ELECTRONICS &

Wireless world

March 1985 85p

Are British ideas going down the drain?

Instruments for IEEE 488

New logic symbols

Novel sub-woofer

Australia	A$	3.30	Italy	L	4200
Denmark	DKr	38.00	Spain	Pts.	370.00
Germany	DM	7.00	Switzerland	SFr.	8.00
Greece	Dra.	24.00	Singapore	M$	7.00
Holland	DFl.	9.00	U.S.A.	$	4.00

Directional power meter TM10

leads by a head

For colour brochure contact:

FARNELL INSTRUMENTS LIMITED
WETHERBY LS22 4DH
TELEPHONE (0937) 61961
TELEX 557294 FARIST G

Farnell

- Single detector head covers wide frequency and power band
- 25MHz to 1GHz ■ 20mW to 100W and VSWR from 1 to 3
- Head can be used 1.5m from meter (e.g. inside closed car boot)
- Fully portable – works from internal battery or vehicle battery
- Mains adaptor/charger and rechargeable battery available
- Manufactured, tested and inspected to Min. Def. Std. 0524.

CIRCLE 1 FOR FURTHER INFORMATION

CONTENTS

ELECTRONICS &
Wireless world
over 70 years in independent electronics publishing

March 1985 Volume 91 number 1589

FEATURES

17
British invention, innovation and electronics
by R.E. Young
Background to new series

25
Floppy discs
by David March
Continuing the survey of disc storage in microcomputers

Sampled-data servos
The second part of Dr Taub's new analysis — outlining the sampling and aliasing processes — is held over to the next issue

43
The new logic symbols
by Ian Kampel
The new standard explained

49
GPIB
An introduction to the bus accompanied by our equipment survey

31
Aesthetic sub-woofer system
by M. Bronzite
Analysis of path-length difference leads to an unconventional crossover design

66
Alarmphone
by Per Andersen
This final part details the circuitry for the d.t.m.f. emergency autodialler, requiring no line connection

70
Principles of optical storage
by J.R. Watkinson
This second article in our definitive compact disc series details the physics of the readout process

REGULARS

6
Comment and News
Electro-reductionist challenge, World telephones, CB Snafu, Neutrons probe structures

37
Communications
New-look spectrum management?, External voices, Midgley's inventions, Cable & DBS

61
Circuit ideas
Vmos squelch for pulse receivers, Bit-rate generator, Z80 instruction counter, Strobe probe

72
Letters
Current dumping, Causality, IT education

78
New products
Computer music, Low-cost modem, Image frame store

26
Events

46
Literature received

Front cover, designed by Philip Brooker and photographed by Kenneth Crook, illustrates R.E. Young's piece on British invention, which starts on page 17.

NEXT MONTH

Quartz crystals are by no means as simple as they might appear. Gordon Hulyer of Cathodeon explains their characteristics and usage.

Current followers were discussed by F.J. Lidgey in February 1984. He now joins forces with Christofer Toumazou to describe an accurate current follower design, which is used in a universal voltage amplifier.

In "How long is a piece of wire?", John Wiseman looks at electrically short transmitting aerials — those less than a quarter wavelength — which he describes as the no-mans' land of aerial design.

Current issue price 85p, back issues (if available) £1.06, at Retail and Trade Counter, Units 1 & 2, Bankside Industrial Centre, Hopton Street, London SE1. Available on microfilm; please contact editor.
By post, current issue £1.30, back issues (if available) £1.40, order and payments to EEP Sundry Sales Dept., Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. Tel.: 01-661 3378.
Editorial & Advertising offices: Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.
Telephones: Editorial 01-661 3614. Advertising 01-661 3130.
Telex: 892084 BISPRS G (EEP)
Subscription rates: 1 years £15 UK and £19 outside UK.
Student rates: 1 year £10 UK and £12.70 outside UK.
Distribution: Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. Telephone 01-661 3248.
Subscriptions: Oakfield House, Perrymount Road, Haywards Heath, Sussex RH16 3DH. Telephone: 04444 59188. Please notify a change of address.
USA: $49.40 surface mail, $102.60 airmail. Business Press International (USA). Subscriptions Office, 205 E. 42nd Street, NY 10017.
USA mailing agents: Expediters of the Printed World Ltd, 527 Madison Avenue, Suite 1217, New York, NY 10022, 2nd class postage paid at New York.

ISSN 0043 6062.

Editor
PHILIP DARRINGTON
01-661 3128

Deputy Editor
GEOFFREY SHORTER, B.Sc.
01-661 8639

Technical Editor
MARTIN ECCLES
01-661 8638

Projects Editor
RICHARD LAMBLEY
01-661 3039

News Editor
DAVID SCOBIE
01-661 8632

Drawing Office Manager
ROGER GOODMAN
01-661 8690

Technical Illustrator
BETTY PALMER

Advertisement Manager
BOB NIBBS, A.C.I.I.
01-661 3130

MICHAEL DOWNING
01-661 8640

ASHLEY WALLIS
01-661 8641

Northern Sales
HARRY AIKEN
061-872 8861

Midland Sales
BASIL McGOWAN
021-356 4838

Classified Manager
BRIAN DURRANT
01-661 3106

IAN FAUX
01-661 3033

Production
BRIAN BANNISTER
(Make-up and copy)
01-661 8648

Publishing Director
DAVID MONTGOMERY
01-661 3241

International Agents and the Advertisers Index appear at the back of this issue.

Electro-reductionist challenge

This journal has more than once commented on the threat to human life and ways of life posed by certain applications of electronics. There is now another, different kind of threat from this technology. It takes the form of a challenge to our understanding of what it is to be a human being.

Through a remarkable ability to simulate natural phenomena and processes as well as man-made systems, electronics technology is providing powerful support for the reductionist view of living beings. Reductionism, put crudely, is 'nothing but-ery.' We are arrangements of atoms and molecules — machines — functioning according to physical laws (which most of us accept) and 'nothing but' machines (which many of us vehemently reject).

This is not a doctrine to be easily dismissed. The philosopher John Searle in his 1984 BBC Reith Lectures admitted: "I just cannot square my conviction that I am a free agent with my conviction that. . . the surface features of phenomena are explained by the behaviour of micro-elements."

The first electronic simulators were analogue computers, and electronic analogues are still used to model living processes such as the electrical activity in tissues. Now, digital computer programs are taking over some of this biological modelling. Apart from these specially designed models, set up as aids to research, there are the analogies suggested by existing artefacts. At one time the brain and central nervous system was likened to a telephone exchange. Now it's a computer.

Of course, these popular analogies are simplistic and misleading if pressed too far. But they have nevertheless entered the folklore by their emotional effect, especially when more and more human tasks are being performed by electronically controlled machines. Current discussions on whether such machines 'think' and have 'consciousness' are largely exercises in semantics. But the very fact of such discussions by professionals, like those on nuclear war, makes the subject thinkable.

At the lowest level, although brains don't actually work like computers, "the union of nerve fibres by synapses into systems with given overall properties" are realistically comparable with man-made "nets containing cycles" (quoting from Norbert Wiener's *Cybernetics*). But now that the fifth generation of computers is almost here, the model becomes more sophisticated. Aided by cognitive psychology, it moves a step nearer to the living processes. According to Professor Donald Michie, a researcher in machine intelligence, these new machines will function at "a higher level of conceptualization" than is possible with the existing Turing/von Neumann type computers. As an example, research is being done on distributed associative memories modelled on what is known of human memory processes.

Electro-reductionism, as it might be called, supports the instrumental view of human life epitomised by behaviourism and the technological fix. It is a challenge that must be met. It puts us on our mettle to defend and reaffirm our inner experiences, beliefs and values. Faced with the blind determinism of our own biological mechanisms, we must assert, like Kierkegaard's 'leap of faith', that it is equally valid to describe human life in subjective terms — consciousness, mind, intention, volition etc. — with the freedom of moral choice that these entail.

"We're hoping to get rid of the dongle when it goes into production"

Community radio

The Home Secretary has given the go-ahead for the establishment of a number of low-powered v.h.f. local radio stations, serving the community. There is to be an inquiry into the ways of implementing such a service. At the same time, there is to be a clamp-down on pirate radio stations which are using frequencies likely to be allocated to community radio. We published an article by Norman McLeod, which described a method for the best utilization of wavebands for community radio, in our July 1983 issue.

The world needs more telephones

There is a gross imbalance in the distribution of telecommunications across the world. Three-quarters of the 600M telephones in the world are concentrated in only nine countries. Half the world's population live in countries with less than one telephone for every 100 persons and in such countries these are predominantly concentrated in urban areas, in many rural and remote areas there are no telecommunications at all. There are more telephones in Tokyo than in the whole of Africa. One can only speculate on the extent to which the absence of telecommunications has contributed to the disastrous famine in Ethiopia.

These are some of the startling facts which come from the findings of the Independent Commission for World Wide Telecommunication Development, set up by the International Telecomminications Union. In their newly published Report the Commission has made several recommendations to the ITU. The Commission's members came from India, the USA, Kuwait, Japan, Federal Germany, Morocco, France, Tanzania, Venezuela, Gabon, Senegal, Romania, Indonesia, the USSR, Costa Rica and Saudi Arabia and was chaired by Sir Donald Maitland, the UK representative.

Their chief conclusion is that the industrial nations and telecommunications industries should aid the poorer nations in the development of their telecommunications. This will promote the shared interest in that a more comprehensive world network will increase international traffic and generate funds for investment; trade and other contracts would be stimulated and the standard and quality of life of countless millions would be raised to the general good. The high technology and other industries will then find new markets in the developing world for their products and their expertise. If this common interest is recognised and if higher priority is given to investment in telecommunications as an integral part of the process of development, there is no good reason, in the Commission's view, why be the early part of the next century all mankind should not be within easy reach of a telephone. This is the objective set by the Commission.

In practical terms the Commission proposes the setting up of a Centre for Telecommunications Development. It would have three components: a Development Policy Unit, to collect and disseminate information about telecommunications policies and experience; a Telecommunications Development Service which would offer developing countries disinterested advice of the highest quality on every aspect of creating and operating an effective system; and an Operations Support Group which would provide specific assistance and complement the work of the Technical Co-operation Department of the ITU.

Although the Commission accepts that there is no instant solution, if their recommendations were to be accepted and implemented with vigour, the world wide situation could be transformed within 20 years.

UK's the place for US hi-tech

Geoffrey Pattie, who took over the Ministry for Information Technology has been exhorting Americans to locate their high technology industry in Britain. Addressing the annual meeting of the American Friends of Wilton Park, in Los Angeles, he pointed out that the UK consumption of integrated circuits alone grew 50% last year, to £450M. "The UK is now the largest European market for i.cs. It is also the fastest growing and uses a higher proportion of integrated circuits in its products than any other European country."

He outlined the Governments' work in telecommunications and particularly the development of the TACS cellular radio system which should give 90% of the UK population the opportunity of making telephone calls from their cars by 1990. In another

In another part of his speech he decried the US restriction om the dissemination of unclassified technical data and scientific information. "Such moves have included the withdrawal of scientific and technical papers from open circulation; limitation on the attendance of non-US citizens at scientific conferences; restrictions on US scientists wishing to attend international conferences; and restrictions on the access of foreign students to US laboratories.

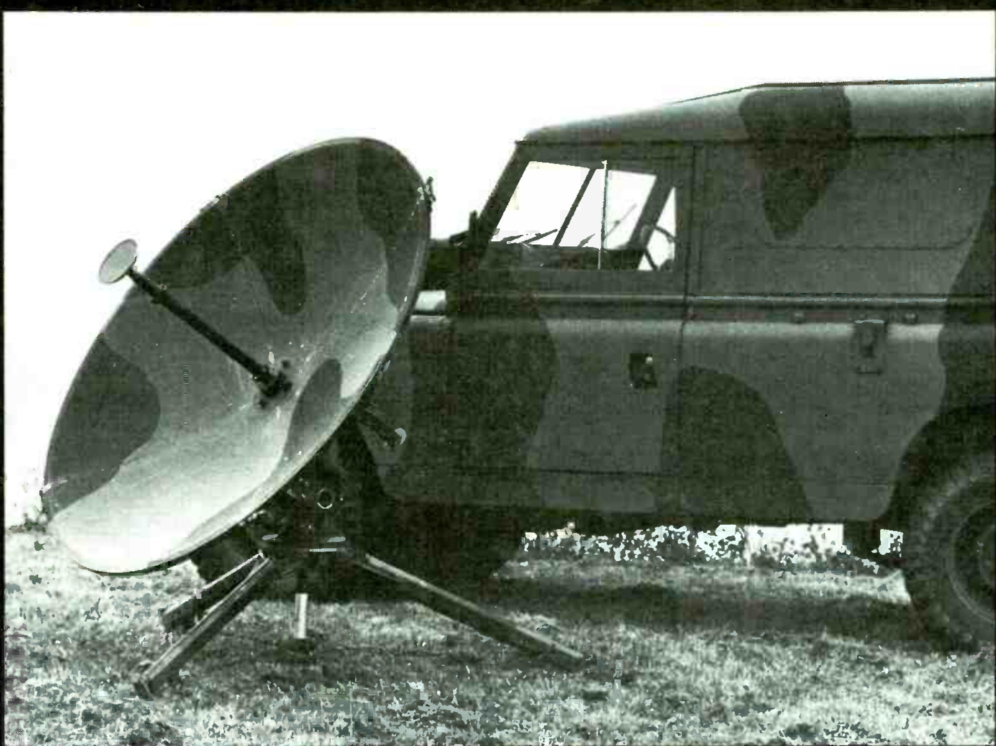
If these restrictions are allowed to grow unchecked, the long-term effect could well be a decline in the quality and a decrease in speed of scientific and technoligical progress; and the increased risk of duplication of effort.

A source for neutrons

What is claimed to be the world's most powerful pulsed neutron source is to be fully commissioned in April. The Spallation Neutron Source (SNS) is at the SERC Rutherford Appleton Laboratory. Initial tests have found it to be a very useful tool and a small but significant discovery has been made in the distortion of the structure of nickel oxide.

The initial test consisted of accellerating protons to 550MeV in a sychrotron (800MeV will be used eventually). The protons are extracted from the synchrotron in high intesity bursts, 50 times a second, and are focused on a target of non-fissile Uranium 238 where 25 to 30 neutrons are released for each incident proton. The pulsed structure allows the measurement of neutron wavelength and energy. The neutrons so generated are too energetic and are therefore slowed down by 'moderators' of which the SNS has four: two of water at room temperature, one of liquid methane at 100K and one of hydrogen at 25K. The pulses of neutrons emerging from the moderators, now comparatively slow in particle terms, are used for experimental purposes.

Neutrons carry no electrical charge and can penetrate an atom and interact with the neucleus. Because they have wavelengths which range from less than the dimensions of an atom to that of large molecules, the neutron beams can be used to probe the structure of molecules and the arrangement of atoms and molecules in crystals, liquids, glasses and plastics. One example is investigate the structure of viruses. Neutrons are very penetrating and can be used to probe the internal structure of bulk materials, for example studying the setting of cement and internal strains in metals. Neutrons have relatively low engergy; about 10^{-5} times less than that of X-rays of comparable wavelength. This allows the investigation of atomic and molecular motion within substances which in turn give information about the atomic-scale forces which



A prototype of what is said to be the first mobile satellite communications ground station from Racal-SES. The company are to supply the MoD with a number of such stations for use in military communications from a forward headquarter position.

control the structure and properties of matter. They also provide the basis for the newly developing technique of neutron radiography. Each neutron has magnetic moment; it behaves like a tiny magnet, and may be used in the study of the magnetic properties of materials.

This combination of all the various properties of the neutron make it a powerful and unique tool for a wide range of studies in chemistry, physics, biology and materials science.

Ten-four breakers?

It appears that the old illegal CB radio rigs will soon become legal but the new legal sets will at the same time become illegal. The Radio Regulatory Division or their masters at the DTI have agreed to adopt the frequencies recommended by the CEPT for use in Europe. These are the same as the American FCC allocated frequencies for CB and were used illegally in this country until parliamentary lobbying, and widespread flouting of the law, forced the Government into making CB legal. The official reason given is that the frequencies allocated on legalization were the only ones useable in the short time-span then available. The CEPT recommendation allows for a 40-channel service operating between 26.96 and 27.40MHz with four watts power and using f.m. only. There is to be a gradual changeover with the final plans and dates not yet fixed. Some channels at the bottom of the band are still occupied by such services as hospital paging systems and most of these have been allocated new channels in Band III following the demise of the 405-line tv service. But eventually CB users will have to get new equipment or have their rigs modified to remain legal. The 934MHz band is to be moved down by 12.5kHz with the channels spacing reduced in order to get 40 channels on this band. After all this has happened breakers will be able to use their sets all over Europe and it is presumed that as they all seem to communicate in their own weird language they should have few linguistic problems there. Perhaps that is what Orwell meant by Newspeak? Our thanks to Reg Moore, G3GZT/VS6CD, for pointing out this addition to the CB snafu saga.

In brief

STC think they can find a niche in the market by providing a connector service. With this in mind they have set up a new company; Five Star Connectors, and have invested several million in buying stock, so that they can offer a same-day, off-the-shelf service for a wide variety of connectors from a number of leading manufacturers. Coinciding with the launch of the new company is the first issue of their catalogue; 104 pages long and seemingly covering any connector that one could imagine.

- Since the poison gas disaster in Bhopal, India, the Ever Ready battery company wish it to be known that they have no connection with Eveready batteries marketed in several countries (though not in the UK) by Union Carbide.

Engineers at the IBA Engineering Centre have successfully received from Norway the first operational service to use the C-MAC/packet d.b.s. system. The pictures are being transmitted by NRK, the Norwegian broadcastine corporation for reception in the Svalbard Islands off the northern coast of Norway, well within the Arctic Circle. This is the first service to use the C-MAC/packet system proposed by the EBU and based largely on the MAC system developed by the IBA. The Norwegians are using the eight sound channel capacity available in the specification to provide two stereo radio channels in addition to the sound accompanying the picture. IBA engineers are currently working on an experimental enhanced form of wide-screen MAC transmission.

The first? Not by a long chalk

Whenever we take the words of a press release for granted, we are invariably wrong. Philips told us that their slow-scan tv system was the first to get BT approval (January News). Not so, says Ibsonmain of Uxbridge. They had approval back in 1978 when BT was still part of the GPO. They claim that they were the first and know of at least three other companies in the same field with official approval. Ibsoscan II is a transceiver that will also autodial, autoanswer, provide remote control of cameras, alarm systems etc. Its built-in line monitoring ensures privacy and there is no limit to the length of time a transmission will take. Moreover the product is British designed, British made and built almost entirely of British components.

Automatic telephone fault-finding

British Telecom are installing automatic line testing equipment to speed telephone fault detection and repair. Beginning in March the equipment will be installed in about 100 of BT's 360 repair service controls. It will automatically test customers' lines and equipment overnight to spot any degradation before it develops into a fault which could affect telephone service. It can also be operated by officers at the control centres in reply to faulty line calls by users dialling 151.

Eventually the records and automatic test computers will be integrated so that if a fault is reported, the customer service operator can call up the line's previous fault record, initiate the automatic test and read the results displayed on a screen. This will usually provide enough information to estimate the time needed to effect the repair and organize an engineer's visit.

Communi-cations for the deaf

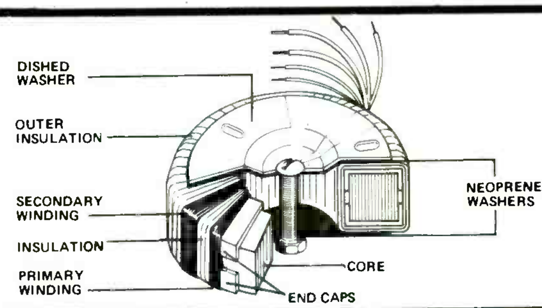
A profoundly deaf young mother from Leeds has called on the Government to provide financial assistance to enable similarly handicapped people to benefit from electronic mail. Doreen Naylor, deaf from birth, has contributed to a book, *Micros for the Handicapped*. She runs a network linking deaf families in Leeds and Bradford and is particularly pleased with the Commstar rom from Pace which she uses in her BBC micro, along with a Pace modem. Doreen is one of several handicapped people who have written first-hand accounts of their experiences in the book, published in Whitby by Helena Press.

Alvey looks at wafers

A major project for developing fault-tolerant design techniques for wafer-scale integration. Plessey, GEC and ICL are to collaborate with Brunel University, Middlesex Polytechnic and King's College, London in the project. It is planned to take three and a half years and involve a total of 50 years' effort for one person.

The objective is to create circuits which can be reconfigured to avoid defects on the wafer. Several approaches have been proposed, but few tested in practive. Such a self-repair system has been described by Ivor Catt in this journal. For the Alvey project it is planned to produce two circuits, one will have a regular array structure while the other being a non-regular cell-based type. C.mos technology is to be used for these demonstration wafers. The project part of the overall VLSI architecture programme of Alvey which aims to produce a variety of methods for exploiting the possibilities of parallel processing offered by VLSI. The WSI project should produce manufacturing techniques of value to all designers of VLSI circuits.

TOROIDALS



The toroidal transformer is now accepted as the standard in industry, overtaking the obsolete laminated type. Industry has been quick to recognise the advantages toroidals offer in size, weight, lower radiated field and, thanks to I.L.P., PRICE.

Our large standard range is complemented by our SPECIAL DESIGN section which can offer a prototype service within 14 DAYS together with a short lead time on quantity orders which can be programmed to your requirements with no price penalty.

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

Why a Toroid?

- Smaller size & weight to meet modern 'slimline' requirements.
- Low electrically induced noise demanded by compact equipment.
- High efficiency enabling conservative rating whilst maintaining size advantages.
- Lower operating temperature.

Why ILP?

- Ex stock delivery for standard 240V range
- Fast prototype service available
- 3 weeks despatch for special orders
- 2 year no quibble quarantee
- No price penalty for call-off order

Prices including P & P and VAT

VA	Size	£	VA	Size	£
15	0	7.06	160	5	12.17
30	1	7.67	225	6	13.75
50	2	8.90	300	7	14.97
80	3	10.06	500	8	19.60
120	4	10.65	625	9	22.30

For 110V primary insert "0" in place of "X" in type number.
For 220V primary (Europe) insert "1" in place of "X" in type number.
For 240V primary (UK) insert "2" in place of "X" in type number.
IMPORTANT: Regulation — All voltages quoted are FULL LOAD.
Please add regulation figure to secondary voltage to obtain off load voltage.

Mail Order — Please make your crossed cheques or postal orders payable to ILP Electronics Ltd.

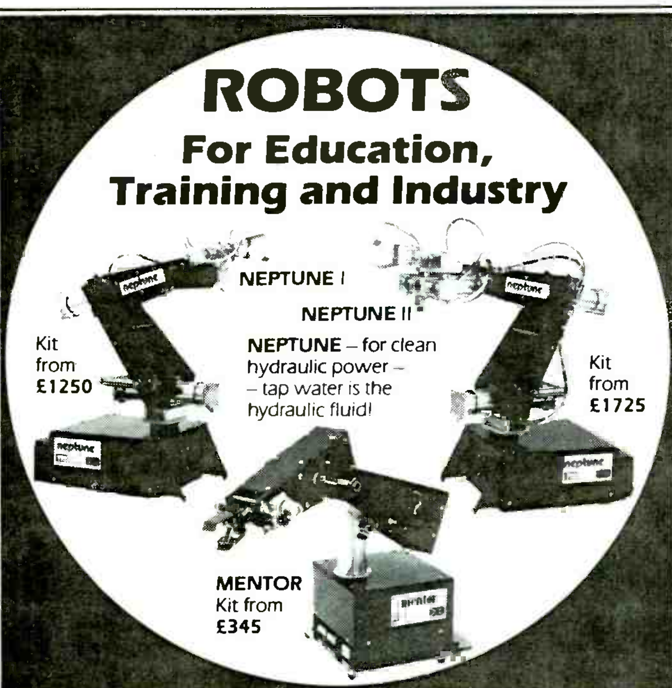
Trade — We will open your credit account immediately upon receipt of your first order.

Post to: ILP Electronics Ltd., Dept. 3 Graham Bell House, Roper Close, Canterbury, Kent. CT2 7EP
Tel: (0227) 454778 Telex: 965780

VISA

ILP ELECTRONICS LTD.

CIRCLE 41 FOR FURTHER DETAILS.



NEPTUNE I 6 axes; 8 bit control system; 2.5Kg capacity; 1120mm reach.

NEPTUNE II 7 axes; 12 bit control system; 2.5Kg capacity; 1120mm reach.

MENTOR DC servo desktop robot; 8 bit control system; 300gm capacity; 420mm reach.

Robots programmed from keyboard or hand-held simulator (model robot).

Robots may also be taught by 'lead by the nose' method

Extensive software is supplied free with each robot.

Leads available for connection to BBC, ZX Spectrum, Apple IIe, Commodore 64 and VIC 20.

Most other micros are also easily usable with these robots.

Cybernetic Applications

Please phone for brochure: 0264 50093.
West Portway Industrial Estate, Andover SP10 3WW.
A private and independent company giving prompt, personal service.

CIRCLE 17 FOR FURTHER DETAILS.

A GENUINE OPPORTUNITY TO PURCHASE THE AUDIO DISTRIBUTION CONSOLE

MODEL RTM4-100

SYSTEM SPECIFICATION

DISTRIBUTION FACILITIES

The following distribution facilities are provided.

1. Single channel radio distribution from integral variable AM/FM tuner.
2. Single channel cassette tape distribution from integral cassette player.
3. Four channel mixed speech distribution from any standard 200 ohm impedance microphones.

Note that the output of all facilities can be mixed if required and that bass and treble control is provided on the mixed output.

RECORD FACILITY

The integral cassette tape recorder can be used to record the mixed output of the four microphone channels and the radio distribution channel.

