	4.00
5Z4G	2.50
5Z4GT	2.50
6-30L2	1.75
6AB4	1.75
6AB7	3.00
6AC7	3.00
6AF4A	4.25
6AG7	3.00
6AH6	5.00
6AK5	7.10
6AK6	2.50
6AL5	1.50
6AM4	4.00
6AM5	9.69
6AM6	6.00
6AN5	4.75
6AN8A	3.50
6AQ5	2.25
6AS6	8.66
6AS7G	8.75
6AT6	1.25
6AU5GT	5.00
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6AV6	1.50
6AX5GT	3.00
6B7	3.25
6B8	3.25
6BA6	1.50
6BA7	5.00
6BA8A	4.00
6BC4	4.00
6BE6	1.50
6BH6	2.50
6BJ6	2.25
6BK4	4.50
6BL6	85.00
6BL7GT	4.50
6BM6	115.00
6BN6	2.00
6BQ7A	3.50
6BR7	6.00
6BR8A	3.50
6BS7	6.00
6BW6	6.00
6BW7	1.50
6BX7GT	5.00
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6C4	1.25
6CB6A	2.50
6CD6GA	5.00
6CG7	2.50
6CH6	13.00
6CL6	3.75

6CW4	8.00
6D2	1.50
6DK6	3.00
6DQ6B	4.75
6EA8	3.00
6EB8	2.50
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6F23	1.60
6F28	1.60
6F33	33.50
6H1	14.00
6H2N	2.75
6H3N	2.75
6H6	3.00
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6J7	4.75
6K4N	2.50
6K6GT	2.75
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6K8	3.00
6KD6	7.00
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6L6GC	3.00
6L6GT	3.00
6L7	2.50
6N2P	2.50
6N3P	2.50
6N7	3.00
6P25	4.00
6Q7	3.75
6R7	3.25
6SA7	3.00
6SC7	2.75
6SF7	2.50
6SH7	3.00
6SJ7	3.25
6SK7	3.50
6SK7GT	3.00
6SN7GT	3.00
6SQ7	3.40
6SR7	4.00
6SS7	2.75
6U5G	3.50
6U8A	2.25
6V6GT	2.25
6X4	2.00
6X5GT	1.75
7B7	2.50
7C5	4.00
7C6	2.50
7H7	4.00
7R7	4.25
7S7	3.50
7Y4	2.25
7Z4	2.00
11E3	55.00
12AH8	5.00
12AT6	1.50
12AT7	1.75
12AU6	2.50
12AU7	1.75
12AV6	2.50
12AV7	3.50
12AX7	1.75
12AY7A	4.00
12B4A	3.50

12BA6	2.50
12BE6	2.50
12BH7	1.50
12BY7	3.00
12E1	20.00
12E1ITT	170.00
12E14	35.00
13E1	20.00
19H4	27.50
19H5	47.50
24B9	67.25
30C15	2.00
30C17	2.00
30C18	2.00
30F5	1.60
30FL1/2	1.38
30FL12	1.80
30FL14	2.00
30L1	1.50
30L15	2.00
30L17	2.00
30P4	2.50
30P19	2.50
30PL1	3.00
30PL14	1.80
30PL15	1.80
35W4	1.00
50C5	1.50
75B1	6.05
75C1	4.50
85A1	7.50
85A2	4.45
90AG	12.96
90AV	12.96
90C1	6.00
90CG	14.54
90CV	15.45
92AG	12.96
92AV	12.96
95A1	8.45
150B2	6.50
150B3	8.35
150C2	3.25
150C4	6.00
211	35.00
723AB	125.00
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4212E	300.00
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5651	4.45

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5718	7.50
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5879	5.00
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5965	3.50
6005	2.25
6021	4.50
6057	10.23
6058	12.34
6059	6.00
6061	6.00
6063	3.75
6064	8.58
6067	10.23
6072	6.00
6080	14.00
6097A	235.00
6097B	200.00
6146A	8.25
6146B	8.25
6159B	19.00
6189	9.55
6201	11.40
6442	20.00
6883B	17.54
6973	4.00
7025	3.00
7551	6.25
7586	12.00
7587	18.50
7609	56.00
7868	6.00
7895	12.00
8005	110.49
8068	14.00
8122	90.00
8136	2.50
8417	6.00
18042	11.53
18045	10.49

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4CX250B 6.50

BASES

B7G unskirted	0.22
B7G skirted	0.30
B9A unskirted	0.22
B9A skirted	0.30
Int Octal	0.35
Loctal	0.55
Nuvistor base	0.75
8 pin DIL	0.10
14 pin DIL	0.10
16 pin DIL	0.10
Valve screening cans all sizes	0.30

CRTs

2AP1	8.50
2BP1	9.00
3BP1	12.00
3DP1	5.00
3EG1	10.00
3FP7	6.00
3GP1	6.00
3JP1	8.00
3JP2	8.00
3JP7	10.00
3KP1	15.00
3RP1	35.00
3WP1	20.00

5ADP1	35.00
5CP1	10.00
5CP1A	40.00
5FP15A	15.00
5UP7	25.00
DG7-5	63.32
DG7-31	58.07
DG7-32	58.07
DH3-91	56.83
DH7-11	113.12
VCR97	12.00
VCR138	12.00
VCR138A	12.50
VCR139A	8.00
VCR517A	10.00

VCR517B	10.00
VCR517C	10.00

Tube Bases Prices on application

INTEGRATED CIRCUITS

7400	0.16
7401	0.17
7402	0.17
7403	0.17
7404	0.18
7405	0.18
7406	0.43
7407	0.43
7408	0.20
7409	0.20
7410	0.17
7412	0.29
7413	0.32
7416	0.32
7417	0.32
7420	0.18
7422	0.20

7423	0.33
7425	0.30
7427	0.30
7428	0.43
7430	0.17
7432	0.30
7433	0.40
7437	0.32
7438	0.32
7440	0.32
7441	0.90
7442	0.72
7447AN	1.17
7450	0.18
7451	0.18
7453	0.18
7454	0.18

7460	0.18
7470	0.38
7472	0.33
7473	0.38
7474	0.38
7475	0.54
7476	0.42
7480	0.56
7482	0.75
7483	1.00
7484	1.05
7486	0.39
7490	0.60
7491	0.82
7492	0.60
7493	0.60
7494	0.82

7495	0.73
7496	0.82
7497	3.15
74100	1.54
74107	0.45
74109	0.73
74110	0.51
74111	0.71
74116	1.85
74118	1.00
74119	1.54
74120	0.83
74121	0.43
74122	0.62
74123	1.18
74125	0.58
74126	0.58
74128	0.63
74132	0.72

74136	0.51
74141	0.89
74142	2.30
74143	2.60
74144	2.60
74145	1.00
74147	2.00
74148	1.76
74150	1.80
74151	0.94
74154	1.80
74155	0.90
74156	0.90
74157	0.75
74159	2.20
74170	2.40
74172	4.40
74173	1.42
74174	1.60

74175	1.02
74176	1.16
74178	1.36
74179	1.36
74180	1.20
74190	1.90
74191	1.90
74192	1.90
74193	1.90
74194	1.25
74195	1.20
74196	1.35
74197	1.35
74198	2.70
74199	2.30
TAA570	2.30
TAA630S	3.50
TAA700	3.90
TBA480Q	1.84

TBA520Q	2.30
TBA530	1.98
TBA540Q	2.30
TBA550Q	3.22
TBA560CQ	3.22
TBA673	2.20
TBA700	1.52
TBA720Q	2.30
TBA750Q	2.07
TBA800	1.20
TBA920	2.90
TBA920Q	2.90
TBA990Q	2.90
TCA270Q	2.90
TCA760A	1.38

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MODEL REFERENCE	1302-1 Medium Resolution	1302-2 High Resolution
RESOLUTION	370 x 470 Pixels	580 x 470 Pixels
C.R.T.	14"	14"
SUPPLY	220/240v. 50/60Hz.	220/240v. 50/60Hz.
E.H.T	Minimum 19.5kv Maximum 22.5kv	Minimum 19.5kv Maximum 22.5kv
VIDEO BAND WIDTH	6MHz	10MHz
DISPLAY	80 characters by 25 lines	80 characters by 25 lines
SLOT PITCH	0.63mm	0.41mm
INPUT: VIDEO	R.G.B. Analogue/ TTL Input	R.G.B. Analogue/ TTL Input
SYNC	Separate Sync on R.G.B Positive or Negative	Separate Sync on R.G.B Positive or Negative
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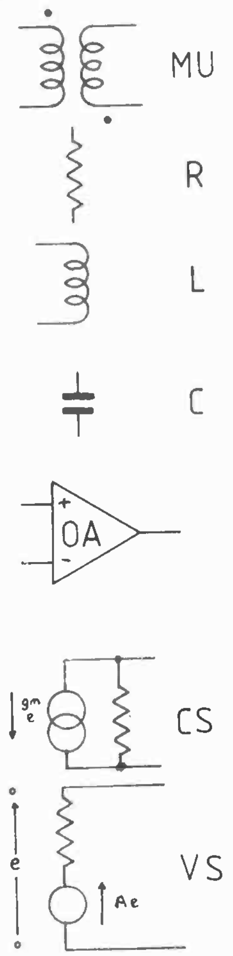

CIRCUIT MODELLER for CP/M

by Harcourt Systems

An engineering package for CP/M and MS DOS* microcomputers to carry out accurate, fast designs of linear circuits.*

CIRCUIT MODELLER can find voltage gain, phase shift, Z_{in} and Z_{out} for most linear electrical and electronic circuits. The limits of capacity are set by the microcomputer RAM, which must be at least 60 KBytes. This gives a capacity of 32 nodes, 101 resistors, 101 capacitors, 101 inductors, 31 mutual inductors, 31 simple operational amplifiers and 31 controlled sources.

Features include:

ADD & EDIT	to construct and alter circuit
LOAD & SAVE	to save and recover circuit from disk
GAIN	to display gain and phase
ZIN	to display input and output impedances
BW	to find centre frequency and −3dB Av points of circuit
SEARCH	to find frequency corresponding to given gain
PRINT	to print synopsis of circuit diagram sufficient for its precise reproduction.

Operating Speed

CIRCUIT MODELLER is an all-compiled package with seven overlays in which the inner two loops of pivotal condensation are written in Z80 assembler. This means that whereas microcomputer CAD is usually slow, **CIRCUIT MODELLER** can solve a four hybrid-pi amplifier in a few seconds.

Graphics

PLOT is an extension to **CIRCUIT MODELLER** enabling an ordinary 132 column printer to plot both dB gain and phase angle against frequency for the circuit. A log/log plot is obtained with automatic axis scaling.

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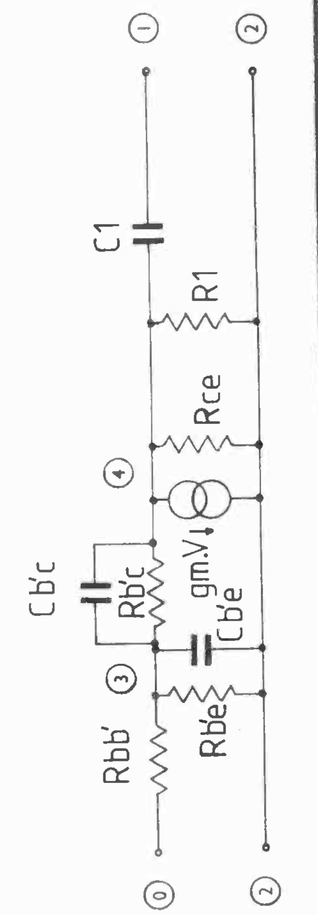

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Efficient thermal design gives fast heating and recovery, and there is a wide range of iron plated bits to choose from. Translucent handle mouldings allow internal lamps to show clearly the operation of the control. Burn-proof 3-wire leads are fitted.

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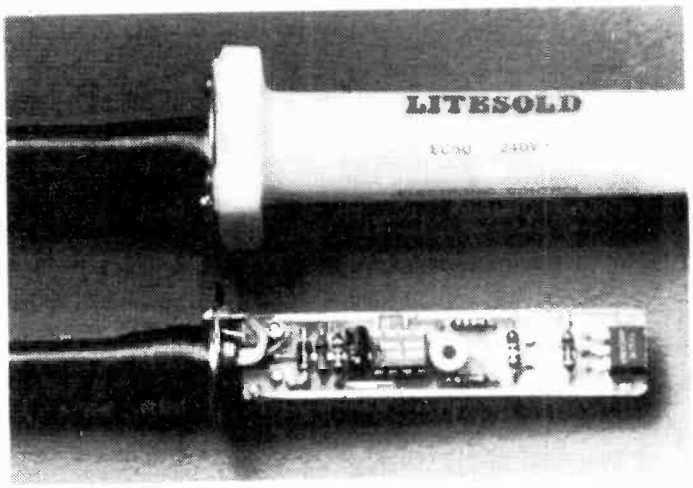

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250V: 1nF to 6n8 7p, 8n2 to 47nF 8p, 56nF to 150nF 10p
100V: 100nF to 150nF 11p, 180nF to 270nF 14p, 330nF to 390nF 20p, 470nF to 560nF 26p, 680nF 30p, 1µF 10mm 35p

POLYESTER 250V RADIAL (C280)
10nF 15nF 22nF 33nF 47nF 68nF 7p, 100nF 7p, 150nF 220nF 10p, 330nF 470nF 13p, 680nF 18p, 1µF 22p, 1.5 2.2 39p

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1 35V 14p, 22 35V 14p, 33 35V 14p, 47 35V 14p, 68 35V 14p, 1.0 35V 14p, 2.2 35V 14p, 3.3 35V 18p, 4.7 16V 18p, 4.7 35V 20p, 6.8 25V 20p, 6.8 35V 21p, 10 16V 18p, 10 35V 27p, 15 10V 22p, 15 16V 30p, 15 25V 32p, 22 6.3V 26p, 22 16V 29p, 33 10V 30p, 47 3V 14p, 47 6.3V 34p, 47 16V 39p, 100 3V 32p, 100 10V 55p