CONSOLE

DIMENSIONS:	465mm High × 435mm wide × 330mm deep approximately
POWER SUPPLY:	200/250 Volts A.C. 50 Hz.
AMPLIFIER:	100 Watts RMS 100 Volt line output

PRICE **£556** inc VAT and Delivery (Mainland only)
Weight 28 Kilos Nett, approx.

TERMS C.W.O. export enquiries welcome. We find it impossible to advertise all we stock. Please telephone, write or telex for further enquiries. Personal callers always welcome.

ELECTRONIC EQUIPMENT Co.

SPRINGFIELD HOUSE, TYSSEN STREET, LONDON E.8. 2ND
TEL NO. 01-249 5217
TLX: 8953906 EECO G

CIRCLE 124 FOR FURTHER DETAILS.

ment Instrument Distribution Division

INVENTORY:

Philips PM 5131 £395
Function generator 0.1Hz to 2MHz, sine, square, tri-angle, TTL, int or ext sweep, output 30Vpp into 50Ω, stepped and variable attenuation.

Philips PM 5519I £785
Pattern generator, 20 combination test patterns, full RF coverage, electronic tuning with 6 preset channels, video and sound mod. comp and frame sync.

Philips PM 5503 £145
Pattern generator, 5 test patterns for mono and colour, video output for CCTV and monitors, RF output in VHF and UHF range, 1kHz tone for sound checks.

Thandar TG 101 £110
Function generator 0.02Hz to 200kHz, sine, square, triangle, variable DC offset, TTL output, external sweep, 10Vpp output into variable 600Ω.

Thandar TG 102 £160
Function generator 0.2Hz to 2MHz, sine, square, triangle, TTL output, variable DC offset, external sweep, 20Vpp output into variable 50Ω.

Thandar TG 105 £105
Pulse generator 5Hz to 5MHz, 10nS, amplitude 0.1V to 10V into 50Ω, free-run, gated or triggered modes, TTL output, pulse width variable 100nS to 100mS.

Thandar TG 501 £295
Function generator 0.005Hz to 5MHz, sine, square, triangle, ramp, pulse, TTL, variable DC offset, variable start/stop phase, 20Vpp into variable 50Ω.

Thandar TG 502 £495
Sweep/function generator 0.005Hz to 5MHz, sine, square, triangle, TTL, internal sweep log or lin, variable sweep rate and marker duration, sweep and pen-lift outputs.

Thandar TG 503 £495
Pulse/function generator 0.005Hz to 5MHz, sine, square, triangle, ramp, TTL, normal, double or delayed pulses, variable pulse width and delay, adjustable base line.

COUNTERS & COUNTER/TIMER

Philips PM 6670/01 £593
Counter/timer, 0.1Hz to 120MHz, period, pulse width, single and average time interval, count, phase, RPM, ratio, high resolution, 10mV sensitivity.

Philips PM 6671/01 £719
Counter/timer, 0.1Hz to 120MHz, as PM 6670 with LED trigger indicators, trigger level outputs, burst frequency average, arming, ext reset/start, gate open monitor.

Philips PM 6672/01 £887
Counter/timer, 0.1Hz to 1GHz, period, pulse width, single and average time interval, count, phase, RPM, ratio, high resolution, 10mV sensitivity to 70MHz.

Philips PM 6668/01 £446
Counter, 10Hz to 1GHz, 7 digit LCD display, auto triggering on all waveforms, 15mV sensitivity, high stability crystal oscillators.

Philips PM 6667/01 £304
Counter, 10Hz to 120MHz, 7 digit LCD display, self diagnosis routine, auto triggering 15mV sensitivity, high stability oscillator.

Thandar TF 200 £175
Counter, 10Hz to 200MHz, 8 digit LCD, battery powered, 10mV sensitivity, time average period, totalize and reset. TP 600 pre-scaler, 40MHz to 600MHz available at £45.

Thandar PFM 200A £76
Counter, 20Hz to 200MHz, 8 digit bright LED, battery powered, 10mV sensitivity, resolution 0.1Hz, selectable gate times, mains adaptor and TP 600 pre-scaler available.

POWER SUPPLIES

Thurlby PL 154 £149
0 to 15V, 0 to 4A, bench power supply, twin LED displays meter voltage and current, high stability and resolution, remote sense facility.

Thurlby PL 320 £145
0 to 30V, 0 to 2A, bench power supply, constant current or constant voltage, precise current limit control and monitor system, ripple and noise <1mV.

Thurlby PL 310 £118
0 to 30V, 0 to 1A, bench power supply, meter accuracy 0.1%, resolution 0.01V and 0.001A, DC output switch, load regulation <0.01% for 50% load change.

MISCELLANEOUS PRODUCTS

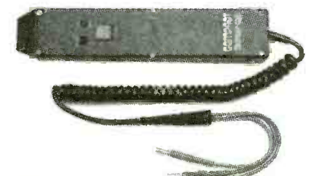
Philips PM 6303 £695
Philips automatic RCL bridge, 4 digit LCD display for measured value and electric dimension, accuracy 0.25%, automatic or stepping parameter menu selection.

Philips PM 6307 £457
Philips wow & flutter meter, crystal controlled oscillator, 3150Hz and 3000Hz selectable, high accuracy and stability, separate drift and flutter indication.

Thandar TH 302 £80
Thandar digital thermometer, LCD display of °C and °F, range −40°C to 1100°C, resolution 0.1° and 1°, for use with type K probes (bead supplied).

Thurlby OM 358 £169
Thurlby multiplexer expands any oscilloscope to 8 channels, displays analogue or digital signals, triggering from any channel, band width 35MHz, precision calibrated attenuator.

Thurlby CM 200 £89
Thurlby digital capacitance meter, 4½ digit LCD, 1pF to 2500μF range, accuracy 0.2%, fast settling, battery or mains operation.



Tachoprobe £70
Compact tacho-probe for use with DMMs or frequency counters, 2 speed ranges from 100 to 20,000 RPM, accuracy 1%, non-contact range 1m.

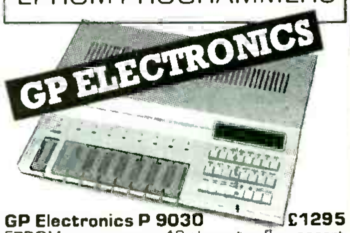
LINE CONDITIONERS

Claude Lyons LVC 500 £330
5A, 1200VA rating, line voltage conditioner, supply frequency 48-63Hz, incorporate ultra isolation transformer and r.f.i. filter.

Claude Lyons LVC 250 £256
2.5A, 600VA rating, line voltage conditioner, fast response (typically 1½ cycles), isolated input/output, compact and portable for easy installation.

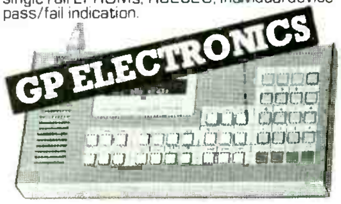
Claude Lyons LVC 65 £175
0.65A, 156VA rating, line voltage conditioner, unaffected by frequency variations, transient and noise suppression. All LVC units have 2 year warrantly.

EPROM PROGRAMMERS



GP Electronics P 9030 £1295
EPROM programmer, 16 character fluorescent message display, menu selection programmes all EPROMs, powerful editor, RS232C interface, label print feature.

GP Electronics P 9020 £995
EPROM programmer, 16 character display, menu device/mode selection, programmes all single rail EPROMs, RS232C, individual device pass/fail indication.



GP Electronics MFL 373 £695
Microsystem fault locator, range functions include Bus test, ROM test, dynamic and static RAM test, supplied with synchrous logic probe.

GP Electronics UV 141 £88
EPROM eraser, variable electronic timer, powerful UV source, up to 14 device capacity, convenient tray loading with safety interlock.

Full specifications on any products distributed by Electronic Brokers are available on request.

OUR SERVICE.

prompt despatch to all parts of the country.
Electronic Brokers offer full technical support and expert advice on all aspects of electronic test and measuring.

Visitors are welcome to our showrooms where all products are on display and demonstration.
For customers wishing to order by phone, we offer a 24 hour answering service.

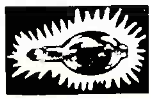
Electronic Brokers Ltd 140-146 Camden Street
London NW1 9PB
Telephone 01-267 7070 Telex 298694

All prices exclusive of VAT. Carriage and packing charges extra on all items unless otherwise stated.
A copy of our trading conditions is available on request.
Prices correct at time of going to press.

CIRCLE 200 FOR FURTHER DETAILS.

SUPER HY-LIGHT STROBE KIT
Designed for Disco, theatrical uses, etc.
Approx. 16 joules. Adjustable speed. Price **£45** + £2 p&p (Total inc. VAT **£54.05**; Case and reflector price **£15** + £2 p&p (total inc. VAT **£19.55**); Foolscap SAE for further details including Hy-Light and Industrial Strobe Kits.

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES



4ft 40 watt **£10.44** (£12.00 inc. VAT)
2ft 20 watt **£7.44** + £1.25 p&p (**£9.99** inc. VAT)
18in. 15 watt **£5.00** + 75p p&p (**£6.61** inc. VAT)
13in. 10 watt **£4.00** + 75p p&p (**£5.46** inc. VAT)
12in. 8 watt **£3.60** + 50p p&p (**£4.71** inc. VAT)
9in. 6 watt **£3.00** + 50p p&p (**£4.02** inc. VAT)
6in. 4 watt **£3.00** + 50p p&p (**£4.02** inc. VAT)

230V AC Ballast Kit for either 6in, 9in or 12in tubes **£5.50** p&p 55p (£6.96 inc. VAT).
For 13in. & 18in. Tubes **£6** p&p 75p (**£7.76** inc. VAT).
For 12V DC op. 12in. & 13in. tubes only **£5.50** p&p 75p (**£7.18** inc. VAT).
175 WATT SELF-BALLASTED BLACK LIGHT MERCURY BULBS. Available for either B.C. or E.S. fitting, price **£10.80** + p&p £1.25 (total inc. VAT **£13.85**).
400W UV LAMP & BALLAST complete — **£48.80** + p&p £3.50 (**£52.30** incl VAT)
400W UV LAMP only, **£20.00** + p&p £2.50 (**£25.88** incl. VAT).
L.T. TRANSFORMERS
"**Special Offer**" 0-6.3V-0-6.3V at 10 Amp (12V 0 10 Amp or 6V at 20 Amp) **Price £9.00** p&p £2.00 – inclusive of VAT **£12.65** N.M.S.

ROBOT ENTHUSIASTS
The following two Motors are ideally suited for experimenters in this field:
1. **ESCAP** precision Swiss-made ironless rotor, 6V DC geared MOtor with 70-1 gearbox. 6V DC – 16 r.p.m. 3V – 8 r.p.m. amazing power; no load current; only 10 ma. approx. Size: **4 × 2½** cm. Ex-equipment, tested and guaranteed. **ONLY £4.50** + 50p p&p (total inc. VAT **£5.75**).
2. **12/24V D.C. Reversible Precision built motor** manufactured by Escap – will operate from 24V down to 2V DC – Current consumption negligible. A range of speeds between 2 to 36 r.p.m. obtainable: 6 Volt DC – 9 r.p.m. N/L 6 MA, 12V DC – 18 r.p.m. N/L 10 MA, 24V DC – 36 r.p.m. N/L 18 MA. Total length of motor and gearbox 90 M/M. Max. Dia 42 M/M. Shaft length 15 M/M. Shaft Dia 6 M/M. Approx. half manufacturers price: **£15.00** p&p £2.00 – total inclusive of VAT **£19.55**.

VBL4 CENTRIFUGAL BLOWER
240V AC powerful 1/50 h.p. 0.23A motor. **£18.00** + £2.00 p&p (Total inc. VAT **£23.00**). N.M.S.
12/24V DC Centrifugal Blower 0.4A producing 30 cu.ft. **£7.50** + £1.00 p&p (Total inc. VAT **£9.78**) N.M.S.

COOLING or EXTRACTOR FAN

Quiet smooth running. Size 4¾ × 4¾ × 1½. Supplied for 240V a.c. operation. Price **£4.75** + £1 p&p (Total inc. VAT **£6.62**) N.M.S.

240V A.C. SOLENOID VALVE
Designed for Air/Gas at 0.7. Water 5 psi. Inlet-outlet ⅜. Forged brass body. Manuf. Dewraswitch Asco. PRice **£5.50** + £1 p&p (**£7.48** inc. VAT) N.M.S.

VARIABLE VOLTAGE TRANSFORMERS

INPUT 230, 240V a.c. 50/60 OUTPUT 0-260V.

200W, 1A Max.	£15.00
0.5KVA 2½A Max.	£19.00
1KVA 5A Max.	£27.00
2KVA 10A Max.	£41.00
3KVA 15A Max.	£54.00
5KVA 25A Max.	£99.00
10KVA 50A Max.	£181.00
15KVA 75A Max.	£275.00

3-PHASE VARIABLE VOLTAGE TRANSFORMERS
Dual input 200-240V or 380-415V. Star connected

3KVA 5amp per phase max.	£113.40	All V.V.Ts
6KVA 10amp per phase max.	£170.10	plus carriage
10KVA 16amp per phase max.	£345.45	and VAT

Comprehensive range of TRANSFORMERS L.T. ISOLATION & AUTO (110-240V). Either cased with American socket and mains lead or open frame type available for immediate delivery. Leaflet on request.

12V D.C. BILGE PUMPS

400 G.P.H. 15ft. head, 3amp. £8.00 + £1.00 p&p (**£10.35** inc. VAT).
700 G.P.H. 10ft. head, 3.5amp, £11.50 + £1.50 p&p (**£14.95** inc. VAT).
1750 G.P.H. 15ft. head, 9amp, £15.00. + £1.75 p&p (**£19.26** inc. VAT).

SINGLE DIAPHRAGM COMPRESSOR NMS
Max. 20 PSI. One CFM approx. 240 volts A.C. **£18** + £2 p&p (**£23** inc. VAT).

EPROM ERASURE KIT
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.
LESS CASE: Price **£13.60** + 75p p&p (Total inc. VAT **£16.50**).
Warning: Tube used in this circuit is highly dangerous to the eyes. Unit must be fitted in suitable case.

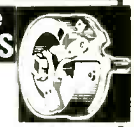
SOLID STATE E.H.T. UNIT
Input 230V A.C. Approx. 15KV. Producing 10mm spark. Built-in 10 sec timer. Easily modified for 20 sec, 30 sec, to continuous. Designed for boiler ignition. Dozens of uses in the field of physics and electronics, e.g. supplying neon or argon tubes etc. **£6.50** + 90p p&p (Total inc. VAT £8.50) N.M.S.

FROM STOCK AT PRICES THAT DEFY COMPETITION

AC GEARED MOTORS	C.F. BLOWERS
DC MOTORS SMALL	AC CAPACITORS
MICROSWITCHES	STROBE KITS
RELAYS	FLASHTUBES
REED SWITCHES	CONTACTORS
SOLENOIDS A.C. or D.C.	SYNCHRONOUS
PROGRAMME TIMERS	MOTORS

WIDE RANGE OF XENON TUBES
WRITE/PHONE IN YOUR ENQUIRIES

Superior Quality Precision Made NEW POWER RHEOSTATS



New ceramic construction, heavy duty brush assembly, continuously rated.
25 WATT 5/10/25/50/100/150/250/300/500/1kΩ 1.5kΩ **£4.25** + 30p p&p. (**£5.23** incl. VAT).
50 WATT 250Ω **£6.50** + 50p p&p (**£8.05** incl. VAT).
100 WATT 1/5/10/25/50/100/250/500/1kΩ/1.5kΩ/2.5kΩ/3.5kΩ **£10.25** + 75p p&p (**12.65** incl VAT)

Black Silver Skirted Knob calibrated in Nos 1-9, 1½in. dia. brass bush. Ideal for above Rheostas **30p ea.** + VAT.

INSULATED TESTERS *NEW!*
Test to I.E.E. Spec. Rugged metal construction suitable for bench or field work onstant speed clutch. Size L 8in., W 4in., H 6in. weight 6lb. **500V** 300 megohms. **£49** p&p £2 (**£58.65** incl. VAT). 1000V 1000MΩ **£55** + p&p £2 (**£65.55** incl VAT) SAE for leaflet.

GEARED MOTORS
5 rpm 240V AC Mf. by Carter, **£6.05** £1 p&p (**£8.11** inc. VAT). N.M.S.
20 rpm 115V AC Synchronous, torque approx 80lb/in. **£20.00** + £4 p&p (Total inc. VAT **£27.60**) N.M.S.
TRANSFORMER 240V operation, **£9.15** + £2.00 p&p (Total inc. VAT **£12.82**).
28 rpm Torque 20lb.in. reversible 1/80th h.p. 110V AC. Price: **£9.50** + **p&p £1.80** (Total inc VAT **£12.99**).
Suitable **TRANSFORMER** for 230-240V AC operation. Price **£5.20** + **p&p** £1.40 (Total inc VAT **£7.59**). N.M.S
38.3 rpm GEARED MOTOR. Torque 35lb in reversible 115V AC inc start capacity Price **£11.55** + p&p (Total inc. VAT **£15.58**) N.M.S
Suitable **TRANSFORMER** 230V AC operation. Price **£5.20** + 50p p&p (**£6.56** incl. VAT)
CROWN 37 rpm 2000lb.in. approx 110V AC, reversible geated motor Price **£35** p&p £4.50 (**£45.42** inc. VAT) N.M.S
Suitable **TRANSFORMER** for above **£10** p&p £1.50 (**£13.22** inc VAT).

57 rpm 240V 1/22 h.p. continuously rated REVERSIBLE 50lb.in. manuf. by Wynstruments New. Ideal for garage doors, curtains etc ONLY **£12.00** + £2.00 p&p (incl. VAT **£16.10**), inclusive capacitor

71 rpm Torque 10lb in reversible 1/70th h.p 110V AC motor. Price: **£9.50** + £1.80 p&p (Total inc VAT **£12.99**)
Suitable **TRANSFORMER** for 230-240V AC operation. Price: **£5.20** + p&p £1.40 (Total inc VAT **£7.59**) N.M.S.
24V DC 200 rpm 10lb/in Mf. by Carter. Ex-equip. tested. **£8.00** + £1.50 p&p (Total inc. VAT **£10.93**).
230/240V AC SYNCHRONOUS, 2 rpm, 6 rpm, 6 rev per day Any type. **£4.80** + 50p p&p (Total inc. VAT **£6.10**).

CHECK METER
230/240 AC 40 amp. fully reconditioned **£7.50** + **£1.75 p&p** (Total inc. VAT **£10.64**)

SANGAMO WESTON TIME SWITCH
Type S251 200/250 A.C. 2 on/2 off every 24 hours, 20 amps contacts with override switch Dimaeter 4" × 3" Price **£8.50** + £1.50 p&p (**£12.65** inc VAT & p&p). Also available with solar dia R&T Other types available from stock

N.M.S. New Manufacturers' Surplus
R&T Reconditioned and tested
Goods normally despatched within 7 days.

Ample parking space
Showroom open
Monday-Friday

BARCLAYCARD VISA

SERVICE TRADING CO
57 BRIDGMAN ROAD, CHISWICK, LONDON W4 5BB. Tel: 01-995 1560
ACCOUNT CUSTOMERS MIN. ORDER £10

Personal callers only. Open Saturdays
9 Little Newport Street
London WC2H 7JJ
Tel: 01-437 0576

CIRCLE 18 FOR FURTHER DETAILS.

ELECTRONICS C.A.D.
"ANALYSER"

PERFORMANCE ANALYSIS of LINEAR CIRCUITS using the BBC MODEL B AND SINCLAIR SPECTRUM 48K MICROS

Simulates Resistors, Capacitors, Inductors, Transformers, Bipolar and Field effect Transistors and Operational Amplifiers in any circuit configuration.

Performs FREQUENCY RESPONSE ANALYSIS on Circuits with up to 30 Nodes and 100 Components, for Phase and Gain/Loss, Input Impedance and Output Impedance.

Ideal for theanalysis of ACTIVE and PASSIVE FILTERS, AUDIO, WIDEBAND and R.F. AMPLIFIERS, LINEAR INTEGRATED CIRCUITS etc, etc.

"ANALYSER" can greatly reduce or even eliminate the need to breadboard new designs.

USED BY INDUSTRIAL AND UNIVERSITY R&D DEPARTMENTS WORLD WIDE.

VERY EASY TO USE. PRICES FROM £20
PAYMENT BY ACCESS OR AMERICAN EXPRESS WELCOME...

For further details write or phone **NUMBER ONE SYSTEMS DEPARTMENT WW**
9A CROWN STREET, ST IVES
HUNTINGDON
CAMBS. UK. PE17 4EB.

TEL: 0480 61778
TELEX: 32339

CIRCLE 88 FOR FURTHER DETAILS.

TALKING COMPUTER TERMINAL
TDS2000 FOR PRECISION DATA INPUT

IEEE488 & RS232C INTERFACES. £1611.00

Triangle Digital Services Ltd.
100a Wood Street, Walthamstow, London E17 3HX
Tel: 01-520-0442 Telex 262284 (Quote REF 775)

CIRCLE 74 FOR FURTHER DETAILS.

Hi-Tech components

HI-TECH COMPONENTS, GILRAY ROAD, DISS, NORFOLK. TEL: 0379 4131

TERMS OF BUSINESS

- ★ All prices exclude V.A.T. and carriage. Please add carriage to order total before adding V.A.T.
- ★ Carriage charges extra on all orders as follows:
  Components £0.75
  Disc drives £4.50
- ★ Strictly cash with order or credit card (Access or VISA) only.
- ★ Delivery is normally from stock but please allow up to 28 days.
- ★ Any query or complaint regarding an order should be made in writing within 7 days of receipt of the order. No telephone queries will be entertained.
- ★ Goods incorrectly ordered cannot be accepted for replacement without our prior agreement. Due to high processing costs, a minimum of 15% handling charge may be levied on any returns or cancelled orders.
- ★ We will issue a full immediate refund, if requested, for out of stock items.
- ★ All items carry full manufacturers warranty.
- ★ A V.A.T. receipt will be supplied with all orders.
- ★ Prices quoted are correct at the time of going to press but we reserve the right to effect changes without prior notice.

6502 FAMILY

6502	3.50
6502A	4.95
6520	2.25
6520A	2.45
6522	3.25
6522A	4.45
6532	5.00
6532A	5.95
6551	5.25

8086 FAMILY

8086	19.50
8088-2	22.50
8216	1.75
8237A-5	23.50
8251A	6.00
8253-5	7.50
8255A-5	5.50
8259A	6.60
8272	35.00
8284A	9.50
80C86	46.65
80C88	46.65
82C52	15.68
82C54	19.04
82C55A2	12.98
82C59A	15.22
82C82	6.26
82C84A	8.94
82C88	16.80

6800 FAMILY

6800	2.50
6802	3.50
6803C	8.40
6809E	6.25
6809P	6.25
6810	1.70
6821	1.70
6840	3.70
6845	7.50
6850	1.70
6862	3.75
6875	8.00
68B00	4.30
68B09	11.00
68B10	1.88
68B21	3.70
68B40	6.60
68B50	2.00
68B54	8.75

Z80 FAMILY

Z80ACPU	2.50
Z80ACTC	2.50
Z80ADMA	7.95
Z80APIO	2.50
Z80ASIO-0	6.20
Z80ASIO-1	7.95
Z80ASIO-2	7.95
Z80BCPU	5.95
Z80BCTC	5.95
Z80BPIO	5.95
Z80BSIO-0	19.95
Z80BSIO-1	19.95
Z80BSIO-2	19.95
Z80SIO-0	6.00
Z80SIO-1	6.00
Z80SIO-2	6.00

MEMORIES — EPROM

2532-300ns	4.95
2532-450ns	3.95
2564-300ns	6.95
2708-450ns	3.95
2716-450ns	3.50
2716-3 RAIL	7.95
2732-350ns	4.95
2732-450ns	4.45
2764-200ns	7.95
2764-250ns	5.15
2764-300ns	4.75
27C64-250ns	10.95
27C64-300ns	10.45
27128-250ns	19.00
27128-300ns	16.00

MEMORIES RAM

4116-150ns	1.30
4116-200ns	1.20
4164-150ns	4.00
4416-200ns	4.70
4532-200ns	2.45
4564-150ns	4.45
8118-100ns	1.95
81256-150ns	25.00
8416-200ns	6.00
8416-LP-200ns	6.40
8417-200ns	6.00
8417-LP-200ns	6.40

MEMORIES — RAM *ZERO POWER ZKXB CMOS*

MK48Z02B-150ns	32.00
MK48Z02B-200ns	24.00
MK48Z02B-250ns	23.00

BIPOLAR PROMS

TBP18S030N	1.54
TBP18SA030	1.38
TBP24S10N	2.06
TBP24S41N	6.68
TBP24S81N	5.50
TBP24SA10N	1.40
TBP24SA41N	4.40
TBP28L22N	3.10
TBP28LA22N	4.14
TBP285166N	19.00
TBP28S42N	4.50
TBP28S46N	4.50
TBP28S86N	5.00
TBP28SA42N	4.50
TBP28SA46N	4.50
TBP28SA86N	8.62
AM27S13PVC	3.74
AM27S19PC	1.92
AM27S191DC	15.00
AM27S25DC	15.00
AM27S29DC	6.46
AM27S35DC	22.00

MEMORIES E2 PROM

X2804AP-300ns	14.95
X2804AP-350ns	13.45
X2804AP-450ns	12.75
X2816AP-300ns	29.95
X2816AP-350ns	25.00
X2816AP-450ns	22.50

0379 4131

LINEAR/INT. DEV.