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AXIALS (µFd V)
47 63 8p, 47 100 9p, 47 350 30p, 1 63 8p, 1 100 9p, 1 500 40p, 2.2 25 8p, 2.2 63 9p, 2.2 100 11p, 2.2 350 30p, 3.3 25 10p, 3.3 40 11p, 3.3 63 12p, 4.7 16 8p, 4.7 25 9p, 4.7 40 11p, 4.7 63 12p, 4.7 100 14p, 10 25 8p, 10 40 12p, 10 63 14p, 10 100 16p, 22 25 11p, 22 40 14p, 22 63 16p, 22 100 21p, 47 25 14p, 47 40 17p, 47 63 26p, 47 100 28p, 100 16 14p, 100 25 16p, 100 40 22p, 100 63 25p, 100 100 30p, 220 10 16p, 220 16 17p, 220 25 22p, 220 40 25p, 220 63 30p, 220 100 40p, 470 16 22p, 470 25 28p, 470 40 33p, 470 63 43p, 470 100 60p, 1000 16 30p, 1000 25 38p, 1000 40 46p, 1000 63 65p, 2200 16 40p, 2200 25 63p, 2200 40 70p, 2200 63 134p, 4700 16 75p, 4700 25 89p

RADIALS PCB wires one end Matsushita only (µFd V)
10 16 6p, 22 10 6p, 22 16 7p, 47 10 7p, 47 16 8p, 100 10 9p, 100 16 10p, 220 10 11p, 220 16 12p, 470 10 17p, 470 16 18p, 1000 10 20p, 1000 16 24p, 2200 10 34p, 2200 16 44p

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6 6 9 9 1.25A 4.25

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Prices per Metre: Solid connecting wire 5p
Mains/Speaker Cable Twin 1 amp 14p, Twin 2½ amp 16p, 3 Core 2½ amp 18p, 3 Core 6 amp 31p, 3 Core 13 amp 56p
Screened Cable Single 14p, Stereo 27p, Mini Single 12p, Mini Stereo 15p, 4 Core 4 Screens 44p, 4 Core 1 Screen 54p, 8 Core 61p, 12 Core 80p
Aerial Cable 50Ω RG58A 36p, 75Ω UHF 36p, 75Ω VHF 28p, 300Ω Flat 14p
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40411 2.85, 40412 90p, 40673 83p, 40822 1.80, 40871 79p, 40872 79p, AC125 49p, AC126 32p, AC127 32p, AC128 35p, AC132 68p, AC141K 28p, AC142K 28p, AC151 51p, AC152 45p, AC153 55p, AC153K 64p, AC176 27p, AC176K 37p, AC187 25p, AC187K 28p, AC188 25p, AC188K 40p, AF239 55p, AF240 1.00, BC107 10p, BC107A 12p, BC107B 12p, BC108 10p, BC108A 12p, BC108B 12p, BC108C 14p, BC109 10p, BC109B 12p, BC109C 12p, BC140 29p, BC141 37p, BC142 29p, BC143 30p, BC147 10p, BC147A 10p, BC147B 10p, BC147C 20p, BC148 10p, BC148A 12p, BC148B 13p, BC148C 13p, BC149 10p, BC149B 12p, BC149C 13p, BC152 35p, BC153 23p, BC154 27p, BC157 11p, BC157A 12p, BC157B 13p, BC158 10p, BC158A 12p, BC158B 13p, BC159 11p, BC159A 12p, BC159B 13p, BC159C 18p, BC160 42p, BC161 48p, BC167 10p, BC167A 10p, BC167B 13p, BC168 10p, BC168B 10p, BC168C 10p, BC169 10p, BC169B 10p, BC169C 10p, BC177 16p, BC177A 25p, BC177B 25p, BC178 16p, BC178A 24p, BC178B 25p, BC179 20p, BC179A 25p, BC179B 25p, BC179C 27p, BC182 10p, BC182A 12p, BC182B 12p, BC182L 10p, BC182LA 13p, BC182LB 14p, BC183 10p, BC183A 11p, BC183B 12p, BC183C 12p, BC183L 10p, BC183LA 13p, BC183LB 13p, BC183LC 14p, BC184 10p, BC184B 12p, BC184C 13p, BC184L 10p, BC184LB 13p, BC184LC 14p, BC186 24p, BC187 24p, BC212 10p, BC212A 12p, BC212B 13p, BC212C 13p, BC212L 10p, BC212LA 12p, BC212LB 13p, BC213 10p, BC213A 11p, BC213B 12p, BC213C 13p, BC213L 10p, BC213LA 13p, BC213LB 13p, BC213LC 14p, BC214 10p, BC214B 12p, BC214C 13p, BC214L 10p, BC214LB 13p, BC214LC 14p, BC237 14p, BC237A 16p, BC237B 17p, BC237C 18p, BC238 14p, BC238A 15p, BC238B 16p, BC238C 17p, BC239 16p, BC239A 16p, BC239B 17p, BC239C 17p, BC300 45p, BC301 40p, BC302 43p, BC303 47p, BC327 15p, BC328 14p, BC337 15p, BC338 15p, BC440 32p, BC441 33p, BC460 32p, BC461 33p, BC516 40p, BC517 40p, BC547 13p, BC546B 15p, BC556B 15p

BC547A 14p, BC547B 14p, BC548 12p, BC548A 13p, BC548B 13p, BC548C 15p, BC549 13p, BC549B 14p, BC549C 15p, BC550 15p, BC550C 25p, BC557 15p, BC557A 15p, BC557B 16p, BC558 14p, BC558A 15p, BC558B 16p, BC558C 17p, BC559 16p, BC559B 16p, BC559C 17p, BC560 15p, BC560C 25p, BC650 45p, BC651 46p, BCY70 16p, BCY71 16p, BCY72 19p, BD131 44p, BD132 44p, BD135 40p, BD136 40p, BD137 42p, BD138 39p, BD139 39p, BD140 39p, BD237 98p, BD238 98p, BD239A 57p, BD239C 64p, BD240A 59p, BD240C 73p, BD241A 61p, BD241C 67p, BD242A 65p, BD242C 70p, BD243A 72p, BD243C 85p, BD244A 82p, BD244C 1.00, BD245A 1.14, BD245C 1.30, BD246A 1.20, BD246C 1.50, BD249A 2.00, BD249C 2.31, BD250A 2.11, BD250C 2.46, BD419 1.29, BD420 1.37, BD437 88p, BD438 88p, BD539 90p, BD440 91p, BD441 91p, BD442 93p, BD529 1.20, BD530 1.30, BD535 75p, BD536 75p, BD537 80p, BD538 80p, BD539 80p, BD539C 1.10, BD540 85p, BD540C 1.20, BD675 72p, BD676 77p, BD677 78p, BD678 83p, BD711 1.32, BD712 1.32, BDX32 3.47, BDX66B 5.95, BDX67B 5.95, BDY54 1.70, BDY55 1.75, BDY56 1.80, BDY57 5.25, BDY58 6.15, BF194 12p, BF195 12p, BF196 12p, BF197 12p, BF198 15p, BF199 15p, BF200 1.49, BF224 32p, BF225 35p, BF244A 35p, BF245A 30p, BF245B 51p, BF246 55p, BF246A 39p, BF246B 53p, BF247A 54p, BF247B 55p, BF254 39p, BF255 42p, BF256A 35p, BF256B 48p, BF257 62p, BF257 30p, BF258 32p, BF259 35p, BF457 46p, BF458 58p, BF459 62p, BF469 86p, BF470 86p, BFR39 22p, BFR40 22p, BFR41 22p, BFR79 22p, BFR80 22p, BFR81 22p, BFR90 1.00, BFS28 2.95, BFS61 1.00, BFS98 1.10, BFX29 26p, BFX30 27p, BFX50 23p, BFX51 23p, BFX52 23p, BFX53 31p, BSX19 24p, BSX20 24p, BSX21 40p, BU104 2.22, BU105 1.70, BU108 3.95, BU109 3.29, BU126 1.47, BU204 2.25, BU205 1.75, BU206 1.89, BU208 1.98, BU226 3.96, BU326S 2.95, BU406 1.45, BU407 1.45, BU408 1.35, BU500 2.95, BUY18S 3.95

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8A: TIC116A 66p, TIC116B 68p, TIC116C 71p, TIC116D 73p, TIC116M 80p
12A: TIC126A 72p, TIC126B 72p, TIC126C 73p, TIC126D 77p, TIC126M 96p

TRIACS Texas 400V TO220 Case
TIC206D 4A 66p, TIC225D 6A 74p, TIC226D 8A 88p, TIC236D 12A 1.16, TIC246D 16A 1.22, TIC253D 20A 1.90, TIC263D 25A 2.11

DIACS BR100 25p, ST2 25p

ZENER'S

400 500mW E24 Series 2.4 47V 7p
1.3 Watt E24 Series 3.3 82V 14p

BRIDGE

PIV shown in brackets, 1 amp type: W01 (100) 20p, W02 (200) 26p, W04 (400) 28p, W08 (800) 40p
2 amp type Square with hole: S01 (100) 37p, S02 (200) 40p

OPTO

LEDs R Red, G Green, Y Yellow. Prices 1 / 50+
Large diffused: R5D 9p 7p, G5D 15p 12p, Y5D 15p 12p
Small diffused: R2D 8p 6p, G2D 12p 10p, Y2D 12p 10p
Micro 0.1: R1D 25p 22p, G1D 27p 25p, Y1D 27p 25p
Large clear: R5E 12p 10p, G5C 17p 13p, Y5C 17p 13p
Super bright high efficiency Large (100 times brighter): R5U 38p 29p, G5U 42p 34p, Y5U 42p 34p
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RC4136 59p, TBA500 2.97, TBA500Q 3.11, TBA510 2.95, TBA510Q 3.05, TBA520 2.57, TBA520Q 2.75, TBA530 2.56, TBA530Q 2.76, TBA540 2.72, TBA540Q 2.74, TBA550 3.25, TBA550Q 3.27, TBA560C 2.87, TBA570 2.37, TBA570Q 2.48, TDA1002 3.39, TDA1003 3.94, TDA1004 2.87, TDA1005 3.94, TDA1010A 2.25, TDA1022 4.95, TDA2611A 2.50, TL061 40p, TL062 60p, TL064 99p, TL071 34p, TL072 50p, TL074 99p, TL081 29p, TL082 50p, TL084 89p, UAA170 1.69, UAA180 1.69, ULN2003 85p, UPC575C2 2.50, UPC1156 2.75, XR2206 2.92, ZN409 2.25, ZN414 1.00, ZN1034 1.99, TDA7000 3.45

74TTL

7400 16p, 7401 16p, 7402 16p, 7403 16p, 7404 16p, 7405 16p, 7408 14p, 7409 14p, 7410 15p, 7411 16p, 7412 18p, 7413 18p, 7414 25p, 7416 19p, 7417 19p, 7420 15p, 7421 19p, 7422 19p, 7423 19p, 7425 19p, 7426 19p, 7427 19p, 7428 26p, 7430 19p, 7432 22p, 7433 22p, 7437 25p, 7438 21p, 7440 19p, 7441 55p, 7442 32p, 7443 89p, 7444 89p, 7445 49p, 7446 59p, 7447 39p, 7448 49p, 7450 15p, 7451 15p, 7453 15p, 7454 14p, 7460 15p, 7470 34p, 7472 25p, 7473 55p, 7474 55p, 7475 55p, 7476 55p, 7480 39p, 7481 1.19, 7482 63p, 7483 38p, 7484 69p, 7485 60p, 7486 19p, 7489 1.68, 7490 20p, 7491 35p, 7492 25p, 7493 25p, 7494 36p, 7495 36p, 7496 35p, 7497 89p, 74100 80p, 74104 56p, 74105 55p, 74107 19p, 74109 25p, 74110 35p, 74116 50p, 74118 55p, 74119 59p, 74120 59p, 74121 25p, 74122 35p, 74123 35p, 74125 30p, 74126 29p, 74128 35p, 74132 29p, 74136 27p, 74141 55p, 74142 1.75, 74143 1.95, 74144 1.95, 74145 38p, 74147 89p, 74148 55p, 74150 49p, 74151 35p, 74153 35p, 74154 49p, 74155 40p, 74156 39p, 74157 29p, 74159 75p, 74160 59p, 74161 48p, 74162 39p, 74163 39p, 74164 39p, 74165 39p, 74166 48p, 74170 1.25, 74172 2.50, 74173 59p, 74174 54p, 74175 49p, 74176 39p, 74177 45p, 74178 79p, 74180 40p, 74181 1.15, 74182 80p, 74184 89p, 74185 89p, 74186 4.69, 74188 2.50, 74190 48p, 74191 48p, 74192 45p, 74193 45p, 74194 40p, 74195 40p, 74196 45p, 74197 39p, 74198 79p, 74199 83p, 74221 53p

74LS TTL

74LS00 15p, 74LS01 15p, 74LS02 15p, 74LS03 15p, 74LS04 15p, 74LS05 15p, 74LS08 15p, 74LS10 15p, 74LS11 15p, 74LS12 15p, 74LS13 15p, 74LS14 24p, 74LS15 15p, 74LS20 15p, 74LS21 15p, 74LS22 15p, 74LS27 15p, 74LS28 15p, 74LS30 15p, 74LS32 15p, 74LS33 15p, 74LS37 15p, 74LS38 15p, 74LS40 15p, 74LS42 28p, 74LS47 35p, 74LS51 14p, 74LS54 14p, 74LS55 14p, 74LS73 18p, 74LS74 18p, 74LS75 19p, 74LS76 18p, 74LS78 19p, 74LS83 36p, 74LS85 41p, 74LS86 16p, 74LS90 24p, 74LS92 29p, 74LS93 24p, 74LS95 39p, 74LS96 93p, 74LS107 35p, 74LS109 23p, 74LS112 22p, 74LS113 19p, 74LS114 22p, 74LS122 32p, 74LS123 36p, 74LS124 89p, 74LS125 24p, 74LS126 25p, 74LS132 30p, 74LS136 24p, 74LS138 28p, 74LS139 28p, 74LS145 99p, 74LS147 99p, 74LS148 99p, 74LS151 37p, 74LS153 39p, 74LS154 79p, 74LS155 29p, 74LS156 36p, 74LS157 24p, 74LS158 29p, 74LS160 50p, 74LS161 35p, 74LS162 35p, 74LS163 35p, 74LS164 40p, 74LS165 49p, 74LS168 84p, 74LS169 85p, 74LS170 69p, 74LS173 49p, 74LS174 34p, 74LS175 34p, 74LS181 88p, 74LS183 1.05, 74LS190 36p, 74LS191 36p, 74LS192 36p, 74LS193 37p, 74LS194 32p, 74LS195 32p, 74LS196 45p, 74LS197 48p, 74LS221 59p, 74LS240 95p, 74LS241 95p, 74LS242 95p, 74LS243 95p, 74LS244 95p, 74LS245 95p, 74LS247 95p, 74LS248 96p, 74LS249 96p, 74LS251 29p, 74LS253 32p, 74LS257 29p, 74LS258 35p, 74LS259 55p, 74LS261 99p, 74LS266 18p, 74LS273 54p, 74LS275 1.25, 74LS279 29p, 74LS280 89p, 74LS283 39p, 74LS289 4.70, 74LS290 39p, 74LS293 39p, 74LS295 74p, 74LS298 79p, 74LS299 1.49, 74LS323 1.59, 74LS324 1.45, 74LS325 2.96, 74LS326 2.39, 74LS327 2.39, 74LS347 95p, 74LS348 88p, 74LS352 61p, 74LS353 61p, 74LS362 7.25, 74LS365 29p, 74LS366 29p, 74LS367 29p, 74LS368 29p, 74LS373 55p, 74LS378 68p, 74LS386 1.14, 74LS390 46p, 74LS393 42p, 74LS395 89p, 74LS396 1.90, 74LS398 2.70, 74LS399 1.59, 74LS445 99p, 74LS490 2.20, 74LS540 89p, 74LS541 1.20, 74LS640 99p, 74LS641 99p

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1 Amp TO220 7905T 44p, 7912T 44p, 7915T 44p, 7924T 44p

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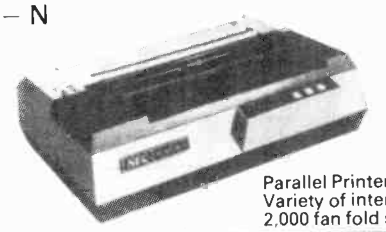

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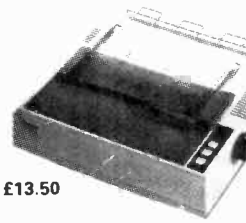

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20	145p	125p	195p
26	175p	150p	240p
34	200p	160p	320p
40	220p	190p	340p
50	235p	200p	390p

D CONNECTORS

No. of ways	9	15	25	37
MALE				
Solder	80p	105p	160p	250p
Angled	150p	210p	250p	365p
FEMALE				
Solder	105p	160p	200p	335p
Angled	165p	215p	290p	440p
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21-way	160p	165p
31-way	170p	170p
DIN 4161Z		
2×32-way St. Pin	220p	275p
2×32-way Ang. Pin	275p	320p
3×32-way St. Pin	260p	300p
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40-way	180p
50-way	200p
64-way	280p

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	0.1"	0.156"
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2×22-way	190p	240p
2×23-way	175p	–
2×25-way	225p	220p
2×28-way	190p	–
1×43-way	260p	–
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1×77-way	600p	
5100 Conn		600p

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7439 36p
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74123 90p
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74126 50p
74128 70p
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74136 45p
74141 70p
74142 175p
74143 200p
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74147 120p
74148 120p
74150 150p
74151A 60p
74153 60p
74154 120p
74155 55p
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74163 55p
74164 60p
74165 75p
74166 90p
74167 200p
74170 150p
74172 250p
74173 65p
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74181 140p
74182 50p
74184 120p
74185A 120p
74190 60p
74191 60p
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74198 120p
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74LS48 60p
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74LS54 20p
74LS55 20p
74LS73A 20p
74LS74A 30p
74LS75 36p
74LS76A 27p
74LS83A 46p
74LS85 60p
74LS86 30p
74LS90 32p
74LS91 60p
74LS92 40p
74LS93 32p
74LS95B 50p
74LS96 90p
74LS107 33p
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74LS113 30p
74LS114 32p
74LS122 60p
74LS123 60p
74LS124/629 150p
74LS125 45p
74LS126 45p
74LS132 42p
74LS133 30p
74LS136 30p
74LS138 42p
74LS139 42p
74LS145 90p
74LS147 120p
74LS148 120p
74LS151 50p
74LS153 50p
74LS154 150p
74LS155 40p
74LS156 40p
74LS157 40p
74LS158 35p
74LS160A 60p
74LS161A 60p
74LS162A 75p
74LS163A 90p
74LS164 60p
74LS165A 75p
74LS166A 120p
74LS168 140p
74LS169 110p
74LS170 100p
74LS173A 120p
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74LS241 120p
74LS242 75p
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74LS244 140p
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74LS253 45p
74LS256 200p
74LS257A 45p
74LS258A 45p
74LS259 120p
74LS260 35p
74LS261 80p
74LS266 25p
74LS273 140p
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74LS366A 36p
74LS367A 36p
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74LS466 120p
74LS467 120p
74LS490 130p
74LS540 120p
74LS541 150p
74LS608 700p
74LS610 £19
74LS612 £19
74LS624 150p
74LS626 150p
74LS628 150p
74LS629 150p
74LS640 200p
74LS640-1 250p
74LS641 200p
74LS642-1 250p
74LS643 200p
74LS643-1 250p
74LS644 200p
74LS645 200p
74LS645-1 250p
74LS668 70p
74LS669 70p
74LS670 120p
74LS674 550p
74LS682 250p
74LS684 400p
74LS687 450p

74S SERIES
74S00 30p
74S02 30p
74S04 30p
74S05 60p
74S08 60p
74S10 40p
74S11 50p
74S20 40p
74S21 50p
74S22 50p
74S30 40p
74S32 70p
74S37 60p
74S51 75p
74S74 75p
74S85 300p
74S86 90p
74S112 90p
74S113 90p
74S114 90p
74S124 300p
74S132 110p
74S133 60p
74S138 110p
74S139 120p
74S140 60p
74S151 180p
74S153 180p
74S157 250p
74S158 195p
74S163 300p
74S174 250p
74S175 320p
74S188 150p
74S194 300p
74S195 300p
74S196 300p
74S200 450p
74S201 320p
74S225 650p
74S240 250p
74S241 300p
74S244 300p
74S251 250p
74S257 250p
74S258 250p
74S260 70p
74S261 300p
74S262 850p
74S283 300p
74S287 225p
74S288 150p
74S299 550p
74S373 400p
74S374 400p
74S387 250p
74S472 1150p
74S474 400p
74S475 825p
74S571 620p
74S573 900p

4000 CMOS
4000 10p
4001 10p
4002 12p
4006 50p
4007 14p
4008 38p
4036 275p
4037 110p
4038 110p
4039 290p
4040 40p
4041 40p
4042 40p
4043 40p
4044 40p
4045 105p
4046 50p
4047 45p
4048 50p
4049 24p
4050 24p
4051 45p
4052 60p
4053 50p
4054 90p
4055 90p
4046 90p
4059 450p
4060 55p
4063 90p
4066 27p
4067 225p
4068 14p
4069 14p
4070 14p
4071 14p
4072 14p
4073 14p
4075 14p
4076 48p
4077 16p
4078 16p
4081 14p
4082 15p
4086 55p
4089 125p
4093 24p
4094 90p
4095 75p
4096 70p
4097 290p
4098 90p
4099 100p
4500 575p
4502 60p
4503 45p
4504 75p
4505 400p
4506 35p
4507 35p
4508 130p
4510 45p
4511 45p
4512 48p
4514 120p
4515 110p
4516 55p
4518 40p
4520 50p
4521 90p
4522 120p
4526 60p
4527 60p
4528 50p
4532 70p
4534 400p
4536 270p
4538 90p
4539 70p
4543 75p
4553 245p
4555 35p
4556 35p
4557 300p
4560 120p
4566 160p
4568 250p
4569 170p
4572 30p
4583 60p
4584 40p
4585 75p
40014 40p
40085 90p
40097 45p
40102 140p
40103 170p
40105 110p
40106 40p
40109 100p
40110 275p
40163 60p
40174 50p
40175 75p
40193 75p
40244 160p
40245 180p
40257 160p
40373 160p
40374 160p
14411 700p
14412 800p
14416 380p
14419 280p
14490 350p
14495 300p
14500 700p
14599 290p

COUNTERS
74C925 £4
74C926 £5
74C928 £6
72168 £22
ZN1040 670p

DIL SWITCHES
4-way 90p
8-way 120p
6-way 105p
10-way 150p

LINEAR ICs
AD7581 £15
ADC0808 990p
AN103 200p
AY1-5050 99p
AY3-1270 750p
AY3-1350 350p
AY3-8910 350p
AY3-8912 500p
AY5-3600 600p
AY5-4007D 600p
CA3019A 80p
CA3028A 120p
CA3046 70p
CA3048 220p
CA3059 350p
CA3060 350p
CA3080E 70p
CA3086 60p
CA3089E 200p
CA3090AQ 375p
CA3130E 90p
CA3130T 110p
CA3140E 45p
CA3140T 90p
CA3160E 100p
CA3161E 150p
CA3162E 450p
CA3189E 300p
CA3240E 110p
CA3280G 200p
D7002 390p
DAC0800 £2
DAC0808 £2
DG308 300p
HA1366 190p
HA1388 250p
ICL7106 700p
ICL7611 95p
ICL7650 400p
ICL7660 250p
ICL8038 300p
ICM7217 750p
ICM7555 100p
ICM7556 140p
LC7120 300p
LC7130 325p
LC7137 350p
LF347 150p
LF351 48p
LF353 95p
LF355 95p
LF356P 95p
LF357 110p
LF13331 350p
LM10C 325p
LM301A 25p
LM307 45p
LM308CN 75p
LM310 120p
LM311 70p
LM318 150p
LM319 160p
LM319N 160p
LM324 30p
LM334Z 90p
LM335Z 140p
LM339 40p
LM348 65p
LM358P 60p
LM377 225p
LM380 75p
LM381AN 180p
LM382 120p
LM386 90p
LM387 120p
LM389 95p
LM391 150p
LM392N 60p
LM393 100p
LM394CH 300p
LM709 36p
LM710 50p
LM711 70p
LM725C 300p
LM733 60p
LM741 18p
LM747 70p
LM748 35p
LM1011 480p
LM1014 150p
LM1801 300p
LM1830 250p
LM1871 300p
LM1872 300p
LM1886 500p
LM1889 350p
LM2917 200p
LM3302 75p
LM3900 50p
LM3909 85p
LM3911 125p
LM3914 250p
LM3915 250p
LM3916 250p
LM13600 110p
M51513L 230p
M51516L 500p
MB3712 200p
MB3730 400p
MC1310P 150p
MC1413 75p
MC1458 36p
MC1493 100p
MC1495L 350p
MC1496 70p
MC3340P 160p
MC3401 50p
MC3403 65p
MF10CN 360p
MK50240 900p
MK50398 790p
ML920 800p
MM57160 620p
MN6221A 600p
NE531 140p
NE544 190p
NE555 16p
NE556 45p
NE564 420p
NE565 120p
NE566 155p
NE567 140p
NE570 410p
NE571 400p
NE592 60p
NE5532 160p
NE5533 140p
NE5534P 110p
NE5534AP 120p
PLL02A 500p
RC4136 60p
S566B 225p
SAA1900 £16
SAD1024A 1150p
SFF96364 800p
SN76488 500p
SN76489 400p
SN76495 400p
SP0256AL2 £10
TA7120 150p
TA7130 160p
TA7204 150p
TA7205 90p
TA7222 150p
TA7310 150p
TBA231 120p
TBA800 80p
TBA810 100p
TBA820 80p
TBA950 225p
TC9109 750p
TCA210 350p
TCA220 350p
TCA270 350p
TCA940 175p
TCA965 120p
TDA1004A £4
TDA1008 320p
TDA1010 250p
TDA1022 500p
TDA1024 120p
TDA1170 300p
TDA2002 325p
TDA2003 325p
TDA2004 400p
TDA2006 350p
TDA2020 320p
TDA7000 350p
TL061CP 40p
TL062 65p
TL064 100p
TL071 25p
TL072 45p
TL074 100p
TL081 25p
TL082 45p
TL083 75p
TL084 90p
TL094 200p
TL170 50p
TL430C 70p
UA1003-3 935p
UA2240 120p
UAA170 170p
ULN2003A 75p
ULN2004 75p
ULN2068 290p
ULN2802 200p
ULN2803 200p
ULN2804 200p
UPC575 275p
UPC592H 200p
UPC1156H 275p
UPC1185H 500p
XR210 400p
XR2206 400p
XR2211 575p
XR2240 120p
ZN414 100p
ZN419C 190p
ZN423E 130p
ZN424E 130p
ZN425E 350p
ZN426E 300p
ZN427E 600p
ZN428E 450p
ZN429E 210p
ZN450E 750p
ZN459CP 250p
ZN1034E 200p
ZN1040E 670p
ZNA134J £23
ZNA234E 950p

VOLTAGE REGULATORS
FIXED PLASTIC

1A	+ve		-ve	
5V	7805	40p	7905	45p
6V	7806	40p	7906	45p
8V	7808	50p	7908	50p
12V	7812	40p	7912	45p
15V	7815	40p	7915	45p
18V	7818	50p	7918	50p
24V	7824	40p	7924	45p
5V 100mA	78L05	30p	79L05	45p
6V 100mA	78L06	30p		
8V 100mA	78L08	30p		
12V 100mA	78L12	30p	79L12	50p
15V 100mA	78L15	30p	79L15	50p