4702	8.90
HCI-55564-5 (Speech Synthesis)	10.66
AM7910DC	34.88
AM7911DC	34.88
25LS2518PC	3.60
25LS2521PC	3.28
25LS2538PC	2.72
25LS2539PC	2.72
26LS31PC	2.62
26LS32PC	2.62
6402	6.40
75107BN	0.69
75110AN	0.86
75150P	0.86
75154N	1.05
75159	2.30
75160AN	2.60
75161AN	2.82
75162AN	4.08
75172NG	1.96
75173N	1.44
75174	2.82
75175	1.96
75182	0.50
75183	0.50
75188	0.86
75189	0.86
75451BP	0.22
75452BP	0.29
75453BP	0.22
75454BP	0.22
75468N	0.88
75491N	0.31
75492N	0.41
AY-3-1015	3.50
AY-3—1270	9.40
AY-3-8910	4.50
AY-5-3600	8.84
DP8304	4.50
L203	0.99
LF398	3.80
LM301AN	0.30
LM308AN	0.94
LM308N	0.56
LM311N	0.60
LM317MT	0.80
LM317T	1.06
LM319N	1.90
LM324N	0.40
LM337T	1.20
LM339	0.48
LM339N	0.38
LM348N	0.64
LM350T	3.12
LM358N	0.60
LM3900	0.68
LM393N	0.48
LM725CN	2.90
741CP	0.16
LM747CN	0.60
LM748CN	0.30
MC1413P	0.80
MC1416	0.80
MC14411	10.10
MC14412	14.20
MC1458CPI	0.35
MC1495L	6.30
MC1496P	0.70
MC1723P	0.40
MC3242A	6.30
MC3302P	0.48
MC3340P	2.36
MC3357P	1.90
MC3423PL	0.81
MC3441AP	2.90
MC3446AP	2.90
MC3447P	4.30
MC3448A	3.99
MC3470P	6.44
MC3480	7.76
MC3487	1.80
NE555P	0.35
NE556CP	0.42
RO32513-L	9.40
RO32513-U	9.40
TL010-CP	0.44
TL061-CLP	0.28
TL062-CP	0.47
TL064-CN	0.95
TL066-CP	0.28
TL071-CP	0.28
TL072-CP	0.56
TL074-CN	1.10
TL081-CP	0.29
TL082-CP	0.49
TL084-CN	1.02
TL091-CP	0.39
TL092-CP	0.72
TL094-CN	1.30
TL487-CP	0.59
TL489-CP	0.59
TL494-CN	1.99
TL496-CP	0.59
TL507-CP	1.22
ZN450-E	6.08
ZN451-E	7.40
ZN451-KIT	29.95

F.D. CONTROLLERS

FD1771P	30.00
FD1791	15.50
FD1791-02	11.00
FD1793	18.40
FD1793-02	11.00
FD1795	25.00
FD1797	21.00
WD1691	14.00
WD2143	12.00

DATA CONVERTERS

ZN425E-8	3.76
ZN425J-8	8.00
ZN426E-8	1.90
ZN427E-8	6.68
ZN427J-8	12.50
ZN428E-8	5.10
ZN428J-8	9.70
ZN429E-8	1.60
ZN432CJ-10	20.79
ZN432E-10	13.00
ZN433CJ-10	25.00
ZN434	0.98
ZN435	4.38
ZN436E	1.26
ZN440	55.00
ZN441	46.80
ZN447	7.80
ZN448E	6.66
ZN448J	12.48
ZN449	2.72
ZNA134J	22.50
ZNA234E	9.40

VOLTAGE REF.

ZN404	0.50
ZN423	0.98
ZN458	0.92
ZN458A	0.92
ZN458B	1.12
ZNREF 025	1.90
ZNREF 040	1.90
ZNREF 050	1.90
ZNREF 062	1.90
ZNREF 100	3.05

UHF MODULATORS

UM1111	2.95
UM-1233	3.45

VOLTAGE REG.

7805	0.45
7812	0.45
7815	0.45
78H05SC	7.50
78H12ASC	8.95
78HGASC	9.95
78L05	0.30
78L12	0.30
78L15	0.30
78S40DM	7.50
78S40PC	3.00
7905	0.45
7912	0.45
7915	0.45
LM309K	0.95
LM317K	2.45
LN323K	4.95
LM338K	4.50

FAIRCHILD FAST

74F00PC	0.60
74F04PC	0.60
74F08PC	0.65
74F109PC	0.65
74F11PC	0.52
74F138PC	0.52
74F138PC	1.26
74F139PC	1.26
74F151	1.26
74F153	1.26
74F157	1.30
74F158	1.17
74F161	2.34
74F164	1.68
74F175	1.82
74F181	3.90
74F189	5.10
74F190	3.20
74F191	3.20
74F194	1.68
74F20PC	0.52
74F240	3.16
74F241	2.42
74F243	2.80
74F244	2.96
74F245	6.08
74F251	1.26
74F253	1.26
74F257	1.26
74F258	1.34
74F280	1.74
74F283	1.74
74F32PC	0.52
74F352	1.26
74F353	1.26
74F373	3.16
74F374	3.16
74F379	1.83
74F381	6.62
74F382	4.22
74F398	3.16
74F399	2.70
74F521	2.76
74F533	3.16
74F534	3.16
74F537	6.02
74F538	4.38
74F539	4.38
74F64PC	0.52
74F74PC	0.58
74F86PC	0.77

HIGH SPEED CMOS

74HC00N	0.42
74HC04N	0.44
74HC08N	0.42
74HC10N	0.64
74HC132N	1.28
74HC137N	1.81
74HC138N	1.20
74HC139N	0.78
74HC151N	1.16
74HC153N	0.90
74HC157N	1.02
74HC158N	1.02
74HC160N	0.90
74HC161N	0.90
74HC162N	1.51
74HC163N	1.51
74HC164N	0.95
74HC165N	2.24
74HC173N	1.35
74HC174N	0.80
74HC175N	0.78
74HC194N	1.28
74HC195N	1.28
74HC20N	0.40
74HC237N	1.80
74HC240N	1.38
74HC241N	1.34
74HC242N	2.24
74HC243N	2.24
74HC244N	1.32
74HC251N	1.03
74HC253N	1.03
74HC257N	1.03
74HC266N	0.92
74HC273N	2.24
74HC27N	0.80
74HC280N	3.26
74HC32	0.40
74HC373N	2.40
74HC374N	2.40
74HC393N	1.78
74HC4002	0.64
74HC4017	1.16
74HC4020	1.46
74HC4024	1.20
74HC4040	1.46
74HC4060	1.46
74HC4075	0.64
74HC42N	0.90
74HC4511	2.51
74HC4514	3.76
74HC4538	2.36
74HC4543	3.04
74HC51N	0.64
74HC533N	2.40
74HC534N	2.40
74HC589N	1.72
74HC58N	0.64
74HC595N	1.84
74HC597N	1.72
74HC73N	0.84
74HC74N	0.84
74HC75N	0.92
74HC76N	0.64
74HC85N	2.02
74HC86N	0.80
74HCU04N	0.80

TTL

74LS00	0.20
74LS01	0.22
74LS02	0.20
74LS03	0.22
74LS04	0.20
74LS05	0.22
74LS08	0.22
74LS09	0.22
74LS10	0.20
74LS109	0.27
74LS11	0.17
74LS112	0.54
74LS113	0.27
74LS114	0.44
74LS12	0.25
74LS122	0.42
74LS123	0.70
74LS124	2.30
74LS125	0.49
74LS126	0.29
74LS13	0.17
74LS132	0.60
74LS136	0.46
74LS138	0.55
74LS139	0.55
74LS14	0.50
74LS145	1.23
74LS148	1.50
74LS15	0.25
74LS151	0.36
74LS153	0.36
74LS155	0.60
74LS156	0.77
74LS157	0.50
74LS158	0.62
74LS160	0.80
74LS161	0.34
74LS162	0.80
74LS163	0.80
74LS164	1.10
74LS165	0.61
74LS166	1.40
74LS173	1.00
74LS174	0.70
74LS175	0.96
74LS181	2.09
74LS190	0.98
74LS191	0.75
74LS192	0.36
74LS193	1.10
74LS194	0.28
74LS195	0.78
74LS196	1.10
74LS197	1.10
74LS20	0.22
74LS21	0.17
74LS22	0.17
74LS221	0.62
74LS240	1.40
74LS241	0.48
74LS242	1.36
74LS243	1.36
74LS244	1.40
74LS245	1.95
74LS248	0.39
74LS249	1.16
74LS251	0.78
74LS253	0.25
74LS257	0.78
74LS258	0.27
74LS259	0.42
74LS26	0.30
74LS261	2.60
74LS266	0.19
74LS27	0.17
74LS273	1.35
74LS279	0.77
74LS28	0.17
74LS283	1.00
74LS290	0.29
74LS293	0.29
74LS30	0.22
74LS32	0.25
74LS33	0.17
74LS365	0.33
74LS366	0.33
74LS367	0.34
74LS368	0.36
74LS37	0.17
74LS373	1.50
74LS374	0.52
74LS375	0.26
74LS377	0.46
74LS378	1.22
74LS379	1.50
74LS38	0.25
74LS386	0.50
74LS390	1.10
74LS393	0.75
74LS40	0.25
74LS42	0.25
74LS47	0.30
74LS48	0.35
74LS49	0.34
74LS51	0.17
74LS54	0.17
74LS55	0.17
74LS670	2.30
74LS73	0.30
74LS74	0.35
74LS75	0.28
74LS76	0.17
74LS78	0.19
74LS83	0.28
74LS85	0.39
74LS86	0.42
74LS90	0.21
74LS91	1.30
74LS92	0.22
74LS93	0.21
74LS95	0.77

CMOS 4000 Series

4000	0.16
4001	0.15
4002	0.16
4006	0.55
4007	0.16
4008	0.50
4009	0.25
4010	0.25
4011	0.19
4012	0.16
4013	0.29
4014	0.40
4015	0.50
4016	0.29
4017	0.40
4018	0.40
4019	0.30
4020	0.41
4021	0.56
4022	0.42
4023	0.23
4024	0.40
4025	0.16
4026	0.74
4027	0.52
4028	0.34
4031	0.93
4033	2.40
4034	1.00
4035	0.54
4040	0.41
4041	0.36
4042	0.40
4043	0.41
4044	0.43
4045	2.00
4046	0.55
4047	0.50
4048	0.40
4049	0.50
4050	0.29
4051	0.40
4052	0.48
4053	0.50
4054	1.30
4055	0.72
4060	0.50
4063	0.60
4066	0.50
4068	0.16
4069	0.23
4070	0.23
4071	0.23
4072	0.23
4073	0.23
4075	0.46
4076	0.48
4077	0.23
4078	0.25
4081	0.23
4082	0.25
4085	0.66
4086	0.40
4093	0.23
4099	0.50
4502	0.55
4507	0.47
4508	0.96
4510	0.45
4511	0.50
4512	0.40
4514	1.00
4515	1.84
4516	0.45
4518	0.40
4519	0.25
4520	0.64
4521	1.32
4522	0.84
4526	0.52
4527	0.52
4528	0.48
4532	0.68
4541	0.82
4543	0.60
4553	2.00
4555	0.36
4556	0.44
4585	0.48

ZIF SOCKETS

24 PIN	5.70
28 PIN	6.90
40 PIN	8.25

CRYSTALS

1MHz	4.50
1.008MHz	2.70
1.8432MHz	3.50
2.4576MHz	2.00
4MHz	1.25
6MHz	1.30
8MHz	1.25
3.6864MHz	2.00
9.8304MHz	2.75
19.6608MHz	2.50

INSULATION DISPLACEMENT CONNECTOR SYSTEM

HEADERS

	SHROUDED 90°	OPEN 90°	OPEN — STRAIGHT PINS
10 way	0.86	0.65	0.47
14 way	1.22	0.83	0.59
16 way	1.34	0.92	0.65
20 way	1.36	1.13	0.77
26 way	1.70	1.40	0.95
34 way	2.04	1.78	1.19
40 way	2.28	2.07	1.37
50 way	2.70	2.54	1.67
60 way	3.20	3.02	1.96

SOCKETS

10 way	0.88
14 way	1.06
16 way	1.16
20 way	1.38
26 way	1.66
34 way	1.94
40 way	2.08
50 way	2.78
60 way	3.34

DIP PLUGS

14 way	0.92
16 way	1.06
24 way	1.60
40 way	2.40

TRANS. CONNS.

10 way	0.86
16 way	1.17
20 way	1.37
26 way	1.67
34 way	1.87
40 way	2.23

CARD EDGE

10 way	1.84
20 way	3.14
26 way	3.80
34 way	4.90
40 way	5.52
50 way	6.68
60 way	8.06

D-TYPE SOCKETS

9 way	1.47
15 way	2.02
25 way	2.90
37 way	3.97

D-TYPE PLUGS

9 way	1.38
15 way	1.85
25 way	2.52
37 way	3.34

DIP JUMPERS

Single Ended — 24" cable

14 pin	1.73
16 pin	1.90
24 pin	2.73
40 pin	3.96

RIBBON CABLE (PRICED PER FOOT)

	GREY	RAINBOW
9	0.16	0.25
10	0.16	0.25
14	0.21	0.35
15	0.22	0.37
16	0.23	0.39
20	0.28	0.48
25	0.34	0.60
26	0.35	0.62
34	0.45	0.80
40	0.52	0.92
50	0.64	1.14
60	0.76	1.35

CABLE ASSEMBLIES IDC JUMPERS SINGLE ENDED

36" cable	IDC socket
10 way	1.72
14 way	2.07
16 way	2.22
20 way	3.14
26 way	3.75
34 way	3.98
40 way	4.23
50 way	5.36
60 way	6.36

Double Ended

	6" cable	12" cable	18" cable
14	2.74	2.84	2.94
16	3.03	3.14	3.25
24	4.18	4.36	4.55
40	5.89	6.18	6.47

D L SOCKETS

	TIN	GOLD	W/WRAP
8 pin	0.07	0.16	0.36
14 pin	0.09	0.20	0.75
16 pin	0.09	0.21	0.86
18 pin	0.15	0.22	0.96
20 pin	0.19	0.28	1.08
22 pin	0.21	0.32	1.18
24 pin	0.24	0.42	1.28
28 pin	0.26	0.46	1.50
40 pin	0.29	0.66	1.70

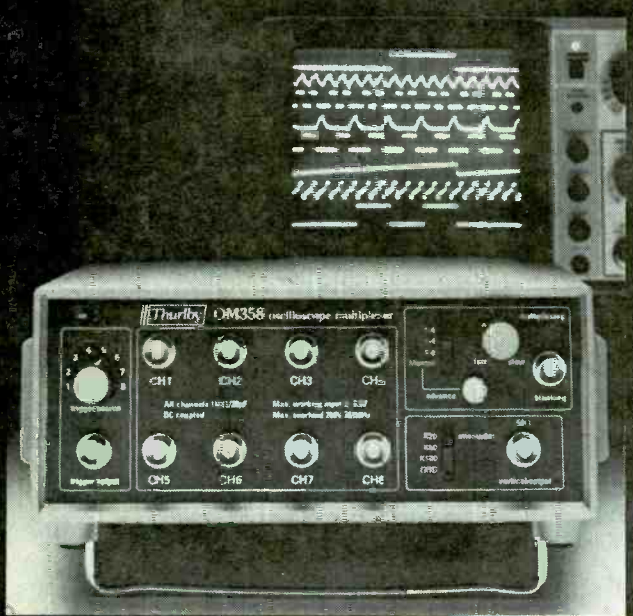
FLOPPY DISC MECHANISMS

FDD2124	Alps 5¼" 40 track single sided	£ 60
MF351	Mitsubishi 3½" 0.5 megabyte 80 track single sided	£100
M4855	Mitsubishi 5¼" 2.0 megabyte 80 track double sided	£170
M4854	Mitsubishi 5¼" 1.6 megabyte (77 track – 8" compatible) double sided	£140
M4853	Mitsubishi 5¼" 1.0 megabyte 80 track double sided	£110
M4851	Mitsubishi 5¼" 0.5 megabyte 40 track double sided	£100
M2896	Mitsubishi 8" 1.6 megabyte 77 track double sided	£310

CIRCLE 77 FOR FURTHER DETAILS.

Add 8 channels to your oscilloscope

New Thurlby OM358 multiplexer £169 + VAT



The new Thurlby OM358 enables any oscilloscope to display 8 channels of information simultaneously.

The OM358 is ideally suited to analysing digital waveforms (in many cases it can be used to solve problems that would otherwise need a high speed logic analyser) but, unlike dedicated logic test equipment, it is equally suited to the display of analogue waveforms.

The ability to simultaneously observe 8 waveforms is an invaluable aid in analysing the complex relationships that exist between signals in today's increasingly sophisticated equipment. Typical application areas include microprocessor based products, data transmission systems, analogue to digital converters, phase locked loops, frequency dividers etc.

The OM358 is a professionally specified instrument with a 3% calibration accuracy and a bandwidth of 35MHz. Each input has an impedance of 1MΩ-20pf and accepts signals up to ± 6V. A mode switch allows an 8 channel, 4 channel or single channel display, and triggering can be selected from any input.

OM358 multiplexer complete with two off BNC cables for connection to oscilloscope £197.80 (incl P + P and V.A.T.)

Thurlby
designed and built in Britain

Full colour data sheet available from
Thurlby Electronics Ltd, New Road, St. Ives, Huntingdon, Cambs. PE17 4BG **Tel: (0480) 63570.**

CIRCLE 62 FOR FURTHER DETAILS.

The world's most advanced low-cost bench multimeter!

Thurlby 1905a £325 + VAT

A complete high performance bench DMM
- 5½ digits; 0.015% acc; 1µV, 1mΩ, 1nA.
- Full ac and current functions as standard

A sophisticated computing and logging DMM
- Linear scaling with offset; null/relative
- Percentage deviation; running average
- dBV, dBm general logarithmic calculations
- Limits comparison; min and max storage
- 100 reading timed data logging
- RS232 and IEEE-488 interface options

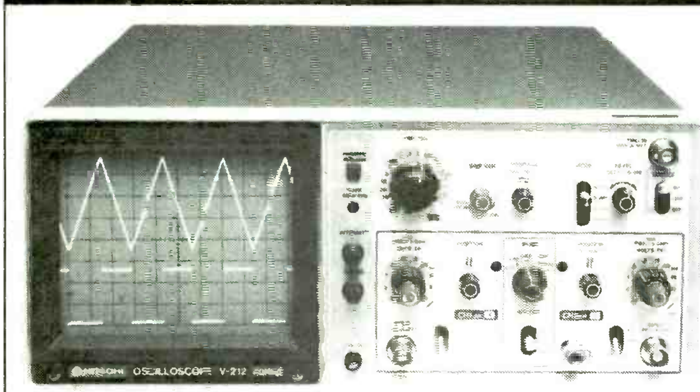
Thurlby Electronics Ltd
New Road, St.Ives, Cambs. PE17 4BG
Tel: (0480) 63570

Thurlby
designed and built in Britain

CIRCLE 63 FOR FURTHER DETAILS.

Hitachi Oscilloscopes

the highest quality the most competitive prices from £299 + VAT



Hitachi Oscilloscopes provide the quality and performance that you'd expect from such a famous name, with a newly-extended range that represents the best value for money available anywhere.

V-212	20MHz Dual Trace (illustrated)	V-209	20MHz Mini-Portable
V-222	20MHz Dual Trace	V-509	50MHz Mini-Portable
V-203F	20MHz Sweep Delay	V-1050F	100MHz Quad Trace
V-353F	35MHz Sweep Delay	V-1100	100MHz DMM/counter
V-422	40MHz Dual Trace	V-134	10MHz Tube Storage
V-650F	60MHz Dual Timebase	VC-6015	10MHz Digital Storage
		VC-6041	40MHz Digital Storage

Prices start at £299 plus vat (model illustrated) including a 2 year warranty. We hold the complete range in stock for immediate delivery.

For colour brochure giving specifications and prices ring **(0480) 63570**
Thurlby-Reltech, 46 High Street, Solihull, W. Midlands, B91 3TB

CIRCLE 64 FOR FURTHER DETAILS.

British invention, innovation and electronics

by R.E. Young. B.Sc. (Eng.), F.I.E.E., M.R.Ae.S.

This series is designed to show that Britain — with her unique technological strengths built up over the years — is as capable as ever of making contributions in these fields at the global level; and is doing so.

Some thirty years ago, Great Britain seemed poised to leap ahead in a technological world centred on electronics and electronically-based systems and techniques. Much of the lead that this country possessed came out of the developments of World War II, notably from radar [1] and — equally important — from parallel peacetime work on UK high-definition television [2].

A comparable position had also been reached with British computers by this time; and this is examined in more detail in later articles. Suffice to say at this stage that the world's first stored-program digital computer (program and data held in the same store) — first operated successfully in Manchester University in June, 1948.

This series is intended to show that Britain — with her unique technological strengths built up over the years — is as capable as ever of making contributions in these fields at this global level; and is, in fact, doing so.

This is, of course, in direct conflict with the adverse criticism which has been voiced in recent years, especially with regard to Britain's alleged failure to keep up with modern technological developments, not only in the high technology of electronics, but also in their application to the older, traditional industries. The key word here is developments — most critics agree that the British are still a nation of inventors, but that their record for bringing their new ideas to fruition is increasingly open to question.

Exceptions to this reading of the situation will immediately spring to mind, one of the most outstanding being British computer-based process and similar control. Other major examples are to be found in aerospace and over the full range of medical electronics.

Nevertheless, it has to be accepted that since the late 1950s, a significant number of projects, potentially of world standing, have not reached their target. In extreme cases they have been abandoned; in others the project time scale has become so extended and the overall cost so high that the further development, which it would have been uneconomic to have carried out, has been completely blocked.

The unsuccessful project is not by any means confined to the British.

However, although the declared aim of this series is to give a considered account of the positive contribution that the UK can make to technology, it is just a vital to safeguard these contributions by indicating where "It can go wrong" as, for example, when the impression is given, falsely, of drive and impetus having been lost.

Education — the concealed but crucial factor

Thus part of this first article will consist of a short review of the changes that have taken place in education in Britain over the period in question, and which have affected engineering policy, 'engineering' being taken in its widest sense.

With the amount of public comment and debate which has been devoted to higher education in Britain it has been possible to see how attitudes to technology have been reflected in the educational field. Perhaps the most significant instance of this is that the Robbins Report, with its far-reaching recommendations, was first published in 1963, i.e. at the beginning of the period.

The Robbins Report, basically concerned with the provision of graduate education in the UK, called for an unprecedented increase in the places available in universities and polytechnics. This expansion was to be achieved by literally increasing the numbers of both; the former objective being attained largely by bringing the old Colleges of Advanced Technology to University status, and the latter involved the setting-up of 30 new polytechnics.

The Robbins Report and its implications have continued to receive attention in a number of connections, particularly with regard to the demand which developed following the Report to reduce specialization in degree courses. As recently as May 8th, 1984 two letters in *The Times* clearly advocated a change away from "our over-specialized and over-academic upper secondary and higher education."

Possible consequences, such as 'dilution' and inadequate course duration (two years proposed for the initial undergraduate course) are clear; but in general academics in the UK seem to have agreed that there were advantages in pursuing the proposals, and that the implied "mass attack" principle was acceptable.

Distribution of UK National Inventive Capacity

Electronics and electronically-based systems engineering

	Individual inventor	Independent small team	large industrial company	University department	Government establishment
Initial personnel	Typically inventor joined later by one or more associates, often no formal arrangement	often 'known' already; otherwise recruited on a highly selective basis.	Usually available within the company, may be recruited from outside if entirely new type of project	Probably 'mix' of staff (at appropriate levels) and selected Post-graduate students	From this and other Government Establishments; secondment often determined during initial planning.
'start-up' development resources	'Domestic' facilities e.g. in garage	Often combination of laboratory and model-shop facilities	Area and equipment made available in existing buildings	Separtated areas and equipment, some shared with other departments	Probably wide-ranging facilities already available
Project commencement	Depends on establishing contacts; some form of demonstration essential	Backing, organisation assumed; forward planning for at least a year aimed at obtaining contracts	Coordinate where possible with other activities of company for economic use of resources	Determine with sponsors (assumed) ratio of academic involvement allowed relative to their work	Project control organization brought into action for coordination and liaison
Project support assurance	Demands firm interest by outside organisation including local industry	Consolidation and extension of range of contracts	Subject to usual commercial hazards, guaranteed by form of contract	Virtual guarantee exists in academic base	For maximum effectiveness, especially with staff, future should be secure

Fig. 1 **Distribution of UK national inventive capacity**

More recently they have been able to cite Japan as well as the United States and France as providing this kind of two-year course.

In contrast, the outcome of the Robbins Report has been somewhat different for UK engineering and invention. The two major issues which have arisen lie in two areas.

'H.N.C.' In the past Higher National Certificate, with its specialist endorsements, had provided a route to Chartered Engineer status through a combination of part-time study and 'real job' working. This represented an element in the technical education which has been described as being the envy of the world.

In fact the H.N.C. — superficially 'down' in academic content — has been seen to provide a unique form of *broad* technical education which has served the country well in the past. Surprising though it may seem, this has applied with special force to engineering research and development, where much of the actual innovative contribution to the 'small team' approach came from H.N.C. members, particularly where systems engineering was concerned. Also the H.N.C. approach provides a reference base for broad technical (engineering) education. There are, of course, other ways of achieving such education. One proposal — already tried out quite comprehensively — is to introduce advanced graduate-apprenticeship-type schemes as a main part of career structures, enabling innovative ability to be recognized and built up under real-life conditions.

Early education and technological thinking.

Similar but less noticeable changes have appeared over this period in conventional education in the UK where the trend has been to reduce the attention given to basic subjects ('the 3 Rs' in English parlance). That the effect of these changes should enter into later life — particularly where engineering is concerned — may seem unlikely. Nevertheless, analysis shows that what can be regarded as a change in policy has had repercussions extending over the whole range of technological thinking.

As will be shown in this and subsequent atticles, these basic subjects become, if anything, increasingly vital with progress up the career ladder, and with the corresponding demands placed on technical grasp. Thus, representative examples of this spread can be quoted in terms of the ability to write *clear* unambiguous English. In the ultimate, this ability can make all the difference between a patent application being accepted or being rejected, or between success and failure in bringing an invention (or any new equipment for that matter) into production, where the hand-over between development and the manufacturing side must be complete. This aspect is examined in more detail later, especially with regard to maintaining continuity of design during this critical, and often lengthy, transfer.