OTHER REGULATORS
LM309K 1A 5V 140p
78P05 900p
LM317K T03 250p
78H12 650p
LM317T 100p
78HGKC 600p
LM337T 225p
78HO5KC 550p
LM323K 3A 5V 450p
78GUIC 200p
LM350T 350p
79GUIC 225p
LM723N 30p
79HGKC 700p
TL494 300p
ICL 7660 250p
TL497 300p
LM305AH 250p
78S40 225p
SG3524 300p

OPTO ELECTRONICS
2N5777 40p
OCP71 180p
ORP12 120p
ORP60 120p
ORP61 120p
TIL32 55p
TIL78 55p
TIL31A 120p
TIL81 90p
TIL100 75p

OPTO ISOLATORS
ILD74 130p
MCT26 100p
MCS2400 190p
MOC3020 150p
ILQ74 180p
TIL111 70p
TIL112 70p
TIL113 70p
TIL116 70p

LEDS
0.125"
TIL209 Red 10p
TIL211 Gr 12p
TIL212 Yel 15p
0.2"
TIL220 Red 10p
TIL222 Gr 12p
TIL228 Yel 15p
Rectangular LEDs (R,G,Y) 30p
FND357 120p
FND500 140p
FND507 140p
MAN4640 200p
MAN8910 250p
NSB5881 570p
TIL311 600p
TIL312/3 110p
TIL321/3 130p
TIL330 140p
7750/60 200p
Bargraph 225p

DISPLAYS
DL704 140p
DL707 Red 140p

DRIVERS
9368 250p
9370 300p

TRANSISTORS
AD161/2 45p
BC107/8 13p
BC109C 14p
BC169C 12p
BC172 12p
BC177/8 17p
BC179 18p
BC182/3 10p
BC184 11p
BC187 30p
BC212/3 11p
BC214 12p
BC237 15p
BC327 16p
BC337 16p
BC338 16p
BC461 25p
BC477/8 30p
BC516/7 40p
BC547B 14p
BC548C 12p
BC549C 16p
BC557B 14p
BC559C 16p
BCY70 18p
BCY71 22p
BD131 75p
BD132 80p
BD135/6 40p
BD139 40p
BD140 40p
BD189 60p
BD232 60p
BD233 75p
BD235 85p
BD241 60p
BD242 60p
BD379 60p
BD380 60p
BD677 40p
BF244B 35p
BF256B 50p
BF257/8 32p
BF337 30p
BFR39 25p
BFR40/1 25p
BFR79 25p
BFR80/1 25p
BFR96 180p
BFX29 40p
BFX30 27p
BFX84/5 40p
BFX86/7 27p
BFX88 27p
BFX89 180p
BFY50 24p
BFY51/2 24p
BFY56 33p
BFY90 80p
BRY39 45p
BSX19/20 24p
BU104 225p
BU105 190p
BU108 250p
BU109 225p
BU126 150p
BU180A 120p
BU205 200p
BU208 200p
BU406 145p
BUX80 600p
BUY69C 350p
E310 50p
MJ802 400p
MJ2501 225p
MJ2955 90p
MJ3001 225p
MJ4502 400p
MJE340 60p
MJE2955 100p
MJE3055 70p
MPF102 40p
MPF103/4 30p
MPF105 30p
MPSA06 30p
MPSA12 50p
MPSA13 50p
MPSA20 50p
MPSA42 50p
MPSA43 50p
MPSA56 32p
MPSA70 50p
MPSA93 40p
MPSU06 63p
MPSU07 63p
MPSU45 78p
MPSU65 78p
TIP29A 35p
TIP29C 40p
TIP30A 35p
TIP30C 40p
TIP31A 45p
TIP31C 45p
TIP32A 45p
TIP32C 40p
TIP33A 70p
TIP33C 80p
TIP34A 90p
TIP34C 120p
TIP35A 120p
TIP35C 140p
TIP36A 140p
TIP36C 150p
TIP41A 50p
TIP41C 55p
TIP42A 60p
TIP42C 65p
TIP54 160p
TIP120 75p
TIP121 75p
TIP122 80p
TIP142 120p
TIP147 120p
TIP2955 78p
TIP4055 70p
TIS93 30p
VN10KM 50p
VN66AF 90p
VN88AF £1
ZTX108 12p
ZTX300 13p
ZTX452 45p
ZTX500 15p
ZTX502 16p
ZTX504 18p
ZTX552 55p
ZTX652 60p
ZTX752 70p
2N697 25p
2N698 45p
2N706A 30p
2N708 30p
2N918 45p
2N930 18p
2N1131/2 36p
2N1613 25p
2N1711 25p
2N2102 70p
2N2160 350p
2N2219A 25p
2N2222A 25p
2N2369A 17p
2N2484 25p
2N2646 40p
2N2904/5 25p
2N2906A 25p
2N2907A 25p
2N2926 9p
2N3053 25p
2N3054 55p
2N3055 35p
2N3442 140p
2N3553 240p
2N3584 250p
2N3643/4 48p
2N3702/3 10p
2N3704/5 10p
2N3706/7 10p
2N3708 10p
2N3773 200p
2N3819 20p
2N3823 30p
2N3866 90p
2N3902 700p
2N3904 15p
2N3906 16p
2N4037 65p
2N4056 65p
2N4123/4 27p
2N4125/6 27p
2N4401/3 25p
2N4427 90p
2N4871 60p
2N5087 27p
2N5089 27p
2N5172 27p
2N5191 90p
2N5245 40p
2N5401 60p
2N5459 30p
2N5460 60p
2N5485 36p
2N5875 250p
2N6027 30p
2N6052 300p
2N6059 325p
2N6107 65p
2N6247 190p
2N6254 130p
2N6290 65p
2SC1306 100p
2SC1307 150p
2SC1957 90p
2SC1969 150p
2SC2028 80p
2SC2029 200p
2SC2078 160p
2SC2335 200p
2SC2612 200p
3N128 120p
3N140 120p
3N141 110p
3N201 110p
3N204 200p
40290 250p
40361/2 75p
40408 90p
40409 100p
40410 100p
40594 120p
40595 120p
40673 75p
40871/2 100p

COMPUTER COMPONENTS

CPUs
1802CE 650p
2650A £12
6502 350p
6502A 500p
6800 225p
6802 250p
6809 650p
68705P35 £25
68B09E £16
8035 350p
8039 300p
8080A 250p
8085A 350p
8086 £22
8088 £18
8748 £18
INS8060 £11
TMS1601 £12
TMS9980 £20
TMS9995 £12
Z8 £24
Z80A 300p
Z80AS10/0/1 £9
Z80AS10/2/9 £9
Z80B £9

SUPPORT DEVICES
2651 £12
3242 800p
3245 450p
6520 280p
6522 310p
6522A 550p
6532 550p
6551 650p
6821 100p
68B21 220p
6829 £12.50
6840 375p
68B40 600p
6850 110p
68B50 220p
6852 250p
6854 700p
68B54 800p
6875 570p
8154 950p
8155 350p
8156 350p
8205 225p
8212 110p
8216 100p
8224 110p
8226 250p
8228 270p
8243 280p
8250 850p
8251 250p
8253 390p
8255 250p
8256 £36
8257 400p
8259 400p
8271 £36
8279 440p
8284 350p
8288 £11
8755 £16
9901 £10
9902 £3
TMS4500 £14
TMS5220 £12
TMS9909 £9
TMS9911 £16
Z80P10 250p
Z80AP10 280p
Z80CTC 250p
Z80ACTC 280p
Z80ADART 700p
Z80ADMA 900p
Z80SI 0/1/2 £9

MEMORIES
2102-3L 120p
2111A 300p
2112A 300p
2114-2L 100p
2147 450p
2764-25 500p
27128-30 £16
27128-25 £20
4027-3 300p
4116-15 120p
4116-20 90p
4118-3 450p
4164-2 400p
4164-15 450p
4416-15 500p
4532-20 250p
4816AP-3 300p
5101 300p
5516 750p
6116-3 420p
6116LP-3 550p
6514-45 200p
6810 120p
74S189 150p
74S201 350p
74S289 150p
93415 600p
93425 600p
93L422 950p

ROMs/PROMs
74S188 140p
74S287 200p
74S288 140p
74S387 225p
74S473 850p
74S474 650p

EPROMs
2532 350p
2532-30 700p
2564 600p
2708 300p
2716 250p
2732 350p
2732A-35 450p
2764-25 450p
27128-25 £22

CRT CONTROLLER
CRT6545 900p
CRT5027 £18
CRT5037 £18
EF9365 £36
EF9366 £36
MC6845 650p
MC6845SP £12
MC6847 650p
SFF96364 £8
TMS9918 £60
TMS9927 £14
TMS9928 £20
TMS9929 £16

INTERFACE ICs
AD558CJ 775p
AD561J £20
AM25S10 350p
AM25LS2521 200p
AM26LS31 125p
AM26LS32 125p
D7002 390p
DAC80 £28
DM8131 275p
DP8304 250p
DS3691 300p
DS8830 150p
DS8831 140p
DS8832 250p
DS8833 225p
DS8836 150p
DS8838 225p
DS8880 170p
LF13201 450p
MC1488 55p
MC1489 55p
MC3418 950p
MC3446 250p
MC3459 450p
MC3470 650p
MC3480 850p
MC3486 500p
MC3487 300p
MC4024 325p
MC4044 325p
MC14411 675p
MC14412 750p
75107 90p
75110/12 160p
75114/15 160p
75121/22 140p
75150P 120p
75154 140p
75159 220p
75365 150p
75451/2 72p
75453/4 72p
75491/2 65p
8T26 120p
8T28 120p
8T95/6 90p
8T97/8 90p
81LS95/6 120p
81LS97/8 120p
88LS120 350p
9602 220p
9637AP 160p
ZN425E-8 350p
ZN426E-8 350p
ZN427E 600p
ZN428E-8 450p

DISC CONTROL ICs
8271 £36
8272 £20
FD1771 £20
FD1791 £22
FD1793 £23
FD1795 £28
FD1797 £28
FD2793 £42
FD2797 £42
WD1691 £15
WD2143 550p

CHARACTER GENERATORS
RO3-2513
U.C. 750p
L.C. 700p
DM86S64 £12
MC66760 750p
SN74S262AN £10

KEYBOARD ENCODER
AY5-2376 950p
74C922 500p
74C923N 500p

BAUD RATE GENERATORS
MC14411 700p
COM8116 800p
4702B 750p

UARTs
AY-3-1015P 300p
AY-5-1013P 300p
COM8017 300p
IM6402 360p
TR1602 300p

ZIF SKTS
(TEXTOOL)
24 pin 575p
28 pin 800p
40 pin 975p

MODULATORS
6MHz UHF 375p
8MHz UHF 450p

CRYSTALS
32.768KHz 100p
100KHz 325p
200KHz 325p
Freq in MHz
1.0 325p
1.008 275p
1.8432 300p
2.00 250p
2.45760 210p
2.5 250p
2.662 250p
3.276 150p
3.5795 120p
3.686 300p
4.00 150p
4.194 200p
4.43 125p
4.608 250p
4.915 250p
5.0 175p
5.068 £2
6.0 150p
6.144 175p
7.0 150p
7.168 175p
8.00 175p
8.86 175p
10.00 175p
10.5 250p
10.7 200p
12.00 150p
14.318 175p
14.756 250p
15.00 200p
16.00 200p
17.7 200p
18.00 200p
18.432 150p
19.968 150p
20.00 200p
24.00 200p
26.690 150p
38.6667 175p
48.0 175p
55.5 400p
116 300p
145.80 250p

REAL TIME CLOCK
MC6818P 550p
MK3805 £TBA
MM58174AN 800p
MSM5832RS 350p

TELETEXT DECODER
SAA5020 600p
SAA5030 700p
SAA5041 £16
SAA5050 900p

LOW PROFILE SOCKETS BY TI
8 pin 9p
14 pin 10p
16 pin 11p
18 pin 16p
20 pin 18p
22 pin 22p
24 pin 24p
28 pin 26p
40 pin 30p

WIRE WRAP SOCKETS BY TI
8 pin 30p
14 pin 42p
16 pin 45p
18 pin 50p
20 pin 66p
22 pin 75p
24 pin 75p
28 pin 100p
40 pin 130p

TRIACS PLASTIC
3A 400V 60p
6A 400V 70p
6A 500V 88p
8A 400V 75p
8A 500V 95p
12A 400V 85p
12A 500V 105p
16A 400V 110p
16A 500V 130p
T2800D 130p
TIC 206D 60p
TIC 226D 75p
TIC 246D 110p

DIODES
BY127 12p
BYX36300 20p
OA47 8p
OA90/91 9p
OA95 9p
OA200 9p
OA202 10p
1N914 4p
1N916 7p
1N4148 4p
1N4001/2 5p
1N4003/4 6p
1N4005 6p
1N4006/7 7p
1N5401/2 14p
1N5403/4 14p
1N5404/5 14p
1N5404/7 19p
IS920 9p

THYRISTORS
3A 400V 45p
8A 600V 180p
12A 400V 160p
16A 100V 180p
16A 400V 180p
C106D 45p
MCR101 38p
2N3525 130p
2N4444 180p
2N5060 30p
2N5061 32p
2N5064 35p

BRIDGE RECTIFIERS
1A 50V 19p
1A 100V 20p
1A 400V 25p
1A 600V 30p
2A 50V 30p
2A 100V 35p
2A 400V 45p
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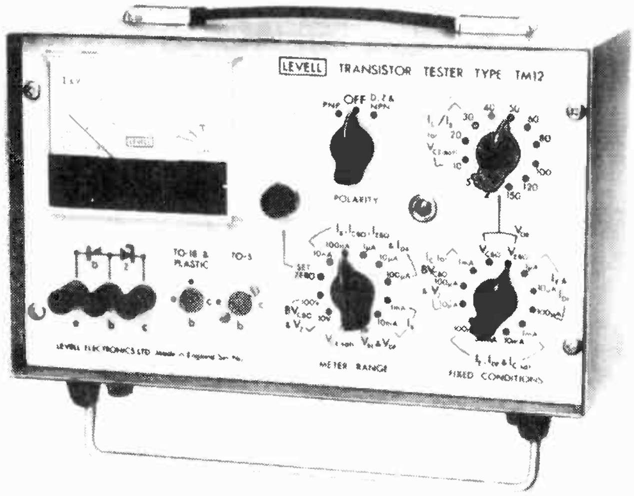
TRANSISTOR TESTER



Tests bipolar transistors, diodes and zener diodes. Measures leakage down to 0.5 nA at 2V to 150V. Current gains are checked from 1μA to 100mA. Breakdown voltages up to 100V are measured at 10μA, 100μA and 1mA. Collector to emitter saturation voltage is measured at 1mA, 10mA, 30mA and 100mA for I_C/I_B ratios of 10, 20, 30. The instrument is powered by a 9V battery.

TRANSISTOR RANGES (PNP OR NPN)

I_{CBO} & I_{EBO}:	10nA, 100nA, 1μA, 10μA and 100μA f.s.d. acc. ±2% f.s.d. ±1% at voltages of 2V, 5V, 10V, 20V, 30V, 40V, 50V, 60V, 80V, 100V, 120V and 150V acc. ±3% ±100mV up to 10μA with fall at 100μA < 5%+250mV.
BV_{CBO}:	10V or 100V f.s.d. acc ±2% f.s.d. ±1% at currents of 10μA, 100μA and 1mA ±20%.
I_B:	10nA, 100nA, 1μA . . . 10mA f.s.d. acc. ±2% f.s.d. ±1% at fixed I_E of 1μA, 10μA, 100μA, 1mA, 10mA, 30mA, and 100mA acc. ±1%.
h_{FE}:	3 inverse scales of 2000 to 100, 400 to 30 and 100 to 10 convert I_B into h_{FE} readings.
V_{BE}:	1V f.s.d. acc. ±20mV measured at conditions on h_{FE} test.
$V_{CE(sat)}$:	1V f.s.d. acc. ±20mV at collector currents of 1mA, 10mA, 30mA and 100mA with I_C/I_B selected at 10, 20 or 30 acc. ±20%.

DIODE & ZENER DIODE RANGES

I_{DR}:	As I_{EBO} transistor ranges.
V_Z:	Breakdown ranges as BV_{CBO} for transistors.
V_{DF}:	1V f.s.d. acc. ±20mV at I_{DF} of 1μA, 10μA, 100μA, 1mA, 10mA, 30mA and 100mA.

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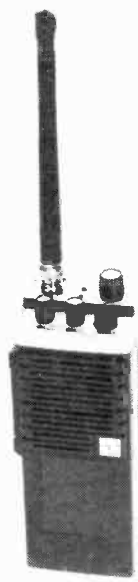

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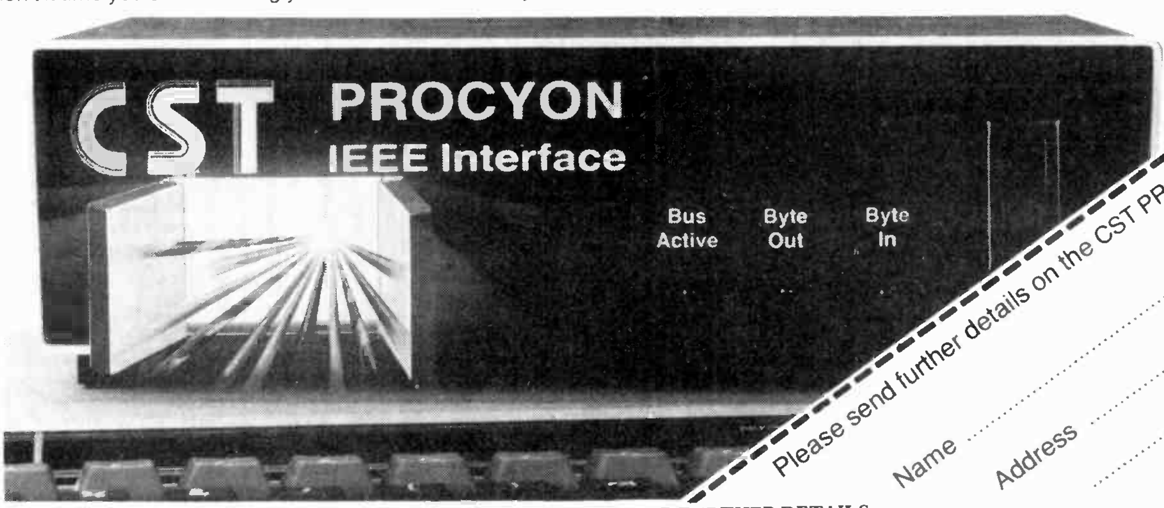

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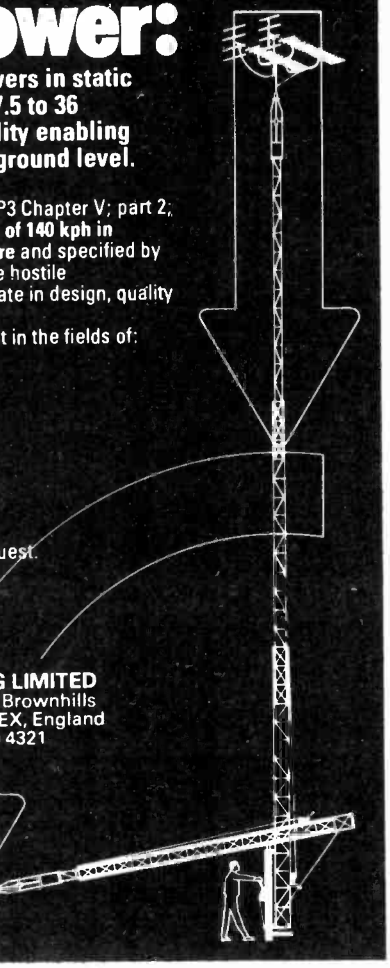

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BC172B	0.10	BD144	1.10	BF336	0.34	OC45	0.55	2SC2314	0.80
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				BF338	0.32	OC71	0.40	3N211	1.95
				BF355	0.37	OC81	0.50		

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AA119	0.08	BY199	0.40	IN4004	0.05
BA102	0.17	BY206	0.14	IN4005	0.05
BA115	0.13	BY208-800	0.33	IN4006	0.06
BA145	0.16	BY210-800	0.33	IN4007	0.06
BA148	0.17	BY223	0.90	IN4148	0.02
BA154	0.06	BY298-400	0.22	IN4448	0.10
BA155	0.13	BY299-800	0.22	IN5401	0.12
BA156	0.15	BYX10	0.20	IN5402	0.14
BA157	0.30	BYX36-150R	0.20	IN5403	0.12
BAX13	0.04	BYX38-600R	0.60	IN5404	0.12
BAX16	0.06	BYX55-600	0.30	IN5405	0.13
BB105B	0.30	BYX71-600	0.60	IN5406	0.13
BT151	0.79	BZY95C30	0.35	IN5407	0.16
BY126	0.10	OA47	0.09	IN5408	0.16
BY127	0.11	OA90	0.05	ITT44	0.04
BY133	0.15	OA91	0.06	ITT923	0.15
BY164	0.45	OA95	0.06	ITT2002	0.10
BY176	1.20	OA202	0.10		
BY179	0.63	IN914	0.04		
BY182	0.55	IN4001	0.04		
BY184	0.35	IN4002	0.04		
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U801	0.75
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UAF42	1.00
UBF80	0.60
UBC41	1.75
UBC81	1.50
UBF89	0.60
UBL21	1.75
UC92	1.20
UCC84	0.70
UCC85	0.60
UCF80	1.00
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UCH41	1.20
UCH42	1.35
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6AB8	0.66
6AC7	2.00
6AF4A	2.50
6AG5	1.50
6AG7	1.95
6AH6	1.50
6AJ4	2.00
6AJ7	2.00
6AK5	1.00
6AK6	2.00
6AL5	0.52
6AM4	3.25
6AM5	6.00
6AM6	1.20
6AN5	3.95
6AN8A	2.15
6AQ5	1.20
6AQ8	0.85
6AR5	2.00
6AR8	2.00
6AS5	1.50
6AS6	1.50
6AS7G	7.50
6AT6	0.75
6AT8	1.75
6AU4	2.00
6AU6	0.85
6AV6	0.72
6AW8A	2.95
6B8G	1.50
6BA6	0.69
6BA6W	1.50
6BA7	4.50
6BA8A	3.50
6BC8	1.00
6BD4	1.50
6BD6	1.00
6BE6	0.72
6BF5	1.50
6BG6G	1.25
6BH6	1.95
6BH8	1.50
6BJ6	1.20
6BK4	4.00
6BK7A	1.95
6BM8	0.58
6BN4	1.65
6BN6	1.65
6BN7	4.50
6BN8	2.75
6BQ5	0.75
6BQ7A	0.72
6BL7GTA	3.95
6BL8	0.65
6BR5	0.70
6BR7	4.15
6BR8	2.15
6BR8A	2.15
6BS7	4.50
6BS8	2.50
6BW4	1.50
6BW6	5.35
6BW7	1.50

6BW8	4.00
6BX6	0.48
6BX7GT	3.50
6BZ6	2.00
6BZ7	2.95
6BZ8	0.95
6C4	1.10
6C5	1.95
6C6	0.50
6C8G	1.50
6C11	2.50
6C15	2.50
6C18	2.50
6CA4	0.60
6CA7	4.50
6CB6	1.50
6CD6GA	4.50
6CF6	1.50
6CH6	10.35
6CL6	3.50
6CL8A	2.00
6CM5	1.60
6CS6	0.75
6CW4	7.25
6CY5	1.00
6DC6	2.95
6DK6	1.15
6DQ5	2.30
6DQ6B	2.50
6EA8	2.50
6EB8	1.75
6EU8	1.75
6EW6	1.50
6F1	2.00
6F6G	2.00
6F12	1.50
6F13	3.00
6F14	1.00
6F17	2.75
6F18	1.50
6F19	0.80
6F21	2.50
6F22	0.70
6F23	0.60
6F24	1.25
6F25	1.25
6F28	1.25
6F33	17.00
6FG5	1.95
6GH8A	0.80
6GK5	1.50
6GK6	2.00
6GV7	2.50
6GW6	2.50
6H3N	1.10
6H6	1.35
6H6GT	1.20
6J4	1.50
6J4WA	3.15
6J5	1.95
6J5GT	1.50
6J6	0.65
6JB6A	3.95
6JE6C	3.95
6JS6C	3.50
6K7G	0.70
6K8Y	3.95
6KD6	5.50
6L1	2.50
6L19	3.95
6L6GC	2.75
6L6GT	1.15
6L7G	0.75
6LD20	0.60
6LF6	4.50
6LQ6	4.50
6N7	2.50
6N7GT	1.50
6P15	1.50
6P25	4.00
6P28	2.00
6Q7	1.20
6Q7GT	1.20
6S4A	1.50
6S7	1.10
6SA7GT	1.00
6SC7	1.50
6SG7	1.20
6SH7	1.20
6SJ7GT	1.20
6SK7	0.80
6SK7GT	1.20
6SL7GT	0.85
6SN7GT	0.69
6SQ7	0.80
6SS7	1.95
6U4GT	1.75
6U5G	1.50
6U8	0.85
6U8A	1.50
6V6GT	0.80
6X2N	1.00
6X4	0.96
6X5GT	0.50
6X5GTY	1.00
6X8A	2.25
7A7	2.00
7AD7	1.75
7B7	2.50
7C5	3.00
7C6	2.50
7H7	2.00
7Q7	2.00
7S7	3.00
7Y4	1.95
8B8	2.50

8FQ7	1.95
10C1	5.50
10C2	0.70
10D2	1.25
10F1	0.75
10GK6	1.95
10P14	2.50
10P18	0.78
10LD11	1.00
10LD12	0.65
11E2	16.50
11E3	55.00
12AE6	0.85
12AG8	1.50
12AL5	1.00
12AT6	0.59
12AT7	0.95
12AT7WA	2.50
12AU6	1.50
12AU7	0.55
12AV6	0.80
12AX4GT	1.00
12AX7	0.65
12AX7WA	2.50
12AYZ	4.00
12AZ7A	1.95
12B4A	3.50
12BA6	1.50
12BE6	1.05
12BH7A	1.80
12BL6	0.70
12BY7A	2.75
12CX6	1.20
12E1	17.95
12E14	28.00
12GN7	3.95
12HG7A	3.95
12J7GT	0.70
12K5	1.00
12K7GT	0.60
12K8	1.10
12Q7GT	0.50
12SA7GT	1.00
12SH7	1.00
12SK7	1.00
12SJ7	0.60
12SN7GT	1.85
13D3	3.20
13D7	3.20
13DR7	2.95
13E1	115.00
14S7	1.00
17DW4A	1.75
17EW8	0.95
17JZ8	2.75
18D3	1.60
19AQ5	1.15
19G3	17.00
19H4	23.95
19Q6	9.00
20A2	10.50
20D1	0.70
20D4	1.75
20LF6	3.50
20L1	0.95
20P1	0.55
20P3	0.60
20P4	1.05
20P5	1.15
21LU8	2.50
25L6GT	1.75
25BQ6	1.75
29C1	19.50
30	2.85
30C1	0.70
30C15	0.40
30C17	0.40
30C18	1.48
30F5	0.95
30FL1	1.00
30FL2	1.00
30FL12	0.95
30FL13	1.10
30FL14	1.25
30L1	0.45
30L15	0.60
30L17	0.60
30P4MR	1.00
30P12	1.00
30P18	0.60
30P19	1.00
30PL1	2.50
30PL13	0.60
30PL14	1.75
31J56A	4.15
35A5	4.50
35L6GT	2.00
35W4	0.70
35Z3	1.85
38HE7	4.50
40KD6	5.50
47	6.00
50B5	1.50
50C5	0.95
50CD6G	1.15
50JY6	2.95
52KU	2.00
61SPT	4.50
75B1	2.50
75C1	2.95
83A1	7.00
84	3.00
85A1	6.50
85A2	2.00
90AV	10.00
90C1	2.70