The need for precise English almost certainly becomes most apparent in the preparation of software. This need remains, in fact, until any computer-based scheme is completed; and as seen in the production of the 'system facilities statement' and in the design and development into which it leads and which is consequent upon it [3].

It is, however, in the process of 'setting to work' that one fully realises how necessary it is to go back to first principles whenever an obscure (effectively intangible) problem arises; and how clear it becomes that these principles and the way of thinking that goes with them have been absorbed during early education.

Examples which can be quoted

in this general connection include the radar installation which appears to be working, and yet is actually 'blind', and the large control complex where a fault on a critical piece of instrumentation is literally hidden by its failure to provide information [4] — and can lead to a complete system breakdown.

Workers in this and comparable fields will be well aware that in these cases the solution is usually simple in the extreme; but they will be equally aware that the process of reaching that solution is not only long and involved, but is almost invariably underestimated. In summarizing, it has to be stated that one cannot put staff of too high a calibre on clearing troubles at this level and the parallel with systems R and D is almost total; while 'sub-inventions', for instance, will be generated as spin-off from the primary investigations.

The inventor, the team and 'high technology'

While still at school, the writer was privileged to see the inventor's model of a mechanical system for removing impurities from brick clay; and made before electronics had taken over. The equivalent of a low-speed centrifuge was represented by concentric circles drawn on paper covering a table top. From there on, however, the model was a scale replica of the final scheme. With much of the operating mechanism made from black strip iron, including the 'signal-box' type controls, the final assembly was a tribute to the friend who had built it from the inventor's design. The large brick-making company for which they both worked provided the greater part of the favourable circumstances and environment which are so necessary for the inventor to have; and which are set out in the 'individual inventor' column of the distribution table.

In this instance, the company — providing a connected employment base and potential interest — had pioneered new techniques in the industry, notably in electrification; and formed part of that type of diversified engineering area which seems to favour British invention and original thinking generally.

In the present instance, the area was that of Peterborough where Sir Henry Royce was an apprentice in "the (then) Great Northern Railway Works" [5]. Here he gained an insight into classical engineering and the "painstaking workmanship" it requires, and in the climate mentioned above. It is felt to be more than apposite to quote the example of Sir Henry Royce in the present context. His technological flexibility in moving from mechanical, through electrical, to automobile and earonautical engineering, combined with his technical insight, match up to all the demands of 'high technology'.

The career and technological achievements of Sir Henry Royce are well documented. Outstandingly he was 'there' when high technology, defined as advanced engineering permeated by electronics, took its shape in Great Britain. The developments of this time are seen, for example, in World War II, when radar became an integral part of aircraft operation.

In this and in a wider connection, the use of 'high technology'; as with R and D, is inescapable; but unfortunate in that both these terms fail to convey anything like the breadth of the fields they cover. Also, and particularly in the UK, high technology is all but synonymous with the silicon chip, and, with this, as only having appeared some two years ago; and there is no doubt that this view has added indirectly but significantly to forming the criticism of British ability to bring ideas to fruition.

To give perspective, it is possible to quote an article [6] published in the first, October 1962, issue of *Industrial Electronics* on 'Microminiaturization in Electronics' which could almost be a 1984 description of the chip and its manufacture — "to produce active and passive components in a silicon block" (the word 'chip' came later)".

In the light of the opening to this series this original publication is of special significance, not least that it marks the firm establishment of 'big-system' control in the UK: the cover picture shows the assembly on site of a mainframe computer used for process and similar control. There is no need to stress the date — but in view of the criticism of the post-1970 period, it is worth recording that British computer based control systems continue to hold their place internationally.

As a more general and broad picture, it may be pointed out that Britain had built up a major presence in this technology at the beginning of this decade. A UK newspaper report (September 15, 1980) can be quoted with regard to the basic manufacture of "semi-conductor processing equipment" in the Bristol area, when it was said that "Much of their products are exported to the main chip-making centres in Japan and the US".

'Cluster' areas

This somewhat cryptic heading covers areas exemplfied by Bristol and Peterborough, where a number of diversified, adaptable, industries are grouped together to produce a powerful cluster with wide-ranging technological facilities and experience; and providing that climate so necessary for the inventor and for innovation generally.

Such areas can be seen to have existed, e.g. in the Midlands and in the North of England, for many years; and, within the experience of many, can be identified even in the smaller centres of population in the country. All have the key feature of adaptability and the ability to move into new technology which can almost be called a national characteristic.

Instances of this have already, in effect, been given, as for example, with the computer work in Manchester with its heritage of the original innovative cotton (and other) industries of the Industrial Revolution.

A justifiable digression here is that when the new electronic and instrument industries moved into the erstwhile cotton mills of the North West, they found ample evidence of the existance of flowline and other modern production techniques in the buildings they

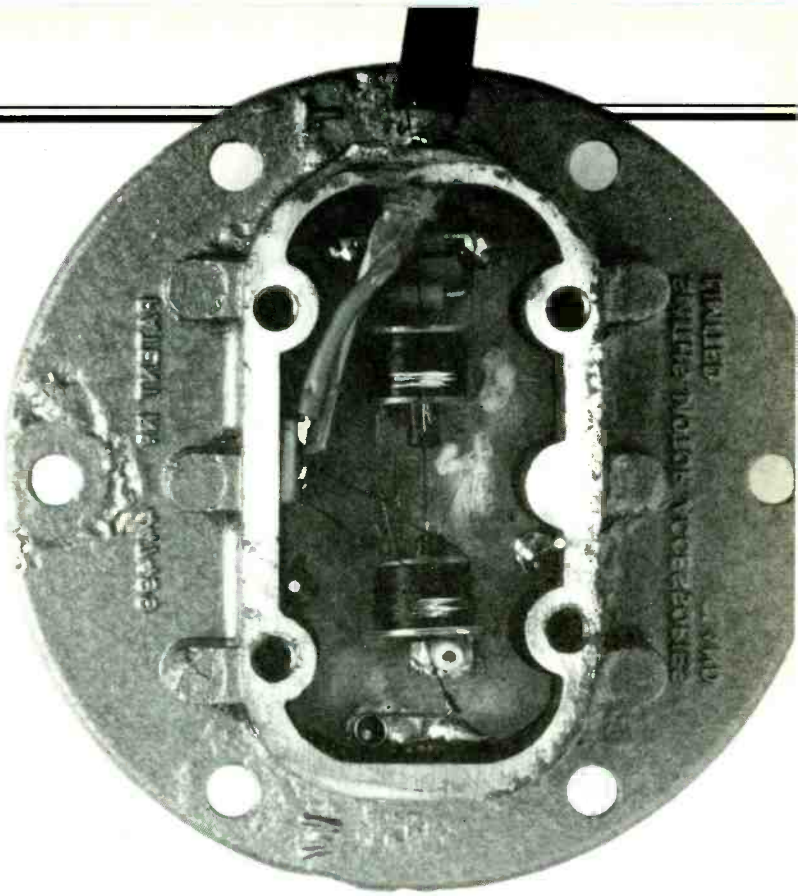


Fig.2 **Frequency output transducer — Electromechanical assembly mounted in standard 2 in (5 cm) case**

had taken over.

Reverting to the pure electronics semiconductor, processing equipment made in Bristol, it is not invidious in the present context to point out that the work carried out in this area on the Anglo-French Concorde airliner is representative of the capabilities of this cluster.

The joint achievement of the two national teams in evolving this unique *successful* supersonic aircraft will be used in a later article to bring out the complexity of such systems engineering. Contrary to virtually all stated opinion, it will be submitted that this project was kept under remarkable R and D management control, with false trail and other sources of development crisis peaks contained.

One of the main elements in the back-up potential of these areas is obviously suitable skilled labour; and it has to be admitted that increasing numbers of announcements of shortages of such labour in the UK represent a threat to any future expansion. However, it is possible to give a specific example showing that these skills are still not far below the surface. The frequency-output transducer in the photograph was built earlier this year by an ex-Polytechnic student working, in this instance, under conditions corresponding with those of the graduate-apprentice type of scheme mentioned earlier. The craftmanship who have contributed much more than is usually realised to British engineering; and who have constituted one of the country's hidden strengths.

Inventive observation and analysis

To complete this extremely brief survey of British inventive capability, two widely separated case histories will be given which show how native talent for inventive observation and analysis can be fostered and brought into coordinated R and D.

The first example is taken from the aerospace/electronics world with a piece of test equipment centred on a calibrated measurement display. As originally envisaged, the calibration facility was to be provided as an electronic graticule with its spaced horizontal lines representing specified measurement ordinates. At the first planning meeting, following closely on initial briefing, the suggestion was made that the graticule should be replaced by a single calibration line which could be selected from a stepped set of chosen frequencies or be made continuously variable. This suggestion — although it demanded no basic changes to the original concept — went far to transforming the whole project, not least with regard to the facility it gave for clear 'At-a-glance' reading [3]. A consequent advantage was that the speed of development was increased markedly with the more definite — simplified — design criteria which came out of the change, and which applied to most of the sub-system modules.

That it proved possible to improve project flow in this and other ways owed much to the coordinated team attitude, with its full interchange, adopted almost automatically by the six engineers concerned. It may be noted that their technical qualifications were H.N.C. or the equivalent; and that their experience of manufacturing methods and techniques contributed in great measure to the process of finalizing the product as development proceeded.

In comparison with the first example, the case history for the second may appear mundane at first sight in that it can be summed up as being the clearance of a fault, actually put on in manufacture. The steps leading up to its clearance, however, cannot be dismissed in this manner, following as they did the long and involved pattern described earlier; and where suspicion of trouble is more a matter of intuitive awareness than of 'solid' detection.

In this instance, slightly high standing-wave ratios on the open wire feeders of a multi-element radar aerial array were eventually traced to incorrect connection — in phase — of one pair of dipoles out of a total of sixteen, arranged in four stacks of four. With horizontal polarization, it will be appreciated that it was extremely difficult to pick up the mis-connection on the individual vertical stack feeder by visual inspection, with fifteen out of sixteen being correct.

In the event, and bearing in mind all the possible explanations of high standing-wave ratio, especially when small, it was clearly necessary to bring in some independent check method [3], which could be relied on to eliminate or preferably confirm one of the unknowns. That the latter was made possible by an ingenious adaptation of the radar set itself to display the aerial radiation polar diagram on the (plan position indicator), with the bearing known and the amplitude of the radial time base made proportional to radiated signal. Bringing in this method showed that 'kinks' did indeed exist in the polar diagram; and the clearance of that fault became a matter of visual checking of the array.

This example is of interest in its own right; but is quoted with this amount of detail to show how the experience and know-how built up during World War II is still relevant in today's thinking.

First of all, this testing method, with all the neatness of a good invention, had been evolved in a small station in the national radar network. That the circumstances existed for this to take place, and for the information to be made available throughout the network, was a tribute to the flexible management attitude adopted both at immediate and at upper levels of authority. This formed part of a unified national effort concentrated on radar, typically British, with much of the coordination and organization developing almost automatically. It would appear that the bringing together of technological effort on this scale has not really been seen in the UK since that time; but there are grounds for suggesting that — as with the instrument making quoted earlier — the potential is even now not far below the surface.

The other main aspect is that the *basic* methods of gathering evidence and data generally, which were developed at that time, do not have to be rediscovered, and are being, and will continue to be, applied in the future. For instance, the gathering and sifting of technological anecdotal evidence developed in analysing obscure radar faults, have been applied to Human Communications. This forms the subject of a later article in this series, and has been generously described as a new discipline by accepted authorities.

Further articles in this series are as follows:

- *Radar and television-interchange and spin-off*
- *Aerospace*
- *R and D management and economics*
- *'Big-system' automation and telemetry*
- *Vehicle instrumentation*
- *Human communications*
- *The future*

References

1. CROWTHER, J.G. and WHIDDINGTON, R.: Science at War, His Majesty's Stationery Office, London 1947
2. YOUNG, R.E.: Radar and Television — Interchange and Spin-Off, *Wireless World*, to be published.
3. YOUNG, R.E.: Control in Hazardous Environments, Peter Peregrinus, Stevenage 1982
4. YOUNG, R.E.: Crisis Control, *Wireless World*, June and July 1982
5. NOCKOLDS, H.: The Magic of a Name, G.T. Foulis & Co. Ltd., London 1949
6. JEFFRIES, P.: Microminiaturization in Electronics, *Industrial Electronics*, Vol. 1 no. 1 October 1962

PHONE 0474 813225 3 LINES

P. M. COMPONENTS LTD

SELECTRON HOUSE, WROTHAM ROAD MEOPHAM GREEN, MEOPHAM, KENT DA13 0QY

TELEX 966371 PM COMP

INTEGRATED CIRCUITS

AN124	2.50
AN214Q	2.50
AN240P	2.80
AN612	2.15
AN7140	3.50
AN7145	3.50
AN7150	2.95
BA521	3.35
CA1352E	1.75
CA3086	0.46
CA3123E	1.50
ETT6016	2.50
HA1377	3.50
HA1156W	1.50
HA1339A	2.95
HA1551	2.95
LA1230	1.15
LA4031P	1.95
LA4102	2.95
LA4140	2.95
LA4250	2.95
LA4400	4.15
LA4420	1.95
LA4422	2.50
LA4430	2.50
LA4461	3.95
LC7120	3.25
LC7130	3.50
LC7131	5.50
LC7137	5.50
LM324N	0.45
LM380N8	1.50
LM380N14	1.75
LM383T	2.95
M51513L	2.30
M51515L	2.95
M51521L	1.50
MB3712	2.00
MC1307P	1.00
MC1310P	1.50
MC1327	0.95
MC1327Q	0.95
MC1330P	1.10
MC1349P	1.20
MC1351P	1.50
MC1351P	1.50
MC1357	2.35
MC1358	1.58
MC1495	3.00
MC1496	1.25
MC145106P	7.95
MC1723	0.50
MC3357	2.75
ML231B	1.75
ML232B	2.50
MSM5807	8.75
PLL02A	5.75
SAA500A	3.50
SAA1025	7.25
SAA5010	6.35
SAS560S	1.75
SAS570S	1.75
SAS580	2.85
SL901B	4.85
SL917B	6.65
SL1310	1.80
SL1327	1.10
SL1327Q	1.10
SN76003N	1.95
SN76013N	1.95
SN76023N	2.75
SN76033N	1.95
SN76110N	0.89
SN76115N	1.25
SN76131N	1.30
SN76226DN	2.95
SN76227N	1.05
SN76533N	1.65
SN76544N	2.65
SN76570N	1.00
SN76650N	1.15
SN76660N	0.80
STK014	7.95
STK015	5.95
STK043	9.50
STK415	7.95
STK433	5.95
STK435	7.95
STK437	7.95
STK439	7.95
STK461	11.50
TA7061AP	3.95
TA7108P	1.50
TA7120P	1.65
TA7130P	1.50
TA7146	3.95
TA7176AP	2.95
TA7203	2.95
TA7204P	2.15
TA7205AP	1.15
TA7222AP	1.80
TA7227P	4.25
TA7310P	1.80
TA7313AP	2.95
TA7321P	2.25
TA7609P	3.95
TA7611AP	2.95
TAA550	0.25
TAA570	1.95
TAA661B	1.20
TAA700	1.70
TBA120AS/B/C/SA/SB/T/U	1.00
TBA231	1.25
TBA395	1.50
TBA396	0.75
TBA440N	2.55
TBA480Q	1.25
TBA510	2.50
TBA510Q	2.50
TBA520	1.10
TBA520Q	1.10
TBA530	1.10
TBA530Q	1.10
TBA540	1.25
TBA540Q	1.35
TBA550Q	1.95
TBA560C	1.45
TBA560C	1.45
TBA560CQ	1.45
TBA570	1.00
TBA641A12	2.50
TBA651R	2.50
TBA720A	2.45
TBA750Q	2.65
TBA800	0.89
TBA810AS	1.65
TBA810P	1.65
TBA820M	0.75
TBA820Q	1.45
TBA890	2.50
TBA920	1.65
TBA950/2X	2.35
TBA990	1.49
TCA270	1.10
TCA270SQ	1.10
TCA650	2.50
TCA940	1.65
TDA440	2.20
TDA1001	1.95
TDA1004A	3.25
TDA1006A	2.50
TDA1010	2.15
TDA1035	2.50
TDA1037	1.95
TDA1170	1.95
TDA1190	2.15
TDA1270Q	3.95
TDA1327	1.70
TDA2002	1.95
TDA2020	2.95
TDA2030	2.80
TDA2522	1.95
TDA2523	2.95
TDA2524	1.95
TDA2530	1.95
TDA2532	1.95
TDA2540	1.95
TDA2541	2.15
TDA2560	2.15
TDA2571	2.95
TDA2581	2.25
TDA2593	2.95
TDA2600	5.50
TDA2610	2.50
TDA2611A	1.95
TDA2640	3.50
TDA2680A	2.75
TDA2690	2.45
TDA3310	2.95
TDA3560	5.50
UPC566H	2.95
UPC575C2	2.75
UPC1025H	1.95
UPC1028H	1.95
UPC1032H	1.50
UPC1156H	2.75
UPC1158H	0.75
UPC1167C2	1.15
UPC1181H	1.25
UPC1182H	2.95
UPC1185H	3.95
UPC1191V	1.50
UPC1350C	2.95
UPC1353C	2.45
UPC1365C	3.95
UPC2002H	1.95
555	0.35
556	0.42
723	0.50
741	0.35
747	0.50
748	0.35
7805	0.65
7808	0.60
7815	0.65

SEMICONDUCTORS

AAY12	0.25
AC126	0.45
AC127	0.20
AC128	0.28
AC128K	0.32
AC141	0.28
AC141K	0.34
AC142K	0.30
AC176	0.22
AC176K	0.31
AC187	0.25
AC187K	0.28
AC188	0.25
AC188K	0.37
AD142	0.79
AD143	0.82
AD149	0.70
AD161	0.39
AD162	0.39
AD161/2	0.90
AF106	0.50
AF114	1.95
AF121	0.60
AF124	0.65
AF125	0.35
AF126	0.32
AF127	0.65
AF139	0.40
AF150	0.60
AF178	1.95
AF239	0.42
AU106	4.50
AU107	3.50
AU110	3.12
BC107A	0.11
BC107B	0.11
BC108	0.10
BC108A	0.11
BC108B	0.12
BC109	0.10
BC109B	0.12
BC109C	0.12
BC114	0.11
BC116A	0.15
BC117	0.19
BC119	0.24
BC125	0.25
BC139	0.20
BC140	0.31
BC141	0.25
BC142	0.21
BC143	0.24
BC147A	0.09
BC147B	0.09
BC148A	0.09
BC148B	0.09
BC149	0.09
BC157	0.12
BC158	0.09
BC159	0.09
BC160	0.28
BC161	0.28
BC170B	0.15
BC171	0.09
BC171A	0.10
BC171B	0.10
BC172	0.10
BC172B	0.10
BC172C	0.10
BC173B	0.10
BC174	0.09
BC174A	0.09
BC177	0.15
BC178	0.15
BC182	0.10
BC182LB	0.10
BC183	0.10
BC183L	0.09
BC184LB	0.09
BC204	0.10
BC207B	0.13
BC208B	0.13
BC212	0.09
BC212L	0.09
BC212LA	0.09
BC213	0.09
BC213L	0.09
BC214	0.09
BC214C	0.09
BC214L	0.09
BC237B	0.09
BC238	0.09
BC239	0.12
BC251A	0.12
BC252A	0.15
BC258	0.25
BC258A	0.39
BC284	0.30
BC300	0.30
BC301	0.30
BC303	0.26
BC307B	0.09
BC327	0.10
BC328	0.10
BC337	0.10
BC338	0.09
BC347A	0.13
BC461	0.35
BC478	0.20
BC527	0.20
BC547	0.10
BC548	0.10
BC549A	0.10
BC550	0.14
BC557	0.08
BC557B	0.08
BC558	0.10
BCY33A	1.60
BD115	0.30
BD116	0.60
BD124P	0.59
BD131	0.42
BD132	0.42
BD133	0.40
BD135	0.30
BD136	0.30
BD137	0.32
BD138	0.30
BD139	0.32
BDD140	0.30
BD144	1.10
BD150C	0.29
BD159	0.65
BD160	1.50
BD166	0.55
BD179	0.72
BD182	0.70
BD201	0.83
BD202	0.65
BD203	0.78
BD204	0.70
BD222	0.46
BD223	0.59
BD225	0.48
BC232	0.35
BD233	0.35
BD234	0.35
BD236	0.49
BD237	0.40
BD238	0.40
BD242	0.65
BD246	0.75
BD376	0.32
BD410	0.65
BD434	0.65
BD437	0.75
BD438	0.75
BD520	0.65
BD538	0.65
BD597	0.95
BD701	1.25
BD702	1.25
BD707	0.90
BDX32	1.50
BDY57	1.65
BF115	0.35
BF119	0.65
BF127	0.39
BF154	0.20
BF158	0.22
BF160	0.27
BF167	0.27
BF173	0.22
BF177	0.38
BF178	0.26
BF179	0.34
BF180	0.29
BF181	0.29
BF182	0.29
BF183	0.29
BF184	0.28
BF185	0.28
BF194	0.11
BF195	0.11
BF196	0.11
BF197	0.11
BF198	0.16
BF199	0.14
BF200	0.40
BF241	0.15
BF245	0.30
BF259	0.28
BF257	0.28
BF258	0.28
BF259	0.28
BF271	0.26
BF273	0.18
BF336	0.34
BF337	0.29
BF338	0.32
BF355	0.37
BF362	0.38
BF363	0.65
BF371	0.25
BF394	0.19
BF422	0.32
BF457	0.32
BF458	0.36
BF459	0.36
BF467	0.68
BF595	0.23
BF597	0.25
BFR39	0.23
BFR40	0.23
BFR81	0.25
BFR88	0.30
BFR90	1.50
BFR91	1.75
BFT42	0.35
BFT43	0.35
BFW92	0.85
BFX29	0.30
BFX84	0.26
BFX85	0.32
BFX86	0.30
BFX88	0.25
BFY50	0.21
BFY51	0.21
BFY52	0.25
BFY90	0.77
BLY48	1.75
BR100	0.26
BR101	0.49
BR103	0.55
BRC4443	1.15
BT100A/02	0.85
BT106	1.49
BT116	1.20
BT119	3.15
BT120	1.65
BU105	1.95
BU108	1.69
BU124	1.25
BU125	1.25
BU126	1.60
BU204	1.55
BU205	1.30
BU208	1.39
BU208A	1.52
BU208D	1.85
BU326	1.20
BU407	1.24
BU500	2.25
BU526	1.90
BU80Y	2.25
BUY69B	1.70
MJ3000	1.98
MJE340	0.40
MJE520	0.48
MPSA13	0.29
MPSA92	0.30
MRF237	3.45
MRF450A	12.50
MRF453	17.50
MRF454	23.50
MRF455	17.50
MRF475	2.50
MRF477	10.00
OC16W	2.50
OC23	1.50
OC42	0.75
OC44	0.75
OC45	0.55
OC70	0.45
OC71	0.55
OC81	0.50
R2008B	1.45
R2010B	1.45
R2322	0.58
R2323	0.66
R2540	2.48
RCA16334	0.90
RCA16335	0.80
SKE5F	1.45
TIP29	0.40
TIP29C	0.42
TIP30C	0.43
TIP31C	0.55
TIP32C	0.42
TIP33B	0.95
TIP34B	0.95
TIP41A	0.45
TIP41C	0.45
TIP42C	0.47
TIP47	0.65
TIP120	0.60
TIP125	0.65
TIP142	1.75
TIP161	2.95
TIP2955	0.80
TIP3055	0.55
TIS91	0.20
TV106/2	1.50
2N2219	0.28
2N2905	0.40
2N3053	0.40
2N3054	0.59
2N3055	0.52
2N3702	0.12
2N3703	0.12
2N3704	0.12
2N3075	0.12
2N3706	0.12
2M3708	0.12
2N3733	9.50
2N3773	2.75
2N3792	1.35
2N4427	1.95
2N4444	1.15
2N5294	0.42
2N5296	0.48
2N5298	0.60
2N5496	0.95
2SA715	0.60
2SC495	0.80
2SC496	0.80
2SC1096	0.80
2SC1106	2.50
2SC1172Y	2.20
2SC1173	1.15
2SC1306	1.00
2SC1307	1.50
2SC1364	0.50
2SC1449	0.80
2SC1678	1.25
2SC1909	1.45
2SC1945	2.65
2SC1953	0.95
2SC1957	0.80
2SC1969	1.95
2SC2028	1.15
2SC2029	1.95
2SC2078	1.45
2SC2091	0.85
2SC2098	2.95
2SC2166	1.95
2SC2314	0.80
2SC2371	0.36
2SD234	0.50
3N211	1.95
3SK88	0.55

DIODES

AA119	0.08
BA115	0.13
BA145	0.16
BA148	0.17
BA154	0.06
BA156	0.15
BA157	0.30
BAX13	0.04
BAX16	0.06
BB105B	0.30
BT151	0.79
BY126	0.10
BY127	0.11
BY133	0.15
BY164	0.45
BY176	1.20
BY179	0.63
BT182	0.55
BY184	0.35
BY199	0.40
BY206	0.14
BY208-800	0.33
BY210-800	0.33
BY223	0.90
BY298-400	0.22
BY299-800	0.22
BYX10	0.20
BYX36-150R	0.20
BYX38-600R	0.60
BYX55-600	0.30
BYX71-600	1.10
BZY95C30	0.35
CS4B	4.50
CS10B	8.45
OA47	0.09
OA90	0.05
OA91	0.06
OA95	0.06
OA202	0.10
IN21DR	5.00
IN23B	5.00
IN23C	5.00
IN23ER	5.00
IN23WE	5.00
IN4001	0.04
IN4003	0.04
IN4004	0.05
IN4005	0.05
IN4007	0.06
IN4148	0.02
IN4448	0.10
IN5401	0.12
IN5402	0.14
IN5403	0.12
IN5406	0.13
IN5407	0.16
IN5408	0.16
ITT44	0.04
ITT923	0.15
ITT2002	0.10

ZENER DIODES

BZX61 Series	0.15
BZY88 Series	0.10

LINE OUTPUT TRANSFORMERS

DECCA 100	7.95
DECCA 1700 MONO	9.95
DECCA 1730	8.95
DECCA 2230	8.25
GEC 2040	8.95
GRUNDIG 1500	15.45
GRUNDIG 5010-6010, 2222.5011-6011	13.45
ITT CVC20	8.20
ITT CVC30	8.25
PHILIPS G8	8.50
PHILIPS G9	8.99
PHILIPS G11	13.39
PYE 725	10.95
RBM T20A	12.40
TANDBERGE 90°	11.15
TELEFUNKEN 711A	11.15
THORN 1590	9.50
THORN 8000	9.20
THORN 9000	9.95
THORN 9800	22.40
THORN MAIN TRANSFORMER 3000/3500	9.70

EHT MULTIPLIERS

ITT CVC20	6.35
ITT CVC30	6.35
PHILIPS G8 550	6.96
RANK T20A	6.91
THORN 3000/3500	7.57
THORN 8500	5.80
THORN 9000	8.00
UNIVERSAL TRIPLER	5.45

REPLACEMENT ELECTROLYTIC CAPACITORS

DECCA 30 (400-400/350V)	2.85
DECCA 80/100 (400/350V)	2.99
DECCA 1700 (200-200-400-350V)	3.55
GEC 2110 (600/300V)	2.25
ITT CVC20 (200/400V)	1.80
PHILIPS G8 (600/300V)	2.25
PHILIPS G9 (2200/63V)	1.19
PHILIPS G11 (470/250V)	2.35

NEW BRANDED CATHODE RAY TUBES

PLEASE ALLOW ADDITIONAL £3 PER TUBE FOR CARRIAGE.

A1865/20	65.00
AW36.11	25.00
CME822W	19.00
CME822GH	25.00
CME1428GH	45.00
CME1428W	39.00
CME1523GA	39.00
CME1523W	39.00
CME1431GH	39.00
CME1431W	39.00
CME202GH	45.00
CME2024W	45.00
CME2325W	45.00
CME3126GH	45.00
CME3128GH	45.00
CME3128W	45.00
CME3132GH	45.00
CME3155W	45.00
CRE1400	25.00
CV429	89.00
CV1450	35.00
CV1526	19.00
CV2185	15.00
CV2191	19.00
CV2193	15.00
CV5119	85.00
CV5320	85.00
CVX389	55.00
D9-110GH	39.50
D9-120	45.00
D10-210GH	45.00
D10-210GH68B	65.00
D10-210GH72	65.00
D10-230GH	35.00
D10-230GM	35.00
D10-293GY/90	55.00
D13-30GH	49.50
D13-33GM	49.00
D13-47GH/26	55.00
D13-47GH/34	55.00
D13-51GL/26	85.00
D13-51GM/26	85.00
D13-450GH/01	55.00
D13-471GH/26	55.00
D13-550GH	65.00
D13-600GM	59.00
D13-610GH	59.00
D13-610GM	59.00
D13-611GH	59.00
D13-611GM	59.00
D13-630GH	59.00
D14-120GH08	65.00
D14-150GH	75.00
D14-150GM	75.00
D14-172GH/84	59.00
D14-172GR	55.00
D14-172GV	55.00
D14-173GH	55.00
D14-173GM	53.00
D14-173GR	55.00
D14-181GH/62	65.00
D14-181GH/98	65.00
D14-181GJ	55.00
D14-181GM	53.00
D14-181GM50	59.00
D14-182GH	59.00
D14-182GM/98	65.00
D14-200BE	89.00
D14-200GA/50	85.00
D14-200GM	75.00
D14-210GH	75.00
D14-270GH/50	75.00
D14-310W	110.00
D14-320GH	85.00
D14-320GH/82	85.00
D14-340GH/KM	45.00
D14-340KA	45.00
D16-100GH	65.00
D16-100GH/65	69.00
D16-100GH/67	65.00
D16-100GH67A	75.00
D16-100GH/79	69.00
D16-100GH/79A	75.00
D16-100GH97	65.00
D18-160GH	69.00
D21-10GH	65.00
D21-10GJ	69.00
D21-10LD	69.00
DG7-5	55.00
DB7.6	35.00
DB7-36	55.00
DG7.32	45.00
DG13.2	45.00
DH3-91	55.00
DH7.91	45.00
DP7.5	35.00
DP7.6	35.00
DN13.78	35.00
F15.101LC	49.00
F16-101GM	55.00
F16-101LD	55.00
F21-130GR	55.00
F21-130LC	55.00
F21-131GR	79.00
F31-10GM	65.00
F31-10GR	65.00
F31-10LC	65.00
F31.10LD	65.00
F31-12LC	65.00
F31-12LD	65.00
F31-13GR	65.00
F31.13LD	65.00
F31-13LG	65.00
F41-123LC	160.00
F41-141LG	160.00
F41-142LC	185.00
M7-120W	19.00
M14-100GM	45.00
M14-100KA	55.00
M14-100LC	45.00
M17-151GVR	175.00
M17-151GR	175.00
M19-100GY	55.00
M19-100W	45.00
M19-101GR	55.00
M19-103W	55.00
M23-110GH	55.00
M23-111W	55.00
M23-111GH	55.00
M23-111LD	55.00
M23-112GM	55.00
M23-112GV	55.00
M23-112GW	55.00
M23-112KA	55.00
M23-112LD	55.00
M23-112W	55.00
M24-120GM	59.00
M24-120GR	59.00
M24-120LC	59.00
M24-120WAR	59.00
M24-121GH	55.00
M24-121LC	59.00
M24-121WA	59.00
M28-12GH	55.00
M28-12LC	55.00
M28-13LC	49.00
M28-13LG	49.00
M28-13GR	49.00
M28-131GR	55.00
M28-132GM	55.00
M28-133GH	55.00
M31-100GH	55.00
M31-101GH	55.00
M31-182GR	55.00
M31-182GV	53.00
M31-183W	55.00
M31-184W	65.00
M31-184GH	65.00
M31-184P31	65.00
M31-185GH/VR	69.00
M31-186W	69.00
M31-190GH	55.00
M31-190GR	55.00
M31-190LA	55.00
M31-190W	59.00
M31-191GH	59.00
M31-191GR	59.00
M31-191GV	55.00
M31-191W	59.00
M31-192W	59.00
M31-195GH	59.00
M31-210GH	59.00
M31-220W	59.00
M31-270GY	65.00
M31-271P31	65.00
M31-271GW	65.00
M31-271W	65.00
M36-12W	75.00
M36-141LA	75.00
M36-141LG	76.00
M36-141W	75.00
M36-170LG	75.00
M38-100GR	65.00
M38-101GH	65.00
M38-103GR	65.00
M38-120W	65.00
M38-120WA	65.00
M38-121GR	65.00
M38-121GHR	65.00
M38-121LA	65.00
M38-121WA	65.00
M38-122GW	65.00
M38-140LA	65.00
M38-141LA	65.00
M38-142GR	65.00
M38-142LA	65.00
M38-340P31	65.00
M38-341GR	65.00
M38-341P31	65.00
M38-344P39	65.00
M40-120W	59.00
M43-12GM/01	65.00
M43-12LG/01	65.00
M44-120LC	65.00
M44-120GR	65.00
M47-25GR/22	65.00
M50-120GH	65.00
M50-120GR	65.00
M50-120GV	65.00
M50-120LC	65.00
M61-120LC	75.00
M61-120W	75.00
S6AB	45.00
SE4/D/P7	45.00
SE42BP31AL	55.00
SE42BP31	55.00
SE52AP31AL	55.00
SE5FP31	55.00
T937	65.00
T948N	65.00
T948H	65.00
V3191	59.00
V4150LC	55.00
V4254B	65.00
V4274GH	65.00
V4283W	65.00
V5002LD	65.00
V5004GR	59.00
V5004LD	59.00
V6001GH	65.00
V6006GH	65.00
V6007DP31	59.00
V6007GW	65.00
V6008GW	59.00
V6008W	65.00
V6034WA	59.00
V6048CLA	59.00
V6048F	65.00
V6048J	49.00
V6052GH	65.00
V6052GR	65.00
V6064BLA	65.00
V6064BP31	55.00
V6064CLA	55.00
V6069GH	55.00
V6070P31	49.00
V7016A	65.00
V7030	59.00
V7031GH	59.00
V7031/67A	59.00
V7035A	49.00
V7037GH	45.00
V8004GR	65.00
V8006GH	65.00
V8010A	65.00
2BP1	9.00
3BP1	13.50
4EP1	30.00
3WP1	18.50
3H/0BM	55.00
5BP1	9.00
5BHP1	30.00
5BHP1FF	30.00
5BHP31	30.00
5CP1	10.00
6EP7/S	39.00
13BP1	13.50
13BP4	17.50
17DWP4	25.00
32J/1085	69.00
88D/89B/89D/89L	15.00
1273	39.00
1564	39.00
1844	45.00
9442E1	80.00
95447GM	75.00
95449GM	75.00
7709631	78.50

TAPE HEADS

MONO HEAD	1.50
AUTO REVERSE	3.50
STEREO HEAD	2.95

ELECTRO-OPTICAL

9524H	25.00
9677M	22.00
P4231BAM	19.00

WIREWOUND RESISTORS

4 Watt	2R4-10K	0.20
7 Watt	R47-22K	0.20
11 Watt	1R5-15K	0.25
17 Watt	1R-15K	0.30

VALVE AND CRT BASES

B5D	5.50	B13B	0.50
B7G	0.25	B14A	3.00
B7G SKTD	0.25	12PIN CRT	0.95
B8G	1.50	NUVISTOR	2.95
B8H	0.70	OCTAL	0.35
B9A	0.35	SK610	35.00
B9A SKT	0.40	UX5	1.75
B9G	0.75	UX7	1.75
B10B	0.20	CANS	0.30

VARICAP TUNERS

ELC1043/05 MULLARD	8.65
ELC1043/06 MULLARD	8.65
U321	8.25
U322	8.25

POTENTIOMETERS

STANDARD VERTICAL POTS	0.12
MIN. VERTICAL POTS	0.12
SANDARD HORIZONTAL POTS	0.12
MIN. HORIZONTAL POTS	0.12
CONVERGENCE PRE-SETS	0.30
SLIDERS LOG	0.48
SLIDERS LINEAR	0.48

PUSH BUTTON UNITS

DECCA, ITT, CVC20 6WAY	7.95
ITT CVC5 7 WAY	10.19
PHILIPS G8 (550) 6 WAY	14.49

20MM QUICK BLOW FUSES

100MA	8p each
200MA — 5AMP	5p each

20MM ANTI SURGE FUSES

100MA — 800MA	15p each
1A — 5AMP	12p each

SPARES & AIDS

FOAM CLEANSER	0.79
FREEZE IT	0.82
SOLDA MOP	0.64
SWITCH CLEANER	0.79
WD40	1.25
PUSH PULL MAINS SWITCH (DECCA, GFC, RANK, THORN ETC.)	1.02
PYE IF GAIN MODULE	6.99
ANODE CAP (27kV)	0.69

PHONE
0474 813225
3 LINES

P. M. COMPONENTS LTD

SELECTRON HOUSE, WROTHAM ROAD
MEOPHAM GREEN, MEOPHAM, KENT DA13OQY

TELEX
966371
PM COMP

A SELECTION FROM OUR STOCK OF BRANDED VALVES

A1714	18.50
A1834	7.50
A1998	11.50
A2087	11.50
A2134	14.95
A2293	6.50
A2599	37.50
A2792	27.50
A2900	11.50
A3042	24.00
A3283	24.00
AC/HL/DD	4.00
AC/THI	4.00
ACT22	59.75
AH221	39.00
AH238	39.00
AL60	6.00
AN1	14.00
ARP12	0.70
ARP34	1.25
ARP35	2.00
ATP4	2.50
AX50	5.50
AZ11	4.50
AZ31	2.50
BL63	2.00
BS450	67.00
BS810	55.00
BS814	55.00
CIK	19.00
C3JA	21.00
C6A	9.00
C1108	54.95
C112G	70.00
C1134	32.00
C1148A	115.00
C1149/1	130.00
C1150/1	135.00
C1534	32.00
CCA	2.60
CC3L	0.90
CL33	2.00
CV Nos Prices on request	
D63	1.20
DA41	22.50
DA42	17.50
DA90	4.50
DA100	125.00
DAF91	0.70
DAF96	0.65
DC70	1.75
DC90	1.20
DCX4-1000	12.00
DCX4-5000	25.00
DET16	28.50
DET18	28.50
DET23	35.00
DET24	39.00
DET25	22.00
DET29	32.00
DF91	0.70
DF92	0.60
DF96	0.65
DF97	1.00
DH63	1.20
DH77	0.90
DH79	0.56
DH149	2.00
DK91	0.90
DK92	1.20
DK96	2.50
DL35	2.50
DL63	1.00
DL70	2.50
DL73	2.50
DL91	1.50
DL92	0.95
DL93	1.10
DL94	2.50
DL96	2.50
DLS10	13.50
DLS16	10.00
DM70	1.95
DM160	2.75
DY51	1.50
DY86/87	0.65
DY802	0.72
E81uF	25.00
E81L	12.00
E82CC	3.50
E83CC	3.50
E83F	5.50
E86C	9.50
E88C	7.95
E88CC	3.50
E90CC	7.95
E90F	7.95
E91H	4.50
E92CC	3.95
E99F	6.99
E130L	19.95
E180CC	6.50
E182CC	9.00
E180F	6.50
E186F	8.50
E188CC	7.50
E1T	15.00
E280F	19.50
E283CC	10.00
E288CC	13.50
E810F	18.50
E88CC Siemens Special	5.95
E1148	1.00
E1524	6.95
EA50	1.00
EA76	1.95
EA79	1.95
EABC80	0.70
EAC91	2.50
EAF42	1.20
EAF801	2.00
EB34	1.50
EB41	3.95
EB91	0.85
EBC33	2.50
EBC41	1.95
EBC81	1.50
EBC90	0.90
EBC91	0.90

EBF80	0.65
EBF83	0.65
EBF85	0.95
EBF89	0.70
EBF93	0.95
EBL1	2.50
EBL21	2.00
EC52	0.75
EC70	1.75
EC80	9.50
EC81	7.95
EC86	1.00
EC88	1.00
EC90	1.10
EC91	5.50
EC92	1.75
EC93	1.50
EC95	7.00
EC97	1.10
EC8010	12.00
ECC32	3.50
ECC33	3.50
ECC35	3.50
ECC81	1.15
ECC81 Special Quality	1.95
ECC82	0.55
ECC82 Philips	1.95
ECC83	0.65
ECC83 Brimar	1.35
ECC83 Philips	1.95
ECC84	0.50
ECC85	0.60
ECC86	2.75
ECC88	0.85
ECC91	2.00
ECC180	0.72
ECC189	0.78
ECC801S	3.50
ECC803S	3.50
ECC804	0.60
ECC2000	12.00
ECF80	1.15
ECF82	1.15
ECF86	1.70
ECF200	1.85
ECF202	1.85
ECF801	0.85
ECF804	6.00
ECF805	2.50
ECF806	10.25
ECH3	2.50
ECH4	3.00
ECH35	3.50
ECH42	1.00
ECH81	0.65
ECH83	0.78
ECH84	0.69
ECH2000	1.50
ECL80	0.60
ECL82	0.65
ECL83	2.50
ECL84	0.74
ECL85	0.69
ECL86	0.80
ECL805	0.69
EF37A	2.00
EF39	1.10
EF41	3.50
EF42	3.50
EF50	2.50
EF55	4.95
EF71	1.50
EF72	1.20
EF73	1.00
EF80	0.55
EF83	3.50
EF85	0.50
EF86	2.25
EF86 Special Quality	3.15
EF89	1.50
EF91	1.95
EF92	2.15
EF93	0.95
EF94	0.95
EF95	1.50
EF97	0.90
EF98	0.90
EF183	0.65
EF184	0.65
EF730	1.80
EF731	3.50
EF732	3.50
EF800	11.00
EF805S	13.50
EF806S	14.50
EF812	0.65
EFL200	1.50
EH90	0.72
EK90	0.72
EL32	0.95
EL33	4.00
EL34	2.25
EL34 Mullard/Philips	4.50
EL36	1.50
EL37	9.00
EL38	4.75
EL41	3.50
EL42	2.00
EL81	6.95
	5.95
EL84	0.75
EL85	4.50
EL86	0.85
EL90	1.50
EL91	6.00
EL95	0.70
EL153	12.15
EL183E	3.50
EL18P	3.50
EL360	6.75
EL500	1.40
EL504	1.40
EL509	5.25
EL519	6.95
EL802	3.65
EL821	8.50
EL822	12.95

EM1	9.00
EM4	9.00
EM80	0.70
EM81	0.70
EM84	1.65
EM85	3.95
EM87	2.50
EN32	1.50
EN91	1.10
EN92	4.50
ESU150	14.95
ESU872	25.00
EY51	0.80
EY81	2.35
EY83	1.50
EY84	5.95
EY86/87	0.50
EY88	0.55
EY91	5.50
EY500A	1.50
EY802	0.70
EZ35	0.75
EZ40	2.75
EZ41	2.75
EZ80	0.75
EZ81	0.75
EZ90	1.50
F6064	2.95
FW4/800	2.95
G55/1K	9.00
G180/2M	9.00
G232 Mullard	3.95
G240/2D	9.00
G400/1K	14.00
GC10B	17.50
GC10D	17.50
GC10/4B	17.50
GC10/4E	17.50
GC12/4B	17.50
GD86W	6.00
GDT120M	5.00
GE10	9.00
GN4	6.00
GN10	15.00
GR10G	4.00
GS10C	16.50
GS10H	12.00
GS12D	12.00
GT1C	14.00
GT1C S/S	13.00
GTE175M	8.00
GTR150W	1.00
GU20	35.00
GU50	17.50
GXU1	13.50
GXU3	24.00
GXU50SS	14.50
GY501	1.20
GY802	1.00
GZ30	1.00
GZ31	1.00
GZ32	1.00
GZ33	4.50
GZ34	2.15
GZ34 U L	3.95
GZ37	4.50
HAA91	1.00
HABC80	0.90
HBC90	0.75
HBC91	0.80
HF93	0.75
HF94	1.50
HK90	1.05
HL2K	3.50
HL23DD	4.00
HL41	3.50
HL42DD	3.50
HL90	0.70
HL92	1.50
HL133/DD	3.50
HR2	4.00
HY90	1.00
HVR2	3.00
JP9-7A	60.00
K3118	85.00
KR6/3	45.00
KT8C	7.00
KT33C	3.50
KT36	2.00
KT44	4.00
KT45	4.00
KT61	4.00
KT63	2.00
KT66 OSRAM	15.00
KT66 USA	9.95
KT66 GEC	14.95
KT77 Gold Lion	10.95
KT81	7.00
KT88 USA	10.95
KT88 G Lion	18.95
KT67	9.00
KTW61	2.50
KTW62	2.50
KTW63	2.00
KTZ63	2.50
L63	1.50
L102/2K	6.95
L120/2K	12.00
LB7-20	95.00
LS9B	6.95
M502A	60.00
	85.00
M537A	60.00
M5143	155.00
M8079	6.00
M8082	7.50
M8083	3.25
M8091	7.50
M8096	3.00
M8098	5.50
M8099	5.00
M8100	5.50
M8136	7.00
M8137	5.50
M8161	6.50
M8162	5.50
M8163	5.50
M8190	4.50
M8195	6.50

M8196	5.50
M8204	5.50
M8223	4.50
M8224	2.00
M8225	3.50
ME1401	29.50
ME1402	29.50
ME1501	14.00
MH4	3.50
MHLD6	4.00
ML4	4.50
MS4B	5.50
MU14	1.50
MZI-100	125.00
N37	12.50
N78	9.85
OA2	0.85
OA2WA	1.50
OA3	2.50
OB2	0.85
OB2WA	1.25
OC2	2.50
OC3	1.50
OD3	1.70
OM4	1.00
OM5B	3.00
OM6	1.75
ORP43	2.50
ORP50	3.95
ORP93	12.00
P61	2.50
P41	2.50
PABC80	0.50
PC86	0.75
PC88	0.75
PC92	3.50
PC97	1.10
PC800	1.10
PC900	1.26
PCC84	0.40
PCC85	0.54
PCC88	0.70
PCC89	0.70
PCC189	0.70
PCC805	0.70
PCC806	0.80
PCE82	0.80
PCF80	0.65
PCF82	0.60
PCF84	0.65
PCF86	1.20
PCF87	0.40
PCF200	1.80
PCF201	1.80
PCF800	0.40
PCF801	1.35
PCF802	0.60
PCF805	1.25
PCF806	1.00
PCF808	1.25
PCH200	1.50
PCL82	0.85
PCL83	2.50
PCL84	0.75
PCL85	0.80
PCL86	0.85
PCL800	0.80
PCL805	0.90
PD500	3.50
PD510	3.65
PE1-100	69.00
PEN25	2.00
PEN40DD	2.50
PEN45	3.00
PEN45DD	3.00
PEN46	2.00
PFL200	0.95
PL21	2.50
PL36	0.95
PL38	1.50
PL81	0.72
PL81A	0.72
PL82	0.60
PL83	0.52
PL84	0.78
PL88	1.00
PL95	1.75
PL302	1.00
PL345	12.50
PL500	1.10
PL504	1.15
PL508	1.75
PL509	4.85
PL519	4.95
PL802	5.95
PL802T	3.50
PL820	2.95
PL5557	29.50
PY32	0.60
PY33	0.50
PY81	0.70
PY82	0.70
PY83	0.70
PY88	0.65
PY500A	1.95
PY800	0.79
PY801	0.79
QB3-300	54.95
QE03-10	3.50
QE08-200	145.00
QF40	65.00
QP25	1.00
QQE03-12	6.50
QQE03-20	27.00
QQV02-6	19.50
QQV03-10	5.50
QQV03-10 Mullard	15.00
QQV03-20	25.00
QQV03-20B	32.00
QQV06-40A	27.50
QQV07-50	63.50
QQZ03-20	42.50
QQZ06-40A	69.50
QS75.20	1.50
QS75/40	3.00
QS92/10	5.00
QS95/10	4.85
QS108/45	4.00
QS150/15	6.95
QS150/30	1.15
QS150/45	7.00

QS1200	3.95
QS1202	3.95
QS1203	4.15
QS1205	3.95
QS1206	1.05
QS1207	0.90
QS1208	0.90
QS1209	2.00
QS1210	1.50
QS1211	1.50
QS1212	3.20
QS1213	5.00
QS1215	2.10
QS1218	5.00
QU37	9.50
QV03-12	4.95
QV05-25	1.75
QV06-20	29.50
QV08-100	145.00
QV2-250	45.00
QY3-125	65.00
QY4-250	70.00
QY4-400	76.00
R10	4.00
R16	12.00
R17	1.50
R18	2.50
R19	2.50
R20	1.20
R1159	55.00
RG1-125	4.95
RG1-240A	14.50
RG3-250A	3.50
RG3-1250A	35.00
RK2K25	62.50
RK-20A	12.00
RL15	1.50
RPL16	12.00
RPY13	2.50
RPY43	2.50
RPY82	2.50
RR3-250	15.00
RR3-1250	35.00
RS613	45.00
RS685	54.95
RS698	52.15
S6F17	5.95
S6F33	28.95
S11E12	38.00
S30/2K	12.00
S104/1K	10.00
S109/1K	15.00
S130	5.95
S130P	5.95
SC1/800	5.00
SC1/1100	6.00
SC1/1200	5.00
SC1/1300	6.00
SC1/2000	9.00
SD6000M	45.00
SP41	5.00
SP42	3.00
SP4B	4.95
SS501	35.00
ST11	1.50
STV280/40	11.95
STV280/80	19.95
SU42	4.95
TB2.5/300	85.00
TB2-300	45.00
TB3/2000	3.95
TBL-2-300	275.00
TD1-100A	25.00
TD03-10F	35.00
TD3-12	4.00
TDD4	5.50
TP25	1.50
TSP4	7.00
TT11	1.50
TT15	34.95
TT21	45.00
TT22	45.00
TT100	57.00
TTR-31MR	65.00
TY2-125A	85.00
TY4-400	70.00
TY8-600W	365.00
TYS2/250	375.00
U18-20	2.75
U19	11.95
U24	2.00
U25	0.90
U26	0.90
U37	9.00
U41	6.95
U50	2.00
U82	3.00
U191	0.70
U192	1.00
U193	0.65
U251	1.00
U801	0.75
UABC80	0.65
UAF42	1.00
UBF80	0.60
UBC41	2.95
UBC81	1.50
UBF89	0.60
UBL21	1.75
UC92	1.20
UCC84	0.70
UCC85	0.60
UCF80	1.00
UCH21	1.20
UCH41	2.50
UCH42	2.50
UCH81	0.65
UCL82	1.75
UF41	1.15
UF42	1.15
UF80	0.80
UF85	1.20
UF89	2.50
UL44	3.50