90CG	13.50
91AG	9.00
92AG	12.50
92AV	12.50
95A1	6.50
108C1	1.50
150B2	3.95
150C2	1.50
150C4	2.15
155UG	25.00
185BT	1.50
205F	12.00
257A	6.00
307	5.00
329	5.00
388A	17.50
425A5	8.00
431U	2.00
572B	35.00
705A	8.00
708A	8.00
715A	6.00
715C	45.00
725A	275.00
803	14.95
805	39.00
807	1.50
810	55.00
811A	12.95
813	18.50
813 USA	59.50
833A	115.00
866A	3.50
872A	19.00
873	60.00
884	5.50
954	0.50
955	0.90
958A	0.90
1299A	0.60
1625	3.00
2050W	9.50
2050	7.00
3545	4.00
4313C	4.00
5642	8.50
5651	3.20
5654	1.95
5663	1.95
5670	3.50
5672	4.50
5675	23.50
5687	4.50
5692	3.50
5696	3.50
5704	3.50
5718	6.50
5725	2.50
5726	2.50
5727	2.50
5749	2.50
5750	2.00
5751	3.50
5763	4.95
5814A	3.25
5840	3.50
5842	6.50
5879	3.90
5881A	4.60
5894	39.50
5899	4.50
5963	2.00
5965	2.25
5993	8.00
6005	1.95
6012	16.00
6021	3.95
6057	2.50
6059	3.75
6060	2.25
6062	4.50
6063	2.00
6064	3.25
6067	1.95
6072	4.20
6080	5.75
6080WA	8.50
6096	2.85
6132	10.00
6136	2.50
6146B	6.45
6201	6.95
6211	2.50
6267	1.50
6350	2.00
6360	5.50
6386	14.50
6545	8.50
6550A	8.00
6870	11.50
6883B	13.95
6973	3.75
7025	2.50
7027A	4.65
7032	2.00
7059	2.50
7189	2.50
7199	3.95
7247	2.00
7360	8.95
7475	5.00
7551	5.75
7558	11.50
7581A	3.00
7586	9.00
7591A	3.95
7609	47.00
7868	3.95
8012	4.20
8136	1.00
8298A	4.95
8417	5.95
9001	0.90
9006	0.90
18042	10.00
18045	10.00

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PREFERRED VALUES

4 Watt	4R7-1K8	0.15
	2K2-6K8	0.18
	10K	0.24
7 Watt	R47-4K7	0.18
	5K6-12K	0.19
	15K-22K	0.20
11 Watt	1R-10K	0.20
	15K-22K	0.24
17 Watt	1R-10K	0.26
	15K-22K	0.28

WW-2

BASES ETC.

B7G	0.15
B7G Skirted	0.30
B8G	0.70
B9A	0.20
B9A Skirted	0.30
B10B	0.16
B13B	0.50
8 Pin DIL	0.14
14 Pin DIL	0.15
14 Pin DIL/Q	0.30
16 Pin DIL	0.17
OCTAL	0.35
CANS	0.27
B9A PCB	0.15
B5	0.75
B9G	0.38

ZENER DIODES

BZX61 0.15

6V2 7V5 8V2 9V1 10V 11V 12V 13V 15V 16V 18V 20V 22V 24V 27V 30V 33V 36V 39V 47V 51V 56V 68V 75V

BZY88 0.07

2V7 3V 3V3 3V6 3V9 4V3 4V7 5V1 5V6 6V2 6V8 7V5 8V2 9V1 10V 11V 12V 13V 15V 18V 20V 24V 27V 30V

THERMISTORS

VA1040	0.23
VA1056S	0.23
VA1104	0.70
VA8650	0.45
VA1097	0.25

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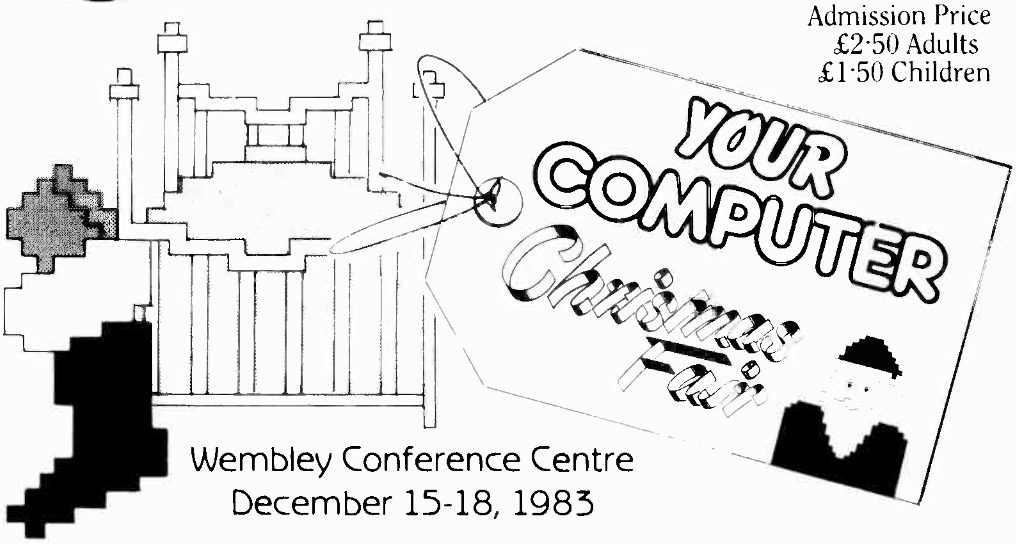

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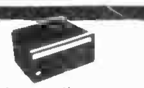

All in one quality computer cabinet with integral switched mode PSU, Mains filtering, and twin fan cooling. Originally made for the famous **DEC PDP8** computer system costing thousands of pounds. Made to run 24 hours per day the PSU is fully screened and will deliver a massive +5v DC at 17 amps, +15v DC at 1 amp and -15v DC at 5 amps. The complete unit is fully enclosed with removable top lid, filtering, trip switch, 'Power' and 'Run' LEDs mounted on Ali front panel, rear cable entries, etc. etc. Units are in good but used condition – supplied for 240v operation complete with full circuit and tech. man. **Give your system that professional finish** for only £49.95 + Carr. Dim. 19" wide 16" deep 10.5" high Useable area 16"w 10.5"h 11.5"d.
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CALCOMP 936 PLOTTER

3 colour 37" digital incremental plotter and accessories. Standard parallel interface. Inspection by appointment. ***£2,500***

VIDEO MONITORS

12" CASED. Made by the British KGM Co. Designed for continuous use as a data display station, unit is totally housed in an attractive brushed aluminium case with ON-OFF, BRIGHTNESS and CONTRAST controls mounted to one side. Much attention was given to construction and reliability of this unit with features such as, internal transformer isolated regulated DC supply, all components mounted on two fibre glass PCB boards – which hinge out for ease of service, many internal controls for linearity etc. The monitor accepts standard 75 ohm composite video signal via SO239 socket on rear panel. Bandwidth of the unit is estimated around 20 Mhz and will display most high def graphics and 132 x 24 lines. Units are secondhand and may have screen burns. However where burns exist they are only apparent when monitor is switched off. Although unguaranteed all monitors are tested prior to despatch. Dimensions approx. 14" high x 14" wide by 11" deep. Supplied complete with circuit. 240 volt AC operation. ***ONLY £45.00 PLUS £9.50 CARR.***

24" CASED Again made by the KGM Co with a similar spec as the 12" monitor. Originally used for large screen data display. Very compact unit in lightweight alloy case dim. 19" H x 17" D x 22" W. All silicon electronics and composite video input make an ideal unit for schools, clubs, shops etc. Supplied in a used but working condition.
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14" COLOUR superb chassis monitor made by a subsidiary of the HITACHI Co. Inputs are TTL RGB with separate sync and will plug direct into the BBC micro etc. Exceptional bandwidth with good 80 col. definition. Brand new and guaranteed. Complete with full data & circuit. 240 v AC working. Dim. 14" x 13" x 13".
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For more information or details of other types of ex stock modems contact sales office.

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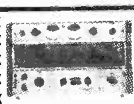

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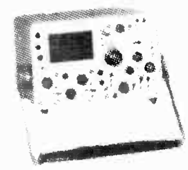

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Careers in electronics

How do you train? What branch of electronics appeals to you? Where will you work and how much can you earn? Ron Slater investigates.

For the boy or girl at school, choosing a career is no easy matter. Natural ability and cultivated interests will clearly play their part, but it is also necessary to try and ensure that the industry or profession which attracts one has a career rather than just a temporary job to offer; and therein lies the rub. An average working life spans some forty years and it would need a highly skilled operator with a turbo-charged crystal ball to forecast the fate of any industry over so long a period. For instance, the last forty years have seen either the total demise or very serious cut-backs in many formerly well established and prosperous British industries – textiles, motor cycles and cars, steel, shipbuilding; the list unfortunately is very long.

So what of electronics? Over the last fifty years or so it has, worldwide, been the fastest growing industry ever known to man. Literally day by day new applications are being found for electronics and there is no reason to suppose that the growth will slacken in the foreseeable future. It can be forecast with a fair degree of certainty that for many years ahead there will be an increasing demand for more sophisticated communication systems and for higher degrees of automation in industry, commerce, transport and, of course, in the home.

The form that electronics will take is very much more problematical and to forecast future developments is well beyond the scope of this article, except so far as one point is concerned. The last 35 years have seen the transition from the thermionic valve through the transistor to integrated circuits. In general, the engineers who have successfully survived through these changes have been those with a thorough grounding in mathematics and physics and that undoubtedly is a sound pointer to the basis of a sound education for the future.

Education and qualifications

The value of a sound technical education and the attainment of recognized technical qualifications cannot be overestimated. It is the initial yardstick by which a person applying for an appointment will be judged and it is the foundation on which experience and a successful career will be built. Although twenty or thirty years ago many persons rose to the top of the engineering profession without formal qualifications it is becoming increasingly difficult to do so. Indeed, at the present time it is almost impossible even to make a start on a career in electronics without having first obtained some recognized technical qualification. The only real exception to this rule is for the comparatively few young persons who are fortunate enough to be accepted as apprentices and where attendance at an academic establishment, either on block or day release, will form part of the terms of engagement.

What are these qualifications and how are they obtained? Before answering this question it is necessary to define the levels of qualification which are generally accepted throughout the industry. Although this can be done in terms of the academic awards made by educational establishments it is, perhaps, easier to look at the somewhat broader division which is made by the Engineers' Registration Board. This is a body set up in 1970 which

by R. C. Slater, F.I.E.R.E.

derives its authority from a Royal Charter granted to the Council of Engineering Institutions (CEI)*. The three registers kept by the Engineers' Registration Board are:

(1) technicians
(2) technician engineers
(3) chartered engineers

To have one's name entered on one of these registers it is normally necessary to obtain specified academic qualifications and also to have had a specified period of approved industrial training and/or experience. Application for entry on one of these registers is generally made through one of the societies or institutions which cater for the needs of electronic technicians and engineers (see later).

The academic requirements for the above grades are briefly as follows.

Technicians

Ordinary National Certificate or Diploma (ONC or OND) in appropriate subjects.

City & Guilds Part II Certificate in course 271 – Telecommunication Technicians, or course 272 – Radio, Television and Electronics Technicians.

TEC (Technician Education Council) Certificates and Diplomas in appropriate subjects, e.g. Electronics and Communications.

Technician engineers

Higher National Certificate or Diploma (HNC or HND) in Electrical and Electronic Engineering.

City & Guilds Full Technological Certificate in course 271 or 272 (see under Technicians).

TEC Higher Certificates in Electronic and Communication Engineering

Chartered engineers

The basic requirement here is a degree awarded by an accredited body and in an appropriate subject, e.g. electronic engineering, electrical and electronic engineering, computing science, physics.

*At the time of writing the functions of CEI are being taken over by the Government sponsored Engineering Council but this will not affect the details given.

The above is an abbreviated list of acceptable qualifications for the various grades of technical staff. There are various other qualifications which are deemed to be equivalent as, for example, various courses of training provided by the armed services and specialist courses such as those for Merchant Navy officers. Advice on such educational matters may be freely obtained from educational establishments and from member bodies of the Engineers' Registration Board. It should also be noted that there are other qualifications which, while not falling into one of the three categories above, are, nevertheless, very worth obtaining. An example of these are City and Guilds Certificates in Electronic Servicing.

At this point it may be worthwhile to say a few words about the societies and institutions which serve the needs of technical personnel and which are members of the Engineers' Registration Board. For technicians and technician engineers, these are the Society of Electronic and Radio Technicians (SERT) and the Institution of Electrical and Electronics Incorporated Engineers (IEEIE). For chartered engineers, they are the Institution of Electrical Engineers (IEE) and the Institution of Electronic and Radio Engineers (IERE). The IERE also has a section for technician engineers: the addresses of all four are given at the end of this article. While it is by no means mandatory for anyone to join a professional body there are considerable advantages in doing so and persons seriously intent on making a career in electronics are strongly advised to obtain details of the various institutions and of the services they provide.

Probably the next question is 'At what level of qualification should one aim?'.

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The easy answer to that is 'As high as possible'; but that is a glib answer which needs some qualification. In the first place it depends to some extent on the type of work which is likely to be most attractive. Second and most important, it depends on one's academic abilities and inclinations. There are many persons who will do very well and be happy doing practical work but who would not do well and would not be happy carrying out more theoretical work. For such persons a good technician or technician engineer qualification may well stand them in better stead than a poor degree. In this respect it is worth noting that the IEE has recently set a minimum standard for corporate membership of a second class honours degree and that is a fair reflection of the standard of graduate that industry requires.

There are a number of ways in which the various qualifications cited above can be obtained. In most cases it will necessitate attendance at a college of further education, a college of technology, a polytechnic or a university. The majority of technician and technician engineer qualifications can be obtained by either full or part-time study. The latter may take the form of day release (one or two days a week at college and the remainder at work), block release (several weeks or months at college alternating with similar periods at work) or by attendance at evening classes. The choice will largely be determined by personal circumstances and by what is currently available. If an apprenticeship can be obtained involving day or block release that is an excellent way to start a career. Unfortunately the rising costs which industry has had to face has resulted in fewer companies providing such schemes; this may well make it necessary to obtain some basic technical education before being accepted into industry.

In the case of degree students, the choice really lies between a full-time course and a sandwich course. A typical sandwich course will involve two or three six-month periods spent in industry with the remainder spent at university or polytechnic. There are advantages and disadvantages to both the full-time and the sandwich course and in the long-term it is probably immaterial which is followed. The full-time course allows a greater continuity of academic work and, generally, a greater length of time in an educational environment. On the other hand a sandwich course can provide a useful and gradual introduction to a working environment together with valuable industrial experience. The emphasis must, however, be on the word 'can'; the sandwich course only enjoys its benefits if the industrial training periods are spent on useful and meaningful work which is pertinent to the course being followed. It is an unfortunate fact that, over the last few years, the number of companies willing to provide industrial training has diminished and many universities and polytechnics are now finding great difficulty in finding suitable industrial placements for their students.

Before leaving the subject of education there is one further point which, although self-evident, needs to be kept in mind and that is that an engineer never finishes learning. Over the last 20 or 30 years the face of electronics has changed dramatically and no doubt it will continue to do so. New technologies evolve and new components and techniques are continually emerging. If an engineer is to make continued progress in this profession it behoves him to keep abreast of technical developments by all means available – by attending courses, colloquia, institution meetings etc. and by reading the technical press.

Types of employment

The electronics industry is very complex and in the confines of this short survey it is not possible to cover all the categories of work in which an electronic engineer or technician may be involved. However, in the following paragraphs a few words will be said about the main classes of employment, the qualifications and personal qualities which are required and, where possible, the avenues for career progression.

Research. Generally speaking, research can be divided into two types of work – pure research, where the primary objective is to increase man's scientific knowledge and applied research where the objective is to solve a known problem. In practice the two will frequently overlap. The main centres for original research are the universities and polytechnics, Government research establishments and the laboratories of the larger manufacturers.

Direct entry into research will usually call for a good honours degree and in some cases a higher degree – M.Sc, M.Phil., Ph.D. etc. To be successful also calls for a number of personal qualities – patience, perseverance, a disciplined approach to work, logical and innovative thought and an ability to communicate. It also calls for the resilience to overcome disappointments, for not all research is successful.

For many persons, research may be a part of their education and thus a comparatively short-term occupation as, for example, when carrying out research for a higher degree. For those entering research on a more permanent basis the considerations are somewhat different. Research can, of course, be very intellectually rewarding and can result in a high degree of job satisfaction: in a large organisation, promotion prospects are also good and a reasonable level of income can usually be attained. However, like most sections of industry it is a pyramidal structure and places at the top are not very plentiful; not many can become a manager or director of research. Thus, if one's aspirations run higher than, say, a principal research engineer, it may be necessary to make a transition into a more practical branch of industry. This should not be left too late, the early thirties perhaps, and it may well be advisable to make earlier preparation for such a move. This could, for instance, take the form of a part-time degree or diploma in management studies.

Design and development. This can be a very exciting and satisfying area in which to work. It is the activity which leads to the birth or evolution of new components and products. Without effective design and development no company can hope to stay in business for very long. The stimulus for design and development may come from various sources; it may, for instance, be the result of market forces where a company needs to produce new or updated products to keep abreast of its competitors or where it can see a market waiting for a new product, or it may arise from the needs of a specific customer. In either case, the objective will usually be clearly defined and it will often need to be carried out against tight performance specifications and with the constraints imposed by environmental conditions, international standards, time and cost scales, etc.

The activities and responsibilities of a design and development engineer can differ enormously. The end product may vary from a single component to a large and complex system. Thus the overall activity may involve the work of just one or two men or the combined activities of a large number of multidisciplinary teams. In either case it is seldom possible to separate the design and development phases. From the initial concept to the production of a prototype ready for manufacture is usually a continuous process and the time-scale for this operation may vary from days or weeks to two or three years.

For direct entry into design and development, the majority of companies will be looking for a good degree, although with the right personal attributes some companies will consider persons with lesser qualifications such as an HND. Possession of a higher degree will, in the longer term, prove advantageous, although it will not necessarily result in a higher starting salary.

In addition to technical knowledge, a good design and development engineer needs certain personal qualities; among these may be cited the ability for original and innovative thinking allied to a logical, disciplined and enthusiastic approach to the job in hand. He will need to keep up-to-date with new components and technologies and in most cases he will need to have a sense of commercial awareness, for whatever he produces will usually have to be sold in a competitive market. In most cases he must have the willingness and ability to work as a member of a team and, most important, he must be able to communicate precisely with his colleagues and with other people – customers, suppliers, etc. – who have an interest in his work.

In most companies of reasonable size a design and development engineer will have the opportunity for a worthwhile career progression. He may, for instance, go from engineer to senior engineer to section leader to project leader. For the most able engineers the progression to development manager or technical director is by no means impossible. A few years spent in design and development can also be a valuable stepping-stone towards a successful career in other branches of the industry such as sales and marketing, production and general management.

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Although it has been stated that the usual qualification for direct entry into research, design and development is a degree, good career opportunities exist in these departments for both technicians and technician engineers. Generally, they will be employed in supporting roles, as assistants to the engineers, on the construction of prototypes, on the maintenance and calibration of test equipment and in the drawing office. Additionally, some companies will provide their technicians with the opportunity to obtain higher academic qualifications by giving them time off work to attend day or block release courses. There are many cases where a young man has entered a company as a junior technician and who by hard work and study has reached the highest level.

Production engineering. It has often been said that the British are very good at inventing things but not very good at producing them. This, unfortunately, tends to be true and one of the many reasons for this is that far too few of the most able people go into production engineering as a career. This is in contrast to other successful industrial nations such as Japan, Germany and the USA where the complexities of actually producing goods efficiently and cost effectively are solved by some of the best brains available to them. Good design goes for nought if the product cannot be produced effectively; at the other end of the process, the best marketing and sales organization cannot sell goods if they are not well produced, available on time and competitively priced. In other words, production engineering and production supervision offer a real challenge, yet the majority of graduates and technicians shy away from it. It may be that many still think of a factory in Dickensian terms but, in reality, a modern electronic production unit is far removed from that gloomy and depressing environment.

For the person who likes solving problems, working with people and seeing the tangible result of his efforts, production has much to offer. Jobs in this category include production planning and co-ordination, procurement of components and equipment, production supervision, production equipment maintenance right through to production management. Opportunities in production exist for all levels of technical staff, from technicians to graduates, and it is certainly an area where hard work and enthusiasm can lead to the top. Initial qualifications for entry into this sphere of activity may be in electronic engineering, mechanical engineering, production engineering and various combinations thereof. Again, further studies will pay dividends and these may for example, be directed towards the examinations of the National Education Board for Supervisory Studies or those of the Institute of Works Managers.

Reliability and quality engineering. In any manufactured goods reliability and quality are important. In many applications of electronics they are absolutely vital; examples which readily come to mind include patient monitoring and life support systems, satellites, aircraft navigational systems, process control equipment and defence systems. Thus, in many sections of the electronic industry engineers concerned with reliability and quality have a most important role to perform and consequently enjoy a high status within the company.

Although the nomenclature applied to the various tasks may vary from company to company there are really three separate jobs here; reliability engineering, quality control and quality assurance.

The reliability engineer will be concerned with the inherent reliability of an equipment and he may well be involved from the early stages of design through to production. His area of interest may be very wide, ranging from choice of circuit techniques and components to methods of construction and packaging (packaging for use, not transport that is!).

The quality control engineer will be more concerned with the manufacturing process and test procedures, ensuring that finished goods meet the specifications and standards laid down for them and with the remedial action to be taken if they do not.

The duty of the quality assurance engineer is to provide the evidence to show how well the quality function is being performed and will include activities such as quality audits, failure analysis, qualification approval by outside bodies, etc.

In some organizations, the above will be separate functions. In other companies, two or more of the functions may be combined. In most cases the persons involved will usually have to co-operate with various departments within the company and frequently with outside companies and official bodies. The minimum academic requirement will usually be at HNC/HTC level but in a number of cases a degree will be needed. It calls for a broad knowledge, or the willingness to acquire such knowledge, of specifications, standards, manufacturing processes, measurement techniques, methods of analysis and assessment. A good knowledge and interest in statistics is generally necessary, as is the ability to deal tactfully but efficiently with people at varied levels.

The quality function is an important one in the electronics industry, as indeed it should be, and it is to some extent becoming a profession in its own right. This is evidenced by the fact that quality assurance engineers have their own professional institution (The Institute of Quality Assurance).

Test. Under this heading we consider the jobs and careers available in the test of completed components and equipment. It is a section of industry which calls for an extremely wide range of technical skill and experience. For many young technicians and for an increasing number of graduates the test department will be their first introduction to industry. It is also an area of activity which will fully use the skills of highly trained and experienced engineers. The reason for this is, quite simply, that the item under test can range from a simple component to a large and highly complex system; clearly the methods employed and the skills required will vary enormously. This disparity is accentuated by the fact that the test technician or engineer will usually be called upon to find and often rectify any faults on the equipment under test.

In addition to testing manufactured products, the staff of the test department may also be called upon to draw up test schedules, devise appropriate methods of testing and to design and construct special test equipment. Further, with the increasing use of automatic test equipment (a.t.e.) they may be required to design interfaces between the item under test and the a.t.e. and to write computer programs to enable the a.t.e. to operate in the required mode.

Sales and marketing. A career in technical sales has a lot to offer. It can provide a high degree of job satisfaction and financially can be very rewarding. But it is no easy job and requires personal attributes that not all possess.

A sales engineer can come from any academic level, the main criteria being that he has a sufficient technical knowledge to acquire an in-depth knowledge of the products he is selling and be able to understand and help to solve the problems of his customers. Clearly, the required level of technical knowledge will vary enormously with the complexity of the product.

The next requirement for a successful sales engineer is a real desire to sell and to succeed. In addition he needs to be able to communicate effectively and with enthusiasm, to be self-motivated and self-disciplined, to be able to stay calm and courteous under pressure, to be at ease with other people – ranging maybe from junior engineers to top management. He also needs to be able to accept failures and setbacks philosophically and then go out and start all over again. In short, he needs sound technical knowledge and a pleasant outgoing personality coupled with mental toughness and resilience. Given these qualities sales engineering can provide excellent career progression right up to board level.

Entry into sales can be made in several different ways. Some companies will take people direct from college or university and provide them with the necessary product and sales training. This will often entail a period spent in a sales office before going on to outside sales. Other companies prefer to select and train their sales engineers from among those who have had several year's experience in other sections of the industry such as development or test.

Marketing is closely related to sales but it encompasses a wider range of activities such as marketing strategy, publicity, market research and often pricing and price agreements. It is an area into which a sales engineer may eventually move.

Installation and commissioning. In many cases, a manufacturer will supply staff to install and commission equipment at a customer's premises or site. Installation is exactly what it says it is; that is, assem-

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bling the equipment in the right place and carrying out the necessary wiring, etc. Commissioning includes testing the equipment, clearing any faults that arise and handing it over to the customer in good working order.

It is a job which will often entail varying periods spent away from home and it many involve a considerable amount of travelling both in the UK and overseas. For the man who likes to do a practical job combined with travelling and meeting other people it can be a satisfying and rewarding way of life.

While the majority of installation and commissioning engineers will be technicians and technician engineers, there are an increasing number of career opportunities for graduates, either in a supervisory capacity or in dealing with the more sophisticated and complex equipments. Although some companies will take men straight from college and provide them with the necessary training, a number of companies prefer to use men who have already gained product knowledge in another department such as test or service.

Service. The job of the service engineer or technician is to diagnose faults in equipment and to repair them; in some cases he may also carry out routine maintenance with the object of preventing faults from occurring.

The 'in-house' or base service engineer will work on his employer's own premises and will have the benefit of workshop facilities and be able to obtain additional technical assistance where needed. Also, more often than not he will work regular hours.

The field service engineer, on the other hand, will be working on a customer's premises. This, depending on circumstances, may involve local, country-wide or overseas travel. He will usually be working on his own, will often need to work irregular hours and may often find himself working with a customer breathing down his neck. In addition to technical expertise it is a job which calls for self-discipline, self-reliance and self-motivation. On the plus side he will, to some extent, be his own boss and may well have a company vehicle at his disposal. It is a job which many young men fancy and for this reason it tends to be oversubscribed.

Service engineering has traditionally been the preserve of technicians and technician engineers, but with the increasing sophistication of modern equipment many companies are now looking towards graduates to fulfil this role. As in most sections of the industry, well-paid management appointments are available for those who prove their worth. Field service engineering also provides experience in customer contact which can make a useful stepping stone to sales engineering.

Other activities. In the space of this short article it has not been possible to mention all the types of work which are available in the electronics industry and only those have been included which employ the greatest number of people. There are many other vitally important tasks but which only employ comparatively small numbers: technical writers who produce technical manuals to go with equipment, a job requiring a high standard of technical knowledge and a high standard of literacy; technical training officers who may be concerned with training a company's own or its customer's personnel; draughtsmen, contract engineers and host of others.

This section could not be left without some mention of the armed Services since they are very large trainers and users of electronic personnel. All three Services provide good training for technicians, and where possible, will allow time off to study for civilian qualifications. They provide sponsored university courses for potential officers and good practical training for graduates. The Services provide an excellent career in themselves and generally speaking persons leaving them are well equipped for a second career in civilian life.