UL84	0.85
UU5	3.50
UU7	8.00
UU8	9.00
UY41	3.50
UY85	0.70
V235A/1K	250.00
V238A/1K	295.00
V240C/2K	225.00
V241C/1K	195.00
V2464A/2K	315.00
V339	3.50
V453	12.00
VLS631	10.95
VP4B	4.50
VP133	2.00
VR75/30	3.00
VR101	2.00
VR105/30	1.50
VR150/30	1.15
VT52	2.50
VU29	4.50
VU39	1.50
W21	4.50
W77	5.00
W729	1.00
W739	1.50
X24	1.00
X66/X65	4.95
X76M	1.95
XC24	1.50
XC25	0.50
XFW47	1.50
XFW50	1.50
XG2-6400	135.00
XG5-500	22.50
XL1-5V	1.50
XL628FT	7.50
XNP12	2.50
XR1-1600A	49.50
XR1-3200A	79.50
XR1-6400A	99.50
Y503	25.00
Y65	6.95
Y602	12.00
YD1100	75.00
YJ1060	265.00
YL1020	29.00
YL1070	130.00
YL1071	135.00
YL1290	65.00
Z77	1.20
Z302C	12.00
Z359	9.00
Z505S	15.00
Z520M	4.00
Z521M	8.00
Z700U	3.00
Z749	0.60
Z759	19.85
Z800U	3.00
Z803U	18.95
ZA1000	12.50
ZA1001	1.50
ZA1002	1.50
ZC1040	8.00
ZM1005	8.00
ZM1020	8.95
ZM1021	8.00
ZM1023	7.95
ZM1041	14.00
ZM1082	9.00
ZM1084	10.00
ZM1177	9.00
ZM1202	55.00
ZM1263	4.00
ZM1612	3.00
1A3	4.50
1AC6	1.20
1B3GT	1.95
1B22	10.00
1B24	14.95
1B35A	29.50
1BC2A	2.50
1C1	2.50
1C5GT	2.50
1D5	2.50
1FD1	2.50
1G3GT	2.50
1K3GT	2.50
1L4	0.60
1L6	1.50
1LA6	1.00
1N2	4.50
1N5GT	2.50
1P28	25.00
1S2	0.55
1S5	0.70
1T4	0.70
1U5	1.00
1X2B	1.40
1Z2	8.95
2B7	1.50
2B22	69.50
2C21	1.00
2C39A	32.50
2C39BA	39.50
2C40	37.00
2C42	29.50
2C51	0.75
2C53	32.00
2CY5	1.50
2D21	1.50
2D21W	2.50
2E26	7.95
2J42	93.00
2K25	24.95
2K25 Raytheon	75.00
2K26	95.00
3A/107B	12.00
3A/108A	9.00
3A/109B	11.00
3A/110B	12.00
3A/141K	11.50
3A/147J	7.50

3A/167M	10.00
3A2	3.95
3A3A	3.95
3A4	1.10
3AL5	0.95
3AT2	3.35
3B2	3.00
3B4	7.00
3B7	4.50
3B24	10.00
3B26	24.00
3B28	12.00
3BZ6	1.50
3C4	1.00
3C23	19.00
3C45	24.00
3CB6	1.50
3CN3A	2.50
3CS6	0.95
3CX3	2.50
3CY5	1.50
3D6	4.50
3D21A	29.50
3D22	19.50
3E22	49.50
3EH7	1.95
3EJ7	1.95
3W4GT	2.50
4B551B	115.00
4-65A	59.00
4687A	9.50
4-125A	55.00
4-250A	65.00
4B32	35.00
4BQ7A	1.75
4BZ6	1.95
4C27	25.00
4C28	25.00
4CB6	1.95
4CX250B EIMAC	49.00
4CX250B tested ex equipment	9.50
4CX250BM EIMAC	75.00
4CX250K EIMAC	95.00
4CX125C EIMAC	125.00
4CX350A	71.50
4D26	75.00
4GS7	2.25
4GV7	2.25
4J52	75.00
4JC6A	2.95
4X150A	35.00
5A/102D	9.50
5A152M	9.00
5A163K	10.00
5A170K	6.25
5A-180M	9.00
5A-206K	10.00
5AMB	2.15
5ANB	1.20
5AR4	2.00
5AU4	1.50
5B8	2.50
5B.110M	10.00
5B-254M	14.50
5B-255M	19.50
5B-256M	9.00
5B-257M	9.00
5B-258M	14.50
5C22	125-00
5R4GB	3.50
5R4GY	3.50
5T4	5.95
5U4G	2.50
5U4GB	2.50
5V4G	1.25
5Y3GT	1.95
5Z4GT	0.85
6/30L2	0.70
6A/203K	9.00
6A7	4.95
6A8G	1.50
6AC7	2.00
6AF4A	2.50
6AF9	4.15
6AG5	1.50
6AG7	1.95
6AH6	2.50
6AJ4	2.00
6AJ7	2.00
6AK5	1.50
6AK6	2.50
6AL5	0.60
6AM4	3.25
6AM5	6.00
6AM6	1.50
6AN5	2.65
6AN8A	2.65
6AQ5	1.50
6AQ8	0.85
6AR8	3.95
6AS5	1.50
6AS6	2.50
6AS7G	4.50
6AT6	0.75
6AT8	1.75
6AU4	2.00
6AU6	0.95

6AV6	0.75
6AW8A	2.50
6B8G	1.50
6BA6	0.95
6BA7	4.50
6BA8A	3.50
6BC8	1.00
6BD4	1.50
6BD6	2.50
6BE6	0.72
6BF5	1.60
6BG6G	3.00
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	2.35
6BQ5	0.75
6BQ7A	0.72
6BL7GTA	3.95
6BL8	0.65
6BL8	1.15
6BR5	0.70
6BR7	4.95
6BR8	2.15
6BR8A	2.15
6BS7	5.50
6BW4	1.50
6BW6	5.35
6BW7	1.50
6BW8	4.00
6BX6	0.48
6BX7GT	3.50
6BZ6	2.50
6BZ7	2.95
6C4	1.10
6C5	1.95
6C6	2.50
6C8G	1.50
6C11	2.50
6C15	2.50
6C18	2.50
6CA4	0.60
6CA7	3.50
6CB5	3.95
6CB6	1.95
6CD6GA	4.50
6CF6	1.50
6CH6	6.95
6CL3	3.95
6CL6	3.25
6CL8A	2.00
6CM5	1.60
6CM7	2.95
6CS6	0.75
6CW4	6.50
6CY5	1.00
6DC6	2.35
6DK6	1.15
6DQ5	4.95
6DQ6B	2.50
6DW4	2.15
6EA4	4.95
6EA7	2.50
6EA8	2.50
6EB8	1.75
6EM5	2.50
6EM7	2.50
6EU7	1.95
6EU8	1.75
6EV7	2.95
6EW6	1.50
6EW7	4.50
6F1	2.00
6F5	4.95
6F6	2.50
6F6G	2.00
6F7	5.50
6F12	1.50
6F13	3.00
6F14	1.00
6F17	2.75
6F21	2.50
6F22	0.70
6F23	0.60
6F24	1.25
6F25	1.25
6F28	1.25
6F32	1.25
6F33	17.00
6FG5	1.95
6FQ7	2.95
6G6G	5.50
6GH8A	0.80
6GK5	1.50
6GK6	1.95
6GS7	2.15
6GV7	2.50
6GW6	2.50
6GW8	0.80
6H1	9.50
6H3N	1.10
6H6	1.35
6H6GT	1.95
6HS6	4.95
6J4	2.15
6J4WA	3.15
6J5	2.50

6J6	0.65
6JB6A	3.95
6JE6C	4.95
6JU8	2.50
6JS6C	4.95
6J7	4.15
6K7G	2.00
6K8Y/G	3.00
6KD6	5.50
6KM8	2.50
6KT8	2.95
6L1	2.50
6L15	3.15
6L19	3.95
6L6GC	2.95
6L6GC(GE)	3.95
6L6GT	1.50
6LD20	0.60
6LF6	7.50
6LJ8	2.50
6LQ6	4.95
6N7	2.50
6N7GT	2.50
6P15	1.50
6P25	4.00
6P26	4.00
6P28	2.00
6Q7	1.20
6Q7GT	1.20
6R7G	3.15
6S4A	1.50
6S7	1.10
6SA7GT	1.35
6SC7	1.50
6SG7	1.35
6SH7	1.35
6SJ7GT	1.20
6SK7	1.35
6SK7GT	1.35
6SL7GT	0.85
6SN7GT	1.35
6SQ7	1.35
6SS7	1.95
6U4GT	1.75
6U8	1.15
6U8A	1.50
6V6GT	1.15
6X2N	1.00
6X4	1.50
6X5GT	1.00
6X5GTY	1.00
6X8A	2.25
7A6	4.50
7A7	2.00
7AD7	1.75
7B7	2.50
7C5	
7C6	2.50
7E7	2.50
7H7	3.50
7AU7	1.50
7J7	5.50
7Y4	2.50
8B8	2.50
8B10	2.50
8BO5	1.95
8FQ7	1.95
10D2	1.25
10DE7	2.50
10F1	0.75
10GK6	1.95
10P14	2.50
10P18	0.78
10LD11	1.00
10LD12	0.65
11E3	55.00
12A6	3.95
12AD6	1.50
12AG8	1.50
12AL5	1.00
12AT6	0.95
12AT7	1.15
12AT7WA	2.50
12AU6	1.50
12AU7	0.55
12AV6	1.95
12AV7	2.50
12AX4GT	1.00
12AX7	0.65
12AX7WA	2.50
12AY7	3.95
12AZ7A	1.95
12B4A	3.50
12BA6	1.50
12BE6	1.95
12BH7A	2.50
12BL6	1.75
12BY7A	2.75
12BZ6	4.95
12CA5	1.95
12CX6	1.20
12DQ6B	3.50
12DW4A	3.50
12DW7	2.50
12E1	17.95
12E14	28.00
12GN7	3.95
12HG7	4.50
12HG7A	4.50
12J7GT	3.50
12K5	1.00
12K7GT	0.60

12K8	1.10
12SA7GT	1.00
12SG7	4.75
12SH7	1.00
12SK7	1.00
12SJ7	0.60
12SN7GT	1.85
12SR7	1.50
12SQ7GT	1.50
13D3	3.20
13D7	3.20
13D9	3.20
13DE7	2.50
13DR7	2.95
13EM7	3.50
14S7	1.00
17DW4A	2.95
17EW8	0.95
17JZ8	4.50
18D3	1.60
19AU4GT	2.50
19G3	17.00
19H4	23.95
19H5	33.50
19Q6	9.00
20A2	10.50
20D1	0.70
20LF6	3.50
20L1	0.95
20P1	0.55
20P3	0.60
20P4	1.95
20P5	1.15
21LU8	2.50
24B1	39.50
25L6GT	1.75
25BQ6	1.75
29C1	19.50
30C17	0.40
30C18	1.48
30F5	0.95
30FL1	1.00
30FL2	1.35
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
31JS6A	5.50
33A/158M	19.50
35A5	4.50
35L6GT	2.00
35W4	0.70
35Z3	1.85
38HE7	4.50
40KD6	5.50
42	6.95
47	6.00
50A5	1.50
50C5	0.95
50CD6G	1.15
50EH5	1.50
50JY6	2.95
52KU	2.00
53CG	15.00
61SPT	4.50
75B1	3.50
75C1	2.50
83	8.50
84	3.00
85A1	6.50
85A2	1.50
90AV	10.00
90C1	2.70
90CG	13.50
91AG	9.00
92AG	19.50
92AV	12.50
95A1	6.50
108C1	1.50
150B2	6.95
150C2	1.50
150C4	2.15
155UG	25.00
185BT	1.50
274A	15.00
307	5.00
328A	15.00
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	1.60
810	45.00
811A	12.95
813	18.50
813USA	45.00
829B	14.50

833A	60.00
866A	4.50
872A	27.50
B73	60.00
884	5.50
930	9.95
931A	13.95
954	1.00
955	1.00
958A	1.00
1299A	0.60
1619	2.50
1625	3.00
1626	3.00
2050W	4.50
2050	3.95
3545	4.00
404A	10.95
927	15.00
1927	25.00
4212E	250.00
4313C	4.00
4328D	9.00
5642	9.50
5651	2.50
5654	1.95
5663	1.95
5670	3.25
5672	4.50
5687	4.50
5692	3.50
5696	2.75
5704	3.50
5718	6.15
5725	2.50
5726	1.50
5727	1.95
5749	2.50
5750	1.85
5751	2.95
5763	4.95
5814A	3.25
5829WA	6.50
5636	5.50
5678	7.50
5840	3.50
5842	11.00
5847	10.95
5879	8.50
5886	13.95
5894	39.50
5899	4.50
5963	1.75
5965	2.25
6005	1.85
6012	16.00
6021	3.65
6057	2.50
6058	3.95
6059	3.75
6060	2.25
6062	4.50
6063	2.00
6064	3.25
6067	1.95
6072	4.20
6080	8.50
6080WA	8.50
6096	2.85
6132	10.00
6136	2.50
6146B	9.95
6157	2.50
6158	3.20
6201	6.45
6205	6.95
6211	2.50
6267	2.25
6350	2.00
6360	4.50
6386	14.50
6545	8.50
6550A	10.95
6688	6.50
6870	11.50
6887	9.50
6883B	9.95
6973	5.95
7025	2.50
7027A	4.50
7032	2.00
7059	2.50
7167	3.95
7189	2.35
7193	7.50
7233	7.95
7239	17.50
7247	2.95
7360	10.50
7462	15.00
7475	5.00
7486	75.00
7551	6.95
7558	9.45
7586	11.00
7587	26.95
7591A	4.95
7609	47.00
7733	5.50
7788	25.00
7868	3.95
8012	15.00
8042	55.00
8102	3.95
8106	2.95
8136	1.00
8156	10.95
8245	107.50
8298A	6.50
8417	5.95
9001	1.50
9006	0.90
18042	10.00
18045	10.00

THERMISTORS

VA1040	0.23
VA1056S	0.23
VA1104	0.70
VA8650	0.45
VA1097	0.25

CALLERS WELCOME

★ ENTRANCE ON A227

50 YDS SOUTH OF MEOPHAM GREEN

CAR PARKING AVAILABLE

Open Mon-Thurs 9am—5.30pm Fridays 9am-5.00pm

★ 24 HOUR ANSWERPHONE SERVICE ★
ACCESS AND BARCLAYCARD ORDERS WELCOME
★ MANY OTHER ITEMS AVAILABLE ★

UK ORDERS P&P 50p PLEASE ADD V.A.T. AT 15%

EXPORT ORDERS WELCOME. CARRIAGE/POST AT COST

CIRCLE 39 FOR FURTHER DETAILS.

TYPE 9051

TYPE 9046

TMOS WIDEBAND LINEAR POWER AMPLIFIERS. 4W/10W/20 watts RF output. Without tuning. Power gain 10dB. 24V. + supply

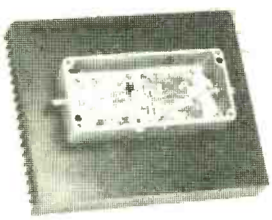
TYPE 9046 100KHz.-100MHz. 4 watts .... £84.50 + £3.50 p&p
TYPE 9051 15MHz.-200MHz. 4 watts .... £84.50 + £3.50 p&p
TYPE 9171 15MHz.-200MHz. 10 watts .... £140.00 + £8.00 p&p
TYPE 9172 As above with integral power supply unit .... £200.00 + £15.00 p&p
TYPE 9174 15MHz.-200MHz. 20 watts .... £180.00 + £8.00 p&p
TYPE 9175 As above with integral mains power supply unit .... £240.00 + £15.00 p&p

TYPE 9152

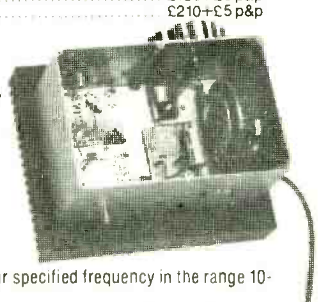
TYPE 9159

TELEVISION LINEAR POWER AMPLIFIERS. Tuned to your specified channels in bands IV or V. (or 400-900MHz).

TYPE 9061 150mV. input, 10mW. output .... £140+£5 p&p
TYPE 9152 10mW. input, 500mW. output .... £180+£5 p&p
TYPE 9159 500mW. input, 5 watts output .... £210+£5 p&p



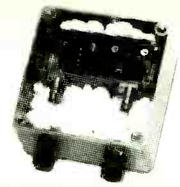
TYPE 9155



TYPE 9157

TMOS RF LINEAR POWER AMPLIFIERS. Tuned to your specified frequency in the range 10-250 MHz.

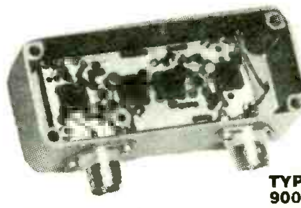
TYPE 9105 10mW. input, 3 watts output .... £160.00 + £10.00 p&p
TYPE 9155 3 watts input, 30 watts output .... £240.00 + £10.00 p&p
TYPE 9156 As above with integral mains power supply unit .... £320.00 + £15.00 p&p
TYPE 9106 100mW. input, 10 watts output .... £180.00 + £10.00 p&p
TYPE 9158 10 watts input, 80 watts output .... £320.00 + £10 p&p
TYPE 9157 As above with integral mains power supply unit .... £400.00 + £15 p&p



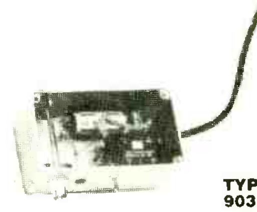
TYPE 9010

TWO STAGE GASFET STRIPLINE PREAMPLIFIERS
Tuned to your specified channels in bands IV or V

TYPE 9002 Two stage Gasfet preamplifier. N.F. 0.7dB. Gain 25 dB. High Q filter .. £85 + £2 p&p
TYPE 9004 UHF two stage Gasfet preamplifier. N.F. 0.6dB. Gain 25dB. Aligned to your specified frequency in the range 250-500MHz. High Q filter .... £85 + £2 p&p
TYPE 9012 Gasfet preamplifier mains power supply unit .... £24.50 + £3 p&p
TYPE 9010 Masthead weatherproof unit .... £9.50 + £2 p&p



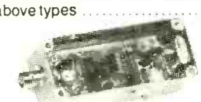
TYPE 9006



TYPE 9035

GASFET RF PREAMPLIFIERS. Aligned to your specified frequency in the range 30-250MHz. Masthead or local use.

TYPE 9006 N.F. 0.6dB. Gain 10-40dB. variable .... £65.00 + £2 p&p
TYPE 9006FM As above. Band II 88-108MHz .... £65.00 + £2 p&p
TYPE 9035 Mains power supply unit for above types .... £24.50 + £3 p&p



TYPE 8034

TYPE 8034 PHASE LOCKED SIGNAL SOURCE using low frequency reference crystal. Specify output in the range 1-600MHz. Output 10mW.+10dBm .... £84.50+£2 p&p
TYPE 9190 80 WATT COLOUR TELEVISION TRANSMITTER. 40-250 MHz. American, British or Continental system £1500.00
TYPE 9191 10 WATT COLOUR TELEVISION TRANSMITTER. UHF bands IV or V. American, British or Continental system £1500.00
TYPE 9086 FM TRANSMITTER 88-108MHz. 50 watts RF output. 24V + supply. Complete modular system .... £480+£30 p&p
TYPE 9087 As above with integral mains power supply unit .... £540+£40 p&p

RESEARCH COMMUNICATIONS LTD.

UNIT 3, DANE JOHN WORKS, GORDON ROAD, CANTERBURY, KENT CT1 3PP
TELEPHONE: CANTERBURY (0227) 456489

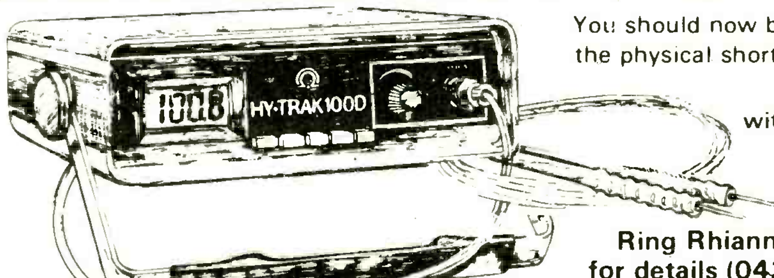
PLEASE ADD 15% V.A.T. ON TOTAL

CIRCLE 78 FOR FURTHER DETAILS.

HYTRAK 100D SHORTS LOCATOR

The **HY-TRAK 100D** is the most sophisticated short-circuit locator available. To locate a solder bridge on a printed circuit board (or any other electronic assembly) you merely have to select the range — super sensitive **HY-TRAK** range for shorts between voltage planes — 200MΩ range for power tracks etc., place the two probes across the shorted tracks and slide the probes along the track until you either obtain the highest pitch or the lowest meter reading.

STOP PRESS:
Now available a new ultra low-resistance **HY-TRAK** *(20mΩ-20Ω)*



You should now be within a few Millimetres of the physical short. What could be easier?

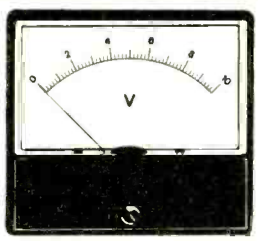
★ Special Price for payment with order — Normally £235–74

★ **PRICE £212-17 C.W.O.**

Ring Rhiannon Jones for details (04252) 77731

CIRCLE 22 FOR FURTHER DETAILS.

METER PROBLEMS?



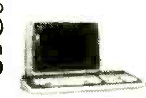
137 Standard Ranges in a variety of sizes and stylings available for 10-14 days delivery. Other Ranges and special scales can be made to order.

Full Information from:

HARRIS ELECTRONICS (London)
138 GRAY'S INN ROAD, W.C.1
Phone: 01-837 7937
Telex: 892301

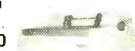
CIRCLE 37 FOR FURTHER DETAILS.

Lynwood GD1 VDUs: Intelligent Green micro controlled, RS232, printer port, 101 key k/b. Full Video enhancements. .... ONLY **£149** + £15 P&P (S/H)



Burroughs MT686/7/TD710: Intelligent Green 12" VDU with 3 micros and 64K store. RS232. Programmable. .. Only **£199** new or £149 S/H + £15 P&P

Open Chassis Video Monitors from above VDUs .... **£40+7.00 p&p**



Multirail Switching PSUs from above 5v 4A 12v +24v .... **£25 +£1.50**

Data General 6012 VDU's very attractive display working RS232 with integral 73 key k/b either dumb terminal mode or page buffered. .... Only **£120.00 + £15.00 p&p**

Centronics 306 Line printers: Professional fast (120 cps), superb quality 80 column printer. Parallel i/f. .... ONLY **£99** + £15.00 P&P

Osborne Executive Portable CP/M system with oodles of software. Twin floppy drives .... **£900 + £15 p&p**

Diablo 630 Daisywheel printer. OEM i/f .... NEW **£599** + £15 P&P

Calcomp 565 Drum Plotter, 10thou steps. .... ONLY **£450** + £10 P&P

Callers welcome by appointment

BECKENHAM PERIPHERALS LTD
01-466 5582
34 Rodway Road, Bromley Kent BR1 3JL

We also buy redundant peripherals

CIRCLE 25 FOR FURTHER DETAILS.

Floppy discs

by David March

David March concludes his survey of disc storage systems for microcomputers with a look at the subtleties of Tandy's TRS-DOS

The original TRS-80 Model I supported up to four external 5¼in disc drives daisy-chained together, each of single-density, single-sided type. Later the TRS-80 Model III was developed with up to two built-in 5¼in drives operating in double-density, single-sided mode. Subsequently an upgrade for the Model I was issued which incorporated many of the features of the Model III operating system including double density.

Both operating systems, known as TRS-DOS, provide many facilities beyond straight forward file handling. Overlays are used extensively, making a resident system disc essential; but in single-drive systems, there is the drawback that space for user files is considerably reduced.

The TRS-80 Model II was a much more expensive business computer using 8in drives.

On start-up the Model I loads and executes a bootstrap program from track 0, sector 0. This track is always recorded in single-density and so allows the upgraded Model I to run either operating system. The bootstrap loads in further TRS-DOS programs which remain in memory and provide the core of the operating system.

Directory structure

The directory occupies the whole of track 17. This track was chosen because it is half-way across a 35 track disc and so minimises head movement when TRS-DOS accesses the directory. This is very important because even system files are accessed via the directory.

The allocation of a whole track to the directory seems at first sight extravagant but it does provide two significant advantages. The f.d.c. used in the Model I supports at least two distinct synchronizing patterns for data fields. By applying one pattern exclusively to the directory track a major benefit ensues: the directory cannot be accessed by normal read/write commands and so is protected from inadvertent access or corruption. Each directory entry is quite generous, allowing comprehensive file security to be implemented.

Two sectors of the directory track contain ancillary information about the disc in general as well as an index to the actual directory entries.

The first sector holds three separate sets of information. First, a bit map indicating which granules are in use, known as the **granule allocation table (Gat).** Second, a map indicating any faulty tracks. Both tables use one byte per track and are sized to allow up to 96 tracks. Lastly, the remainder of the sector contains the disc name and password, creation date and an auto start-up command.

The second sector contains an index to the directory entries in the remaining sectors of the track. Known as the **hash index table (Hit)**, this uses one byte per directory entry. The *value* of each byte is derived from the file name plus extension by a hashing algorithm whilst its *position* in the Hit defines the sector and slot within sector where the corresponding directory entry may be found.

The cost of these two sectors is justified by several benefits:

(a) any granule can be allocated to any file —
- redundant space in a file is limited to less than one granule.
- files can be freely extended or reduced in size at any time.
- by allocating different files to separate areas of the disc, any extension will (probably) be achieved in physically adjacent sectors and so will keep access time short.

(b) the characteristics of a disc are recorded on the disc itself —
- thus TRS-DOS can handle mixed drives of 35, 40 and 80 tracks in any combination.
- a disc with minor damage can be salvaged and the unusable tracks locked out.
- even the use of track 17 for the directory is not sacrosanct as the directory track number is held as a parameter in the bootstrap sector of track 0.

TRS-DOS directory details: Gat Sector

Field	Bytes	Field name	Comments
1	0-95	Granule allocation table	One bit per granule
2	96-191	Track lockout table	255 = track locked out
3	192	Disc size	Number of usable tracks
4	193-205	—	Not used
5	206,207	Disc password	Encoded
6	208-215	Disc name	in Ascii padded with spaces
7	216-223	Creation date	in Ascii mm/dd/yy
8	224-255	Auto command	Start-up option

TRS-DOS directory details: directory entries

Field	Bytes	Field name	Comments
1	0(0-2)	Access control	ranging from 0 = unrestricted to 7 = no access
2	0(3)	File visibility	0 = visible 1 = invisible
3	0(4)	Allocation	0 = directory entry available 1 = directory entry allocated
4	0(5)	—	Reserved
5	0(6)	File type	0 = user file 1 = system file
6	0(7)	Entry type	0 = primary entry 1 = overflow entry
7	1(0-3)	Primary entry number	Backwards pointer to primary entry. For overflow entries.
8	1(4-7)	Primary entry sector	
9	2	—	Reserved
10	3	EOFB	Position of end of file byte in last sector
11	4	Record length	in bytes (0 = 256)
12	5-12	File name	in Ascii padded with spaces
13	13-15	File extension	in Ascii padded with spaces
14	16,17	Update password	Encoded
15	18,19	Access password	Encoded
16	20,21	EOFS	End of file sector, i.e. length of file in sectors
17	22-31	Gaps 1-5	Granule assignment pairs

TRS-DOS directory details: Hit sector			
1	0-127	Hash index table	Whole sector used for 64 entries in single density TRS-DOS
2	128-207	—	Not used
3	208-255	System file table	Only in double density TRS-DOS

(c) within the limits of the hashing algorithm, search time for a particular directory entry is minimised —
- unallocated file names will be detected by a single search of the Hit.
- allocated file entries will be accessed directly via the Hit.

System files

In single-density TRS-DOS, the system files (limited to 16) used the reserved file extension/SYS and occupy the first two slots in each of the remaining directory sectors. This limits the number of user files to 48 but enables the same access mechanism to be used for all files.

In double-density TRS-DOS, a separate system file table holds abbreviated file location information. This minimises access time since no searching is needed, protects system files from unauthorised access and allows up to 128 user files. Each system file entry occupies two bytes and stores file position and length.

In double density, fields 7-9 of each primary entry contain the creation date of the file. This is held in binary with the month in byte 1 and the year in byte 2.

File protection

Fields 1, 14 and 15 provide a high measure of security for files but their use is entirely optional.

Security is invoked in the first instance by quoting a password (up to 8 characters) when a file is created. Subsequent access will be available only if the password is correctly appended to the file name.

The introduction of a second password allows separation of the updating and access security facilities. The update password allows complete freedom to load, run, modify, rename or even delete the file. Operations available via the access password are limited by the value of field 1 (access control). For example, consider a Basic program file having the following particulars —

File name = TARDIS
File Extension = BAS
Access control =EXECUTE
Update password =PRIVATE
Access password = PUBLIC

The normal user will be privy to all particulars except the update password. The only valid reference by this user will be

RUN "TARDIS/BAS.PUBLIC"

Any attempt to access the file for reading, writing, loading or whatever is inhibited unless the update password is quoted. In the above example the access password could equally well have been blank, making the whole security mechanism invisible to the normal user. The user simply enters

RUN "TARDIS/BAS"

In double-density TRS-DOS, the system monitors the running of protected programs and wipes the memory clear on normal or abnormal end of the program.

Each granule assignment pair can take one of three meanings:

(a) first byte less than 254 (this byte is the track number and the next byte defines the position within the track and length of the segment);

(b) first byte = 254 (this indicates that the second byte holds a pointer to an overflow entry);

(c) first byte = 255 (this is a flag to indicate that the end of the file has been reached).

As a Gap holds only the starting position and length of a segment of a file, additional Gaps are needed whenever the storage ceases to be contiguous. Up to four separate segments can be addressed via the primary entry (the fifth Gap is needed to indicate the end of the file).

For any file which is segmented more, an overflow entry is created. In this case Gap5 is used to point to the overflow entry and subsequent file segments are addressed via the Gaps in the overflow entry. This can be carried on indefinitely, but each overflow entry reduces by one the maximum number of user files available.

Access to multi-segment files is slow because of repeated references to the directory. The only way to coalesce such a file is by copying it to a fresh disc since the physical position of storage areas on the disc is not available via TRS-DOS.

Further reading

An introduction to microcomputers vol. 3: Some Real Support Devices, by Jerry Kane and Adam Osborne, Osborne Associates Incorporated.

Computer Peripherals for minicomputers, microprocessors and personal computers, by Louis Hohenstein, McGraw-Hill Book Company.

Data sheet on FD1771-01 floppy disc formatter-controller, Western Digital Corporation.

Data sheet on SAB179x floppy disc formatter-controller family, Siemens Aktiengesellschaft.

Data sheet on WD1691 floppy support logic, Western Digital Corporation.

Data sheet on WD2143-01 four phase clock generator, Western Digital Corporation.

BBC disc system user guide, Acorn Computers Ltd, Cambridge.

The CP/M handbook (with MP/M), by Rodnay Zaks, Sybex Corporation.

TRS-DOS & Disk Basic Reference Manual, Tandy Corporation.

TRS-80 Model I double-density disk system owner's manual, Tandy Corporation.

Microsoft Basic decoded and other mysteries, IJG Computer Services.

TRS-DOS 2.3 decoded and other mysteries, IJG Computer Services.

Super Utility Plus user's manual, Breeze/QSD Incorporated.

EVENTS

February 26
Electromagnetic aspects of optical devices; IEE Colloquium. IEE, Savoy Place, London WC2. Tel: 01-240 1871 Ext. 269.

February 26 to 28
H.f. communication systems and techniques; IEE (and others) Conference at Savoy Place, as above.

March 4
Future communications satellites; IEE lecture. Details as above.

March 6
Software reliability; IEE Colloquium, Details as above.

March 6
Cellular mobile radio — Splitting for growth? IEE Lecture. Details as above.

March 7
Design = Quality; IEE/Design Council Colloquium. Savoy Place. Details as above.
To measure is to know. IEE Lecture. Details as above.

March 10
Components Fair
Pontefract Amateur Radio Society
Carleton Community Centre, Pontefract.

March 11
Vision Systems in robotic and industrial control; IEE Colloquium. Details as above.

March 12
Radiological protection aspects of microwave radiation; IEE lecture. Details as above.

March 12 to 14
Scottish Computer Show and Conference; Anderston Exhibition Centre, Edinburgh. Cahners Exhibitions, Tel: 01-891 5051

March 14
ICs above 1GHz; IEE Colloquium. Details as above.

March 14
Engineering of the human brain; IEE 76th Kelvin Lectuure. Details as above.

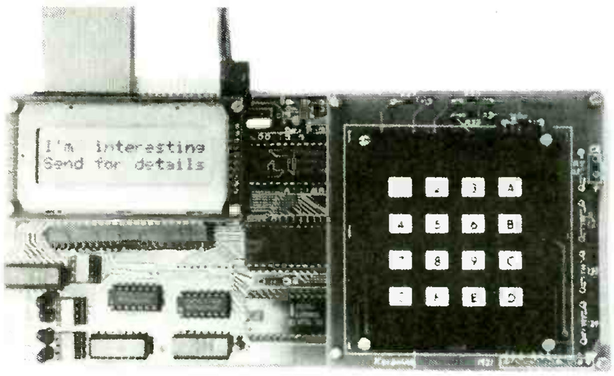
March 18 to 21
Telecommunication transmission; IEE (and others) international conference at Savoy Place. Details as above.

March 20
Connectors 85
Symposium and Exhibition. Post House Hotel, Leicester. Details from Robert Allen. Tel: 0789 204116.

March 24 to 27
VIDTEL 85, Video and tv techniques exhibition. NEC Birmingham. Details from NEC. Tel: 021 780 4141. Ext 710

March 26 to 28
Interconnection Technology; Exhibition, Olympia, London.

NEW NEW NEW NEW NEW NEW NEW NEW



APPLICATION EXAMPLES

- ★ REMOTE INTELLIGENT DISPLAY
- ★ ROBOT CONTROLLER
- ★ PASSWORD SECURITY APPLICATIONS
- ★ SMALL SYSTEM PROCESS CONTROL
- ★ LEARNING TOOL FOR ASSEMBLY LANGUAGE
- ★ WATCHDOG MONITORING
- ★ PRINTER INTERFACE

NEW NEW NEW NEW NEW NEW NEW NEW

Automation and Control Technology Cofton Road, Marsh Barton, Exeter EX2 8QW Tel: 37190

CIRCLE 58 FOR FURTHER DETAILS.

FIBRE-OPTICS EDUCATOR

A New Concept in Optical Equipment

The Fibre-Optics Educator is a **low-cost,** versatile instrument designed primarily for organisations involved in or about to enter the field of fibre-optics.

It can function as:

TEST EQUIPMENT e.g. for accurate fibre attenuation measurements to a range of 50dB, optical level measurements, and for testing out analogue and digital optical transmitters and receivers. Also, it may be set to give an audible indication of low level infra-red radiation using the analogue loudspeaker output or the digital buzzer output, with a length of optical cable acting as a probe.

TRANSMISSION EQUIPMENT for both **analogue** and **digital** data, over **free-space** as well as **optical fibres.** *It is also ideal for:*

TRAINING engineers, technicians and executives in the growing field of fibre-optics. Suitable for industry, colleges and technology training centres.

The Fibre-Optics Educator comprises fully portable optical transmitter and receiver units, optical cables, together with numerous accessories, a comprehensive manual, and carrying case.

Designed and Manufactured in the U.K.

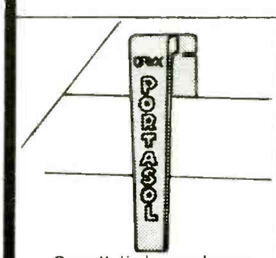
For further details contact:
ELLMAX Electronics Ltd.,
Unit 29, Leyton Business Centre,
Etloe Road, Leyton, London, E10 7BT.
Tel: (01) 539 0136

ELLMAX ELECTRONICS

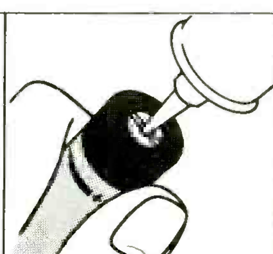
CIRCLE 82 FOR FURTHER DETAILS.

New from ORYX -PORTASOL
Portable Gas Soldering Iron

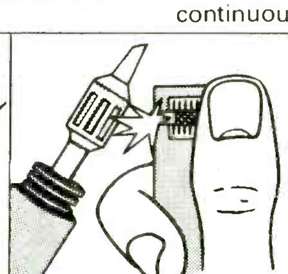
ORYX – market leaders in soldering irons and accessories introduce the revolutionary PORTASOL. This new approach to catalytic soldering iron technology is truly pocket portable (173 mm) and independent of any external energy source. PORTASOL is powered by ordinary cigarette fuel and one filling lasts for 60 minutes continuous use.



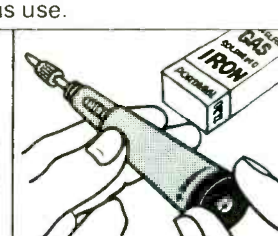
Small, light and can be carried in the top pocket.



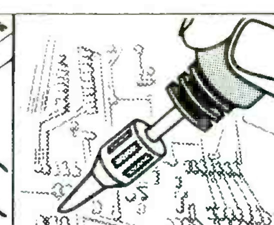
Powered by ordinary cigarette lighter fuel.



Flint ignition system built into the cap.



Adjustable temperature equivalent to electric soldering irons 10 to 60 Watt.



Ease of soldering for engineers, hobbyists, repair men etc.

- ★ Portasol makes an ideal and handy present.
- ★ Immediately available for use anytime anywhere.
- ★ Portasol meets all safety standards.
- ★ No problem with statics.
- ★ Adjustable temperature for sensitive components.

ONLY £17·25 INCLUDING VAT, P&P

ORDER WITH THIS COUPON TODAY

To: Greenwood Electronics, Portman Rd, Reading Berks RG3 1NE.
Please send.............(qty.) PORTASOL at £17.25. I enclose cheque/P.O./cash for £...................... or debit my Barclaycard no. ....Access no. .... Expiry date ....

NAME ....

ADDRESS ....

....

....

Please send technical leaflet. Tick ☐ Allow 14 days for delivery. EWW3

CIRCLE 56 FOR FURTHER DETAILS.

01-208 1177 TECHNOMATIC LTD 01-208 1177

BBC Micro Computer System

BBC Computer & Econet Referral Centre

BBC Computers:

Model B: **£348 (a)** B+DFS: **£400 (a)**
Model B+NFS: **£389 (a)** B+NFS+DFS **£450 (a)**
ACORN 10 Mbyte Hard Disc £1300 (a)
ACORN 2nd Processors: 6502: **£175 (a)** Z80: **£352 (a)**
TORCH UNICORN: Z80 Card: **£275 (a)** Z80 Disc Pack: **£650 (a)**
UNICOMM Communications Package: £159 (b)
20 Mbyte Hard Disc+400K Floppy: £1950 (a)

We stock the full range of ACORN hardware and firmware and a very wide range of other peripherals and firmware for the BBC. For detailed specifications and pricing please send for our leaflet.

PRINTERS

EPSON: RX80FT **£225 (a); FX80 £315 (a)**
FX100 **£435 (a);** RX100 **£345 (a)** RX80T **£215 (a)**
KAGA TAXAN: KP810 **£255 (a);** KP910 **£359 (a)**
BROTHER: HR15 **£340 (a);**
JUKI 6100 **£340 (a).**

ACCESSORIES

EPSON Serial Interface: 8143 **£28** (b); 8148 with 2K buffer **£57** (b).
EPSON Paper Roll Holder **£17** (b); FX80 Tractor Attach **£37** (b); RX/FX80 Dust Cover **£4.50** (d)
EPSON Ribbons: MX/RX/FX80 **£5.00;** MX/RX/FX100 **£10** (d).
JUKI: Serial Interface **£65** (c); Tractor Attach, **£99** (a); Sheet Feeder **£199** (a); Ribbon **£2.50** (a)
BROTHER HR15: Sheet Feeder **£199;** Ribbons — Carbonor Nylon **£4.50;** Multistrike **£5.50** (d);
2000 Sheets Fanfold with extra fine perf. 9.5in. — **£13.50;** 14.5in. **£18.50** (b).
BBC Parallel Lead **£8;** Serial Lead **£7** (d).

BT Approved Modems

MIRACLE WS2000:
The ultimate world standard modem covering all common BELL and CCITT standards up to 1200 Baud. Allows communication with virtually any computer system in the workd, The optional AUTO DIAL and AUTO ANSWER boards enhance the considerable facilities already provided on the modem. Mains powered. **£129(c)** Auto Dial Board/Auto Answer Board **£30 (d) each.** Software lead **£4.50**
TELEMOD 2:
Complies with CCITT V23 1200/75 Duplex and 1200/1200 half Duplex standards that allow communications with VIEWDATA services like PRESTEL, MOCRONET etc as well as user to user communications. Mains powered. **£62 (b)**
BUZZ BOX:
This pocket sized modem complies with V21 300/300 Baud and provides and ideal solution for communications between users, with main frame computers and bulletin boards at a very economic cost. Battery or mains operated. **£52 (c)** Mains Adaptor **£8 (d)**
BBC to Modem data lead **£7**

SOFTY II

This low cost intelligent eprom programmer can program 2716, 2516, 2532, 2732, and with an adaptor, 2564 and 2764. Displays 512 byte page on TV — has a serial and parallel I/0 routines. Can be used as an emulator, cassette interface.
Softy II .... **£195.00(b)**
Adaptor for 2764/2564 .... **£25.00**

DISC DRIVES

These drives, fitted with high quality JAPANESE mechanisms are supplied in attractive steel cases painted in BBC colour. The drives are fully Shuggart A4000 compatible. All dual drives are supplied with integral power supply whilst singles are supplied with or without power supply. All drives come complete with data & power cables, manual and BBC formatting disc.

1×100K (250KDD unformatted)	40TSS TS55A TEAC	**£100 (a)**
1×400K (1MbDD unformatted)	80TDS TS55F TEAC 40/80	**£145 (a)**
2×100K (.5MbDD unformatted)	40TSS TD55A TEAC	**£250 (a)**
2×400 (2MbDD unformatted)	80TDS TD55F Mitsubishi 40/80	**£360 (a)**

CS100 TEC with psu	**£125 (a)**	40/80T Switch Module	**£30 (c)**
CS200 TEC with psu	**£165 (a)**	3in. Hitachi 100K 40T	**£105 (b)**
CS400 MITS with psu	**£195 (a)**	1×200K 40TDS	**£115 (a)**

Authorised Distributor
Data Recording Products

3M FLOPPY DISCS

Industry Standard floppy discs with a lifetime guarantee Discs in packs of 10

40 Track SS DD	**£15 (c)**	40 Track DS DD	**£18 (c)**
80 Track SS DD	**£22 (c)**	80 Track DS DD	**£24 (c)**

DRIVE ACCESSORIES

FLOPPICLENE Disc Head Cleaning Kit with 28 disposable cleaning discs ensures continued optimum performance of the drives. **£14.50** (c)

Single Disc Cable **£6** (d)	Dual Disc Cable **£8.50** (d)
10 Disc Library Case **£1.80** (d)	30 Disc Storage Box **£6** (c)
30/40 Disc Lockable Box **£14** (c)	100 Disc Lockable Box **£19** (c)

MONITORS

MICROVITEC 14in. RGB
1431 Std Res **£165 (a);** 1431 Ap std Res PAL/Audio **£210 (a);**
1451 Med Res **£280 (a);** 1441 Hi Res **£399 (a);**
2031 20in. Std Res **£260 (a);** Plinth for 14in. Monitors **£8.50.**
Microvitec Monitors with TTL/Linear Inputs also available.

KAGA TAXAN 12in. RGB
Vision II Hi Res **£240 (a);** Vision III Super Hi Res **£340 (a)**
Green Screens; KAGA 12G **£99 (a);** SANYO DM811 112CX **£90 (a);**
Swivel Stand for Kaga Green **£21 (c)**
BBC Leads: KAGA RGB **£5** Microvitec **£3.50;** Monochrome **£3.50 (d)**
SANYO CD 3125 NB 14in. RGB Std Res **£179 (a)**

UV ERASERS

UV1T Eraser with built-in timer and mains indicator. Built-in safety interlock to avoid accidental exposure to the harmful UV rays.
It can handle up to 5 eproms at a time with an average erasing time of about 20 mins. **£59 + £2 p&p.**
UV1 as above but without the timer. **£47 + £2 p&p.**
For Industrial Users, we offer UV140 & UV141 erasers with handling capacity of 14 eproms. UV141 has a built in timer. Both offer full built in safety features UV140 **£61,** UV141 **£79, p&p £2.50.**

PRINTER BUFFER

This printer sharer/buffer provides a simple way to upgrade a multiple computer system by providing greater utilisation of available resources. The buffer offers a storage of 64K. Data from three computers can be loaded into the buffer which will continue accepting data until it is full. The buffer will automatically switch from one computer to next as soon as that computer has dumped all its data. The computer then is available for other uses. LED bargraph indicates memory usage. Simple push button control provides. REPEAT, PAUSE and RESET functions. Integral power supply. **£245** (a).
Cable set £30.

ATTENTION

All prices in this double page advertisment are subject to change without notice.
ALL PRICES EXCLUDE VAT
Please add carriage 50p unless indicated as follows:
(a) £8 (b) £2.50 (c) £1.50 (d) £1.00

ACORN IEEE INTERFACE

A full implementation of the IEEE-488 standard, providing computer control of compatible scientific & technical equipment, at a lower price than other systems. Typical applications are in experimental work in academic and industrial laboratories. The interface can support a network of up to 14 other compatible devices, and would typically link several items of test equipment allowing them to run with the optimum of efficiency. The IEEE Filing System ROM is supplied **£282.**

INDUSTRIAL PROGRAMMER

EP8000.
This CPU controlled Emulator Programmer is a powerful tool for both Eprom programming and development work. EP8000 can emulate and program all eproms up to 8K×8 bytes, can be used as stand alone unit for editing and duplicating EPROMS, as a slave programmer or as an eprom emulator £695(a)

CONNECTOR SYSTEMS

I.D. CONNECTORS

(Speedblock Type)

No of ways	Header Plug	Recep-'acle	Edge Conn.
10	90p	85p	120p
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:				
Ang Pins	120	180	230	350
Solder	60	85	125	170
IDC	175	275	325	—
FEMALE:				
St Pin	100	140	210	380
Ang Pins	160	210	275	440
Solder	90	130	195	290
IDC	195	325	375	—
St Hood	90	95	100	120
Screw Lock	130	150	175	—

TEXTOOL ZIF

SOCKETS	24-pin £5.75
28-pin £8.00	40-pin £9.75

EDGE CONNECTORS

	0.1"	0.156"
2×6-way (commodore)	—	300p
2×10-way	150p	—
2×12-way (vic 20)	—	350p
2×18-way	—	140p
2×23-way (ZX81)	175p	220p
2×25-way	225p	220p
2×28-way (Spectrum)	200p	—
2×36-way	250p	—
1×43-way	260p	—
2×22-way	190p	—
2×43-way	395p	—
1×77 way	400p	500p
2×50-way(S100conn)	600p	—

EURO CONNECTORS

DIN 41612		
2 × 32 way St Pin	230p	275p
2 × 32 way Ang Pin	275p	320p
3 × 32 way St Pin	260p	300p
3 × 32 way Ang Pin	375p	400p
IDC Skt A + B	275p	
IDC Skt A + C	350p	

For 2 × 32 way please specify spacing (A + B, A + C).

AMPHENOL CONNECTORS

36 way plug Centronics (solder **500p** (IDC) **475p**
36 way skt Centronics (solder) **550p** (IDC) **500p**
24 way plug IEEE (solder) **475p** (IDC) **475p**
24 way skt IEEE (solder) **500p** (IDC) **500p**
PCB Mtg Skt Ang Pin
24 way 700p 36 way 750p

GENDER CHANGERS

25 way D type

Male to Male £10
Male to Female £10
Female to Female £10

RS 232 JUMPERS

(25 way D)

24" Single end Male	£5.00
24" Single end Female	£5.25
24" Female Female	£10.00
24" Male Male	£9.50
24" Male Female	£9.50

DIL SWITCHES

4-way	90p	6-way	105p
8-way	120p	10-way	150p

TELEPHONE CONNECTORS

4-way plug 110p
6-way plug 180p
6-way rt ang.skt 160p
Flexible cable
4-way 50p/m
6-way 72p/m

RIBBON CABLE

(grey/metre)

10-way	40p	34-way	160p
16-way	60p	40-way	180p
20-way	85p	50-way	200p
26-way	120p	64-way	280p

DIL HEADERS

	Solder	IDC
14 pin	40p	100p
16 pin	50p	110p
18 pin	60p	—
20 pin	75p	—
24 pin	100p	150p
28 pin	200p	—
40 pin	200p	225p

MISC CONNS

21 pin Scart Connector 200p
8 pin Video Connector 200p

Aesthetic sub-woofer system

by M. Bronzite

Practical guidance with particular reference to filter design

With the latest improvements in recording techniques and with the potential use of compact discs in mind, I felt that it was time to extend the low frequency capability of my current speakers. Initial discussions with a higher authority indicated a certain lack of enthusiasm for adding 'useless clutter' to her living room, but agreement was ultimately reached that a coffee table could be added to the room at any convenient wall location. The usual constraints of low cost and small size completed the somewhat unorthodox specification for the design, and the notes which follow indicate one approach to providing such a product.

Much like impending motherhood, the functional status of a loudspeaker is reasonably self-evident at one glance, and, again like i.m., has always been so. So the first problem was to find some basis of operation where the actual loudspeaker could be hidden, and this is supplied by data given in ref.1. Copied directly from Figs 5 and 6 of ref.1, Fig.1 shows that up to about 250Hz there is little difference in performance between a front-facing or rear-facing speaker of reasonable dimensions. Above this frequency there is a 10dB lift which makes the approach unacceptable for a full-range system. However, if the incoming signal is limited with a suitable low-pass filter, then a rear or floor-facing speaker becomes feasible for sub-woofer application, and the speaker, vent, control panel and wires can all be hidden from critical gaze.

Path-length effects

The central problem of sub-woofer application lies in the fact that it almost certainly will not be at the same distance from the ear as the other two speakers. It may be placed adjacent to a different wall and path differences may extend to one or more wavelengths of the filter crossover frequency, i.e. one or two metres. Thus it became necessary to generate a model for examining the impact of gross path differences between two speakers on the phase of the signals involved, and from this to evaluate the variation of the overall amplitude of received signal.

This model is outlined in Appendix 1 which shows how the filtered performance of one speaker can be modified to include path difference effects, and then sum the resultant outputs. With the aid of some standard filter coefficients and a somewhat userphobic computer and using the model already mentioned, the curves for two filters are given for different normalized frequencies in Fig.2. The results are interesting. Having ignored the direct effect of distance on received signal (= 1/d) for clarity, the curves also indicate the effect of any phase change (lead inversion, loudspeaker inductive effects) as equivalent to path difference. Thus, A = 0.5 (path separation $0.5\lambda_0$) is the same as phi = 180° in the speaker coil at the crossover frequency. One could go on, but the main conclusions are clear: (a) for any filter, there will always be a null at crossover frequency at some path separation, and (b) the higher the order of filter, the narrower the frequency band of response perturbation due to path differences.

If, as a consequence, a high-order filter is selected then another problem is introduced — that of phase distortion. This is related to the passage of a non-sinusoidal signal, say a drum beat, through a signal-processing circuit where the phase of the harmonics has been changed in the reconstituted signal with respect to the original. With a steep filter system such phase changes will be severe. Fortunately, while detectable in an anechoic chamber, these phase effects are very difficult to hear in a reverberant environment such as a normal living room — see page 593 of ref.2. Similarly, the problem of signal-null will also be minimized in such an environment due to the multiple reflections that will be generated. In any case I felt that by restricting the possible amplitude effects to a narrow frequency band it would be more difficult to detect any degradation to the total music or speech signal.