Specialization and sectors of industry

Which branch of this vast industry a person gravitates towards will depend on a number of factors, such as personal inclination, locality, the jobs available at a particular time, etc. Good opportunities exist in most sectors and it is not practicable to make any recommendations on the most likely areas of success; this could only be done on an individual basis.

Equally, there are a number of more or less discrete technologies such as analogue equipment, digital devices and microprocessors, and in the latter case there are both hardware and software. Most technical personnel will have to specialize to some extent but the choice is of particular importance to the young graduate starting out on this career. Digital techniques are being used more and more in almost every application of electronics and the microprocessor is finding an increasing number of uses. These trends will doubtless continue but at the end of the day it is an analogue world in which we live and analogue electronics will always be with us. On looking at the c.vs of new graduates there is an utter monotony in reading 'my final year project was a microprocessor-based so and so'. Very few have undertaken analogue projects and even fewer have concentrated on r.f. The result of this is that industry is now crying out for good r.f. designers and they have acquired a scarcity value. The soundest advice to any young person would be to concentrate on what interests them most and not to concentrate on any given technique because it is fashionable. It is also wise to keep one's technical knowledge as broad as possible; specialize by all means but keep abreast of other techniques by reading and by discussion with other engineers.

Location

There are few areas of the UK where there is not some electronic activity, but the greatest concentration is in the Thames Valley and the South East of England plus sizeable slices of the industry in the North West of England and Central Scotland.

One thing is certain, if satisfactory employment is to be obtained it is necessary to go where the work is and it is highly advisable to ascertain the prospects of employment before deciding that such and such a town would be a nice place in which to live. For those starting employment or for those who wish to find fresh employment this may mean relocating. The difficulties of doing this are not overlooked, especially for a married man with school age children, but it will sometimes be necessary. The majority of companies will assist in this by helping with relocation expenses and in some instances these are on a very generous scale.

Salaries

It may seem strange that in an article on careers no mention of salaries has been made. The reason for this is that it is highly misleading to do so. This also applies to the salary surveys which are periodically published by various bodies. One of the main reasons for this is that jobs which come under the same title can vary so enormously in the level of responsibility held and the skill and experience required.

What can be said is that salaries in the electronics industry have increased very considerably over the last few years and that they compare very favourably with other industries. As an example, in 1975 the average starting salary for a new graduate was around £2,450 p.a., in 1978 it was around £4,850 p.a., while this year it is of the order of £6,800 p.a. To give some idea of the progression which can be expected a good graduate with one or two years' experience could expect to earn between £8,000 p.a. and £9,000 p.a. and to be into five figures after four or five years' experience.

Although in various parts of this article technicians and engineers have been referred to as 'he' or 'men' this has been done for ease of writing only and certainly does not imply that there is no career for women in engineering. There have been and are many good female engineers. Indeed, electronics which is usually clean and physically light work can be an ideal profession for any girl who has a leaning towards mathematics and physics. In practically all companies they can, and do, compete with men on even terms.

Relevant institutions

Institution of Electrical Engineers, Savoy Place, London WC2R OBL.

Institution of Electronic and Radio Engineers, 99 Gower Street, London WC1E 6AZ.

Institution of Electrical and Electronics Incorporated Engineers, 2 Savoy Hill, London WC2R OBS.

Society of Electronic and Radio Technicians, 57-61 Newington Causeway, London SE1 6BL.

Institute of Measurement and Control, 20 Peel Street, London W8.

Institute of Quality Assurance, 54 Princes Gate, London SW7.

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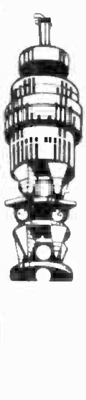

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We have several vacancies within our Test Department where you would find yourself working on a very interesting range of equipment involving thyrister controls, digital logic, microprocessors, etc., in close liaison with the Design Engineers.

Ideally you should have served an apprenticeship in the Electrical/Electronic industry and achieved ONC or HNC or equivalent qualifications. Persons qualified by experience will also be welcome to apply.

Salaries for these positions will reflect experience and personal qualities and a comprehensive relocation package enabling the successful applicant to move into this pleasant, well-serviced rural area where housing costs are low.

Ring Rugeley 5151 for an application form or write including an up to date c.v. to Personnel Manager, Thorn EMI Automation Limited, P.O. Box 4, Rugeley, Staffs.

(2307)

THORN EMI Automation
P.O. Box 4, Rugeley, Staffs. WS15 1DR.
Tel: Rugeley 5151.

THORN EMI

ELECTRONICS TECHNICIAN

The Laboratory of CA Testing and Research at Gosfield in Essex requires an experienced Electronics Technician to construct and maintain analogue test equipment, and to assist in the provision of test facilities to be used over a wide range of activities.

The successful applicant will have:

- experience of analogue circuitry in one or more of the following areas:
  maintenance and repair, design and construction of test equipment, faultfinding, installation and commissioning, test and measurement.
- an appropriate qualification such as City & Guilds 272, 222 or 224.
- a high standard of practical ability.

Salary will be according to experience. If you feel that you match up to our requirements, please write for an application form to:

Consumers' Association Testing and Research

The Personnel Officer
CA Testing & Research
Harpenden Rise
Laboratory
Harpenden Rise
Harpenden, Herts.

www.americanradiohistory.com

Transmitter Engineers

Northern Home Counties

circa £13K

As the acknowledged leader in airborne radar systems our client is widely recognised for its technical excellence. A substantial increase in their workload through the acquisition of new contracts has resulted in the need to make two key appointments.

The work incorporates all aspects of transmitter design and will therefore involve working with high and medium power supplies (peak power being in the MW region) with a particular emphasis on the design of modulators for driving TWT's. One of the positions will also involve a considerable amount of analogue and digital control circuit design for the TWT's.

It is expected that the successful candidates will possess an electrical/electronic engineering degree with at least 5 years relevant post graduate experience.

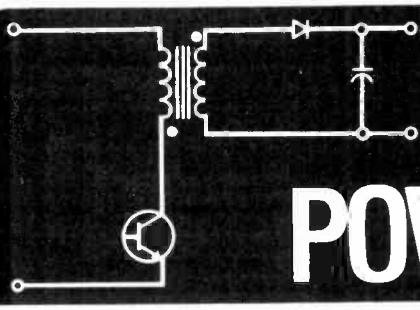
In return the company offers a highly competitive salary and a generous benefits package including relocation assistance in certain cases.

In the first instance please write, listing any company to whom your application should not be sent, to The Manager, Le Tissier Executive Selection, Suite 323, Ely House, 37 Dover Street, London W1X 3RB.

(2304)

Le Tissier

Executive Selection



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Our client, a very successful British company, is able to offer you the chance to lead the development of very advanced, high technology/high reliability power conditioning equipment for a wide range of military products. In particular, this will involve solving the problems of miniaturisation for advanced aero products, such as providing high voltage, switched-mode power supplies for on-board guidance systems.

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MULTI-OUTPUT FLYBACK CONVERTERS
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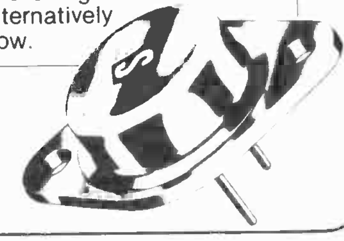
You would have the opportunity to be involved in the managerial as well as the technical aspects of your project, thereby enabling you to develop your managerial skills. Working within this department that has high visibility in a successful, rapidly developing company where vacancies at a senior level frequently arise as a result of expansion, your prospects for further promotion would be first-class.

To be capable of handling these important positions you will need a degree qualification or equivalent and be familiar with power supplies, transformer design, high power switching techniques and have knowledge of modern component technologies.

Our client is located in a pleasant, modern town with excellent amenities surrounded by the delightful Berkshire countryside, putting a wide range of attractive residential locations within your reach. In addition to a **basic salary of up to £13,000 per annum,** there is an attractive benefits package including generous relocation assistance where appropriate and an optional pension scheme.

TO FIND OUT MORE and to obtain an early interview, please telephone BERNARD INNES in complete confidence on HEMEL HEMPSTEAD (0442) 212655 during office hours or on (0442) 211814 evenings or weekends (not an answering machine). Alternatively write to him at the address below.



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Appointments

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(2317)

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They now wish to strengthen their Antenna Group and there are career opportunities for design engineers, systems engineers and project managers. Current design work includes all aspects of reflector antenna technology, including multiple feed systems and shaped reflectors, phased arrays, helices and wavewide aperture radiators.

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Successful applicants should be degree qualified with some antenna experience gained either in industry or within an academic R & D environment.

Interested men and women should telephone or write for an application form to: Jack Burnie, Marconi Space and Defence Systems Limited, Browns Lane, The Airport, Portsmouth, Hants PO3 5PQ. Tel: 0705 674019. Please quote ref BL 118

(All posts are open to men and women)

Marconi
Space & Defence Systems

(2303)

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TEST ENGINEERS

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We're looking for Engineers educated to at least TEC/HNC or appropriate C & G passes. You'll be working on a variety of interesting equipment from PEC through to complete systems (DC to 40 GH_z).

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Ex-Service or Marine Radar maintenance experience would be considered as an acceptable qualification.

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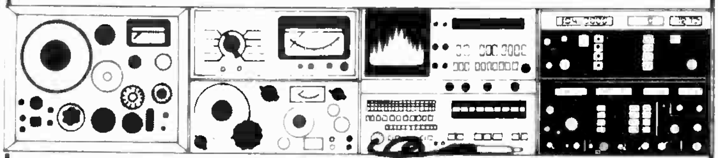
1983

RACAL
The Electronics Group

www.americanradiohistory.com

Appointments

Test & Calibration Engineers



Having introduced an extended new product range, many of which are microprocessor based, Marconi Instruments has once again confirmed itself as Europe's leading manufacturer of sophisticated test and measurement systems. Our products are selling throughout the world and we are naturally developing further new and innovative designs.

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Qualifications

Present Job

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Only shortlisted applicants will be contacted.

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(2297)

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Salary will be in the range £7190 to £10710 p.a. and appointments will be for three years in the first instance. Write with personal details and the names of two referees by 7 November 1983 to Mr J. Deakin, Cavendish Laboratory, Madingley Road, Cambridge CB3 0HE.

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For further details and application form ring Gina Cole on 01-222 7730 ext 3626 or write quoting reference YRIN/902/WW to:

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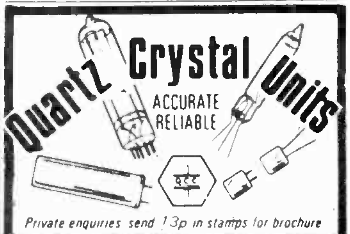

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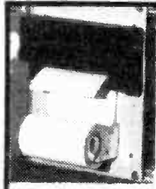

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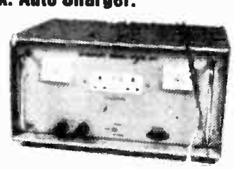

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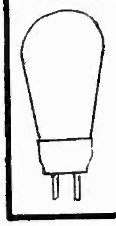

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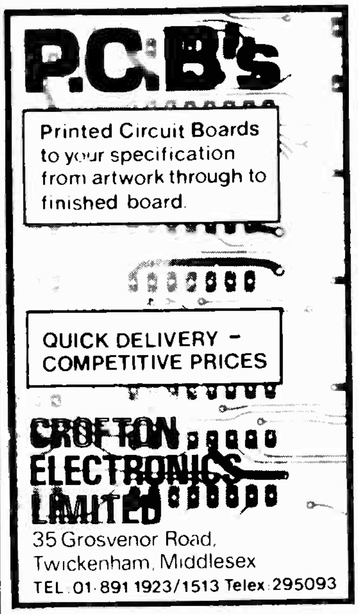

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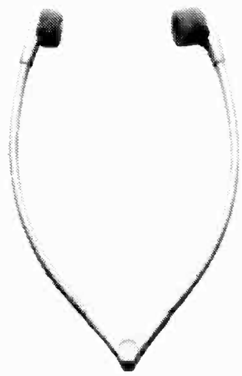

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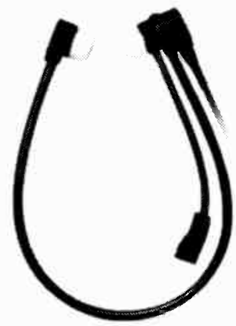

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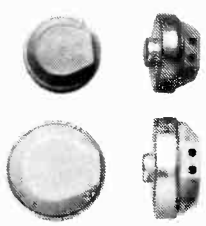

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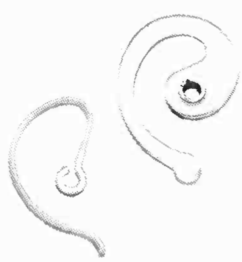

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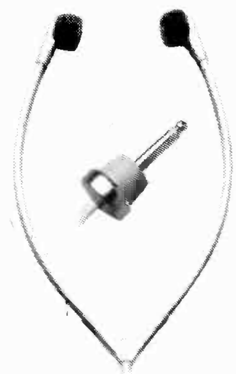

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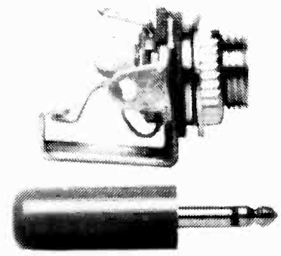

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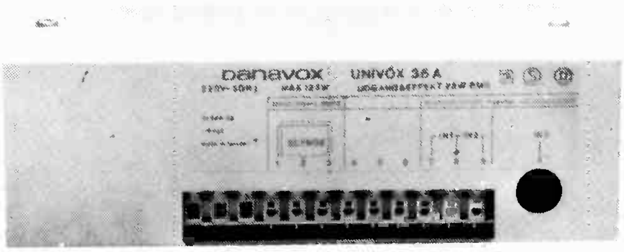

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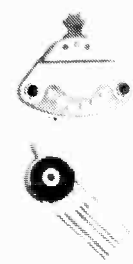

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