Filter implementation

Recall that application of a rear-facing speaker requires that the high frequency response of the woofer shall be well attenuated by 250Hz. Conversely, with currently available small speaker systems, the low frequency roll-off occurs at about 100Hz which ideally should not affect the overall system performance. Thus a high-order symmetrical filter centred at about 160Hz will be required, which is fully in line with the discussion on unequal path length aspects. The selection of a fourth-order 0.5dB ripple Tchebycheff filter appeared to reasonably satisfy all the imposed constraints.

The design was carried out by way of a nostalgic trip back to the classic Sallen and Key format using ref.3 as a basis. The 3dB frequency was selected to be 155.2Hz simply to optimize the resistor values (on an E24 grid) for the high-pass filter, while the low-pass equations were modified to allow the use of standard value capacitors and to generate gain in the low frequency path.

The last-mentioned — about 10dB — is required to take up the 6dB attenuation introduced by the resistive summing of the two input signals, and to ensure that an adequate signal level is presented to the woofer power

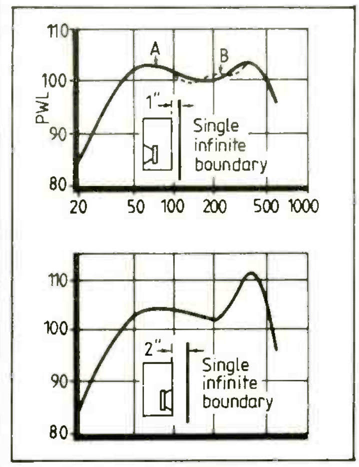
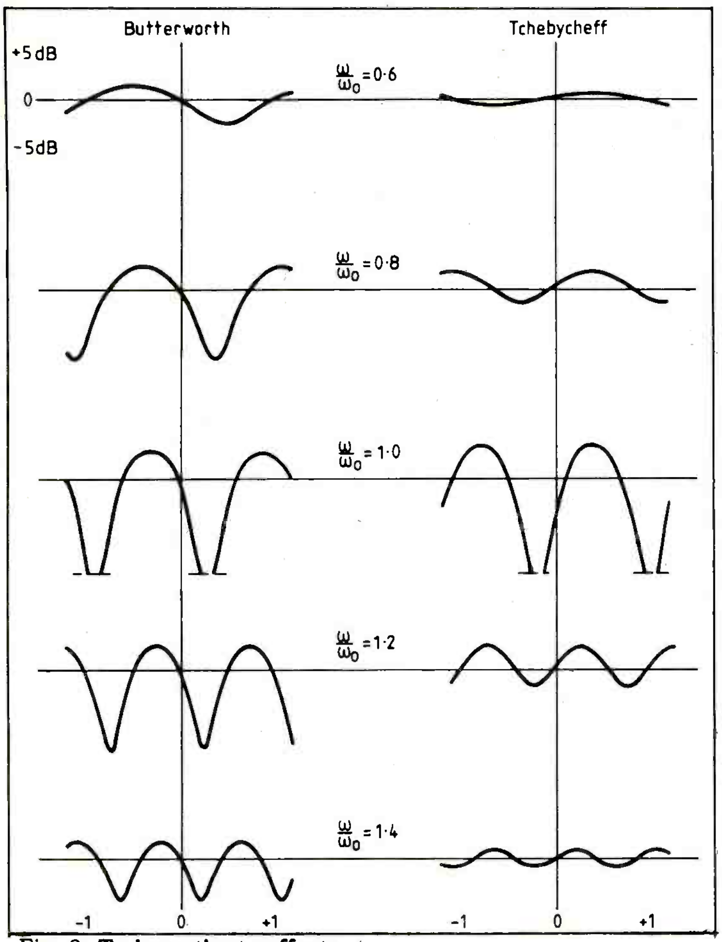


Fig. 1. **There is little difference in performance between front and rear-facing loudspeakers provided input is limited to 250Hz.**

A sub-woofer is normally required to work over a restricted frequency range operating in a reverberant environment. With these assumptions, the problems of phase distortion and path difference signal-null were taken as less important, which allowed the use of an unusually high-slope filter network. It is this filter which acts to restrict the overall impact of path difference effects and to permit speaker locations which can meet some decorative as well as technical demands. The design allows the filter to be embedded in virtually any amplifier configuration and the system to work with any existing stereo speakers. The Active Coffee Table seems to have proved a viable concept.



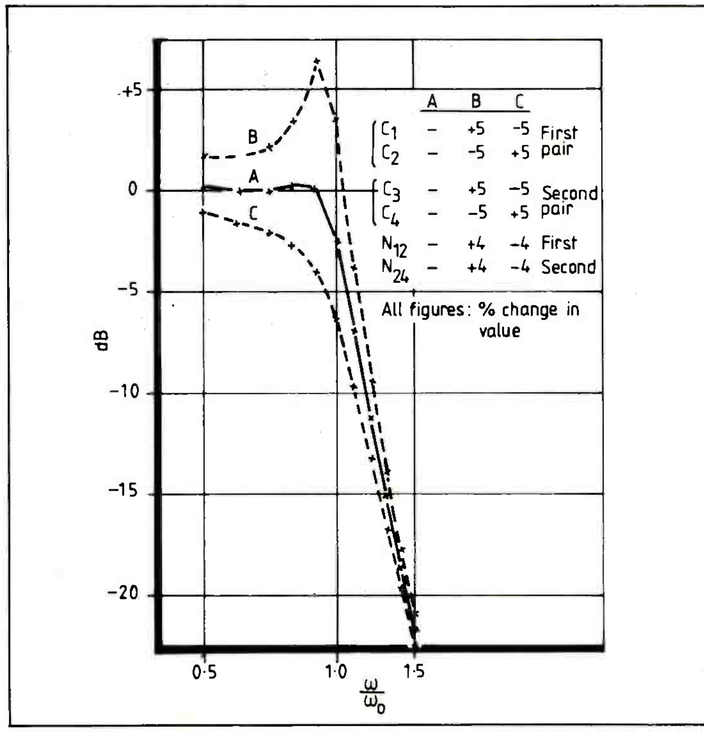


Fig. 4. **Effect of varying capcitor and gain values in crossover region dictates use of 1% resistors and 2% capacitors.**

Fig. 2. **To investigate effects of path-length difference between two speakers, on amplitude response, one speaker's performance was modified to include the consequent phase effects and the two outputs added (modelled as in Appendix 1).**

Fig. 3. **Fourth-order symmetrical Tchebycheff filter centred on 160Hz is designed according to Appendix 2. 3dB frequency of 155.2Hz was chosen to allow E24 resistor values**·

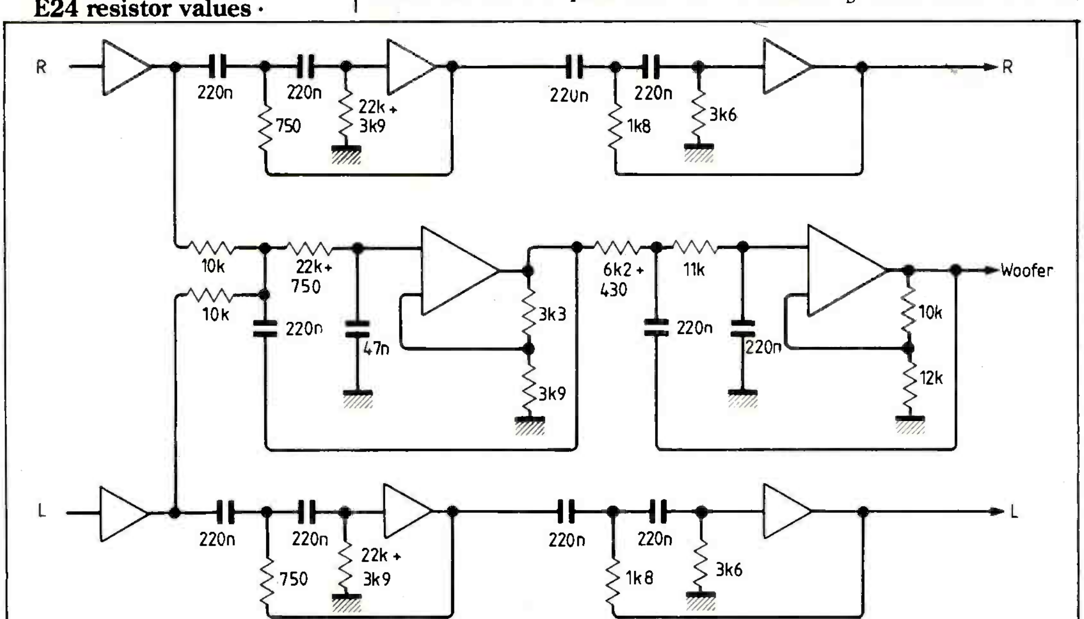
amplifier. The design approach is given in Appendix 2, while the circuit detail is shown in Fig.3, the summing resistors also serve as the first l.p. filter resistor.

One of the drawbacks of the format adopted is the relatively high sensitivity in the crossover region to the component tolerances and subsequent variation with age, and the effect of varying capacitor and gain values is illustrated for the low pass filter in Fig.4. On this basis, 1% resistors and 2% capacitors are used throughout.

Loudspeaker box design

In the first place it is necessary to define the speaker requirements and it seemed reasonable to aim for a 3dB-down frequency of about 40Hz, with a 1 watt acoustic capability at that frequency. With a typical 1% efficiency, this is equivalent to a driver amplifier and speaker capability of about 100 watts. In addition, to meet the 1 watt/40Hz criterion the speaker linear displacement volume (V_D) will need to be about 400cm^3 (Fig.19, page 314, ref.4). In effect, a long-throw, 30cm diameter, 100 watt speaker is needed with suitable parameters to match a low-volume box, and the Philips type AD12250/W8 was selected as a low-cost component for use with a vented-box approach.

Box design was carried out by means of equations provided in ref.5 and repeated in Appendix 3 along with the required calculations. These equations effectively define the box and vent requirements for a ducted system provided that the Theile-Small parameters for the speaker are known i.e. V_{as}, f_s, and Q_T (see Appendix for definition). Equation 1 includes a function of the negative ripple that may be used to extend the frequency response at the expense of a larger box requirement and a dip in the response curve. If not required put $R_H = 0$.



Practical details

Once the required internal box volume is know, the actual design, style and dimensioning of the layout is open to personal choice. In this case an upright box was built using the customary glue, screw and silicone sealant. The selected amplifier and power supply (types HY248 and PSU54X from ILP of Canterbury) were mounted inside the box using rubber washers or gaskets to minimize vibration, while the box vibration itself was reduced using an aluminium L-beam attached to the wall behind the speaker and a 25mm diameter rod about 1mm longer than required forced between the speaker wall and the back wall close to the speaker aperture. These box strengthening techniques were taken from page 93 of ref.6. The vent, comprising a flanged plastics tube was found in the plumbing department of a hardware shop.

The box is fully sealed (vent apart) and entry is via the speaker opening. For this reason wiring was done with connection boxes for ease of maintenance, with fuses and the level adjustment potentiometer brought to a small aluminium panel below the speaker. To avoid potential earth loops, the power lines are two-terminal only while the signal input is provided by a two-wire screened cable (about five metres long), where the screen is attached to the aluminium panel and the rectified power ground within the speaker cabinet. Constructional details are illustrated in Fig.5.

The filter was designed to take minimum additional power from the existing amplifier supply rails using two TL074 quad op-amps, and the supply circuits are shown in Fig.6. The anti-thump circuit also shown is not technically necessary but subjectively reassuring.

The total cost including speaker, electronics, chipboard and veneer came to about £120.

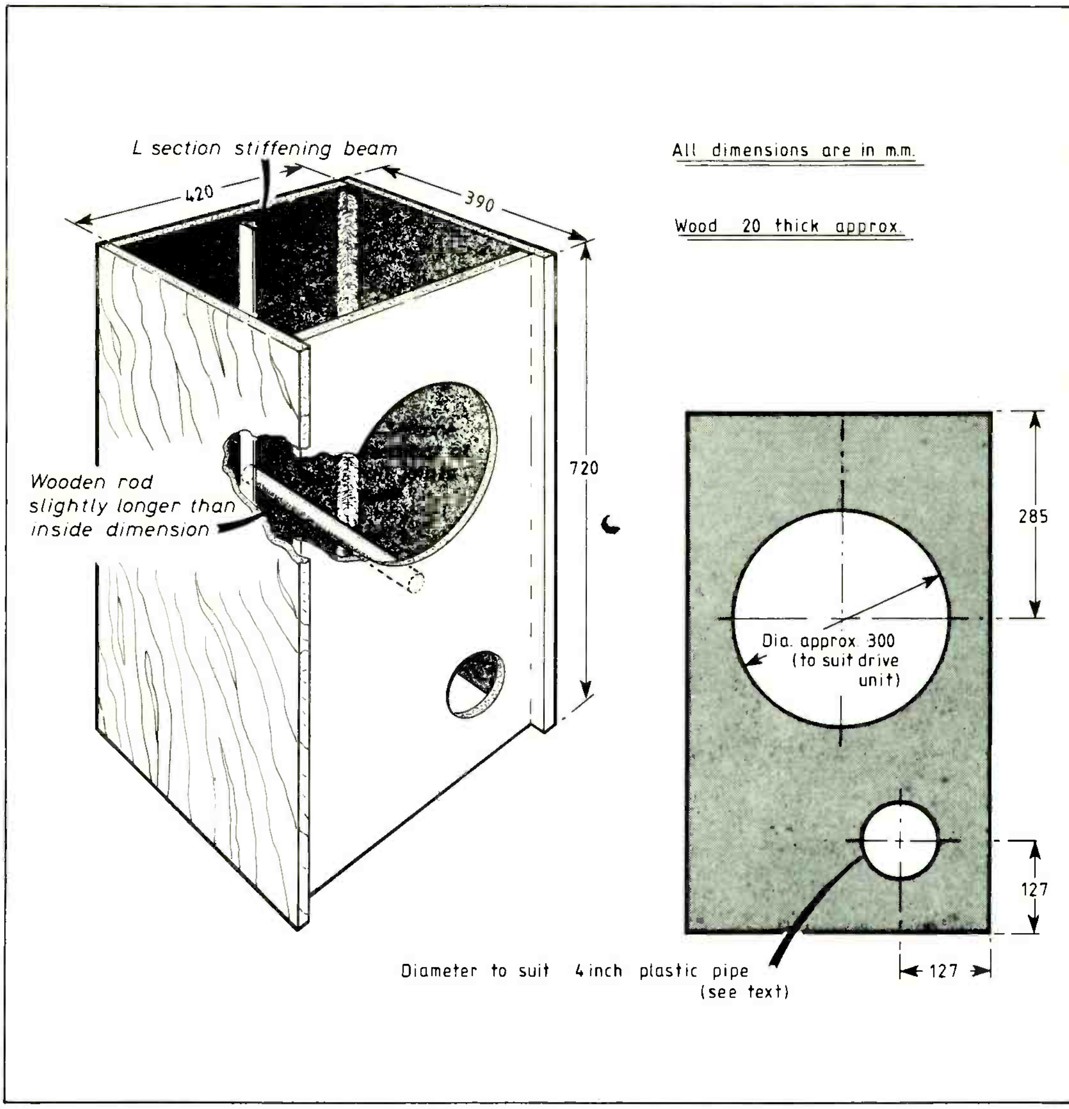


Fig. 5. **Vented enclosure is designed according to equations of Appendix 3, given the Thiele-Small parameters for the speaker. Top and bottom of enclosure, not shown, are fashioned for decorative appeal.**

Results

The test equipment comprised the UREI model 200 automatic plotting system used in conjunction with an AKG type C451EB microphone. With this equipment, the filter responses (suitably adjusted for gain differences) are given in Fig.7. While the responses do not fully match the design objectives, they are probably adequate — being about 18dB down at 100Hz and 250Hz respectively.

The woofer is matched to its location and the other speakers by providing a continuous input tone at the crossover frequency. The level pot. is adjusted until the sound coming from the woofer is equal to the sound from the other sources — detected at

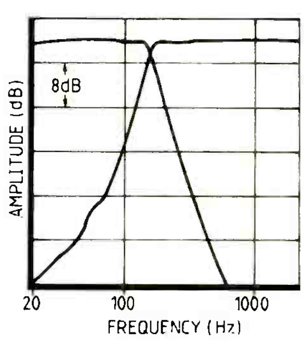


Fig. 7. **Though not quite up to the design objectives, measured filter response is adequate at 18dB down at 100 and 250Hz.**

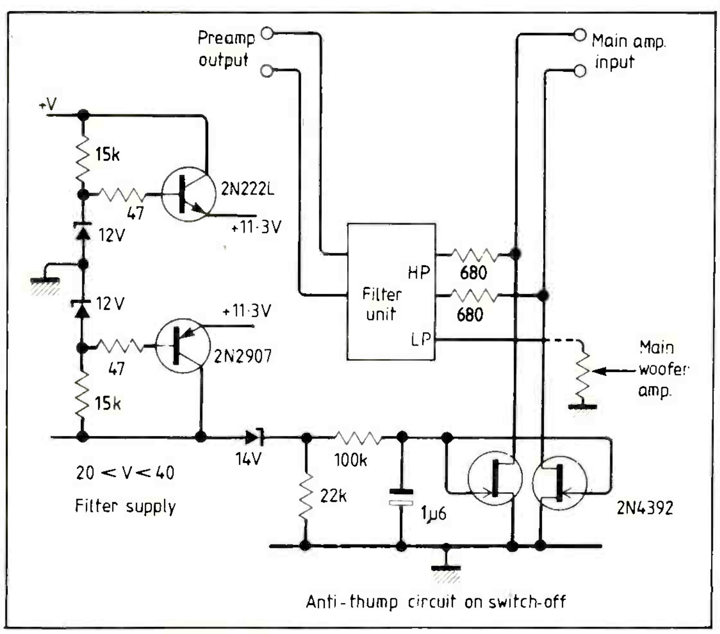


Fig. 6. **Filter circuits of Fig. 3 using TL074 quad op-amps take a minimum of power from the amplifiers used (IPP types, see text). This anti-thump circuit is optional.**

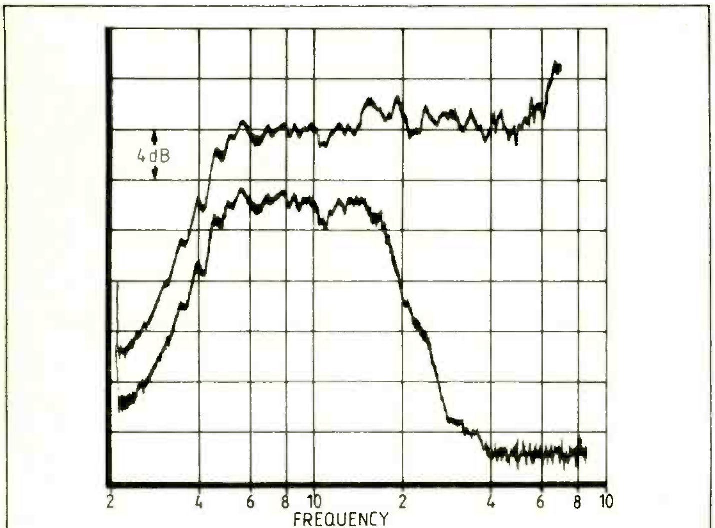


Fig. 8. Third-octave warbler measurements show response in room is 3dB down at 43Hz. Upper curve is for woofer plus one existing speaker, lower curve is for woofer only.

some sensible monitoring point. This level may then be checked and readjusted by carrying out a ful frequency sweep and ensuring that the mean l.f. level is comparable to the mean h.f. level over the range, say, 50-500Hz.

The overall speaker performance in the room was measured using a one-third octave warbler attachment to the recorder system and is shown in Fig.8, where the bottom curve is for the woofer alone while the upper curve is for the woofer plus one existing full-range speaker. Again, not fully meeting design spec, but a charitable view would be 3dB-down at about 43Hz. The upper curve was taken with the microphone placed centrally in the room and its location must have been particularly fortunate because subsequent brief tests with other locations showed variations of about ± 4dB in the crossover region. However, from the path length discussion, this is only to be expected.

Vibration tests were carried out with functionally related test sensors placed on top of the speaker — coffee cups — and while 'cup clatter' could be detected at reasonable volume, it was only in conjunction with resonance noises from the cabinet doors and chatter from the room windows.

Subjective listening was positive. For those who enjoy a 'thump' — be it from beat, electronic or classical sources — the added octave can certainly be detected and appreciated, and no degradation was discernible at any location in the room.

Thanks to D.L. Hermans and H. Wilms for their forthright assistance and particularly to J.P. Vanderreydt for his tolerant and comprehensive guidance.
— M.B.

REFERENCES
1. Influence of Room Boundaries on Loudspeaker Power Output Loudspeakers by Roy F. Allison — Anthology of Articles in J. Audio Eng. Soc. 1953-77 p.339
2. 'On the audibility of midrange phase distortion in audio systems' by Stanley P. Lipshitz, Mark Pocock and John Vanderkooy. *J. Audio Eng. Soc.* vol.30 no.9 1982 September p.580
3. Simple active filters — design procedure by M. Bronzite, *Wireless World* March 1970 p.117
4. Vented-box loudspeaker system by Richard H. Small Loudspeakers — Anthology of Articles in J. Audio Eng. Soc. 1953-77 p.302
5. Personal calculator programs for approximate vented box design by Gerry Margolis and Richard H. Small *Journal Audio Eng. Soc.* vol.29 no.6 June 1981 p.421
6. Loudspeaker enclosure walls by Peter W. Tappan Loudspeakers — Anthology of Articles in J. Audio Eng. Soc. 1953-77 p.88

Appendix 1

Phase effects of path length
Consider two speakers distant l_1 and l_2 from a receiver with a planned cross-over frequency of f_o corresponding to a wavelength of λ_o. Then let

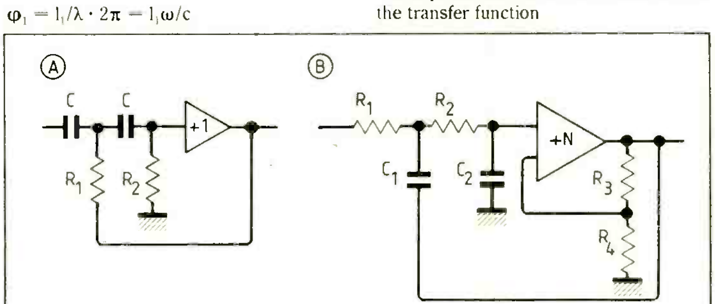
$l_1 - l_2 = A\lambda_o$

where A is a multiplier. Then

$(l_1 - l_2) = Ac/f_o = Ac.2\pi/\omega_o$ ...1

where c is the velocity of sound. For the furthest speaker at some frequency ω, wavelength λ, the phase at the receiver is

$\varphi_1 = l_1/\lambda \cdot 2\pi = l_1\omega/c$



and for the nearer source

$\varphi_2 = l_2 \cdot \omega/c$

$\therefore (\varphi_1 - \varphi_2) = (l_1 - l_2)\,\omega/c$

$= A.c.\ 2\pi/\omega_o \cdot \omega/c$

$= A\,(\omega/\omega_o)\,2\pi$ ...2

This relative phase shift can be represented by multiplying the signal from the furthest source by (a + jb) where

$a = \cos\,[A\,(\omega/\omega_o)\,2\pi]$

$b = \sin\,[A\,(\omega/\omega_o)\,2\pi]$ ...3

which will not affect the amplitude but will add $(\varphi_1 - \varphi_2)$ to the phase of the original signal. Further, any filter can be represented as a straightforward complex expression. As an example:

$$\frac{B}{s^2 + As + B} = \frac{B\,(B-\omega)}{(B-\omega^2)^2 + (A\omega)^2} + j\left[\frac{-A\,B\,\omega}{(B-\omega^2)^2 + (A\omega)^2}\right]$$

since $s = j\omega$. Thus, if the far speaker has say a low-pass filter response, and the near speaker has a corresponding high-pass response, then these may be expressed as

l.p. = C + jD

h.p. = E + jF

and the effect of path length will modify the l.p. response to

(C + jD) (a + jb) = G + jH

where a and b are values defined by equation 3. Finally the total received signal X will be

X = output 1 + output 2

= E + jF + G + jH

i.e. $X_{rms} = \sqrt{(E+G)^2 + (F+H)^2}$ ...4

and in Fig.2 this function in dB has been plotted against variation in normalised frequency and path difference, illustrating the response variation at any frequency as one moves across the room (going from $-\lambda_o$ to $+\lambda$ path difference)

Appendix 2

Filter design (based on ref.3)
1. *High-pass filter*

Select suitable value of C, then

$R_1 = T_1/2\,C\,\beta\,f_{3dB}$

$R_2 = 2\,T_2/C\,\beta\,f_{3dB}$

and f_{3dB} = 155.2Hz (selected)

β = 1.093

T_1 = 0.05582 first dual element

T_2 = 0.48264 first dual element

T_1 = 0.13475 second dual element

T_2 = 0.06700 second dual element

(values taken from tables 2 and 3 ref.3)

2. *Low-pass filter*

The expressions which follow are based on the transfer function

$$G = \frac{\dfrac{N}{t_1\,t_2}}{s^2 + s\left[\dfrac{1}{t_1} - (N-1)\dfrac{1}{t_2} + \dfrac{t_3}{t_1\,t_2}\right] + \dfrac{1}{t_1\,t_2}}$$

where $N = (1 + R_3/R_4)$, $t_1 = R_1C_1$, $t_2 = R_2C_2$, $t_3 = R_1C_2$.

a) Assuming equal resistors, select suitable value for C_1, then

$C_2 = C_1\,(T_2/4T_1)\,m^2$

where $m = \frac{1}{2}\,(1 + \sqrt{1 + 8(N-1)\,T_1/T_2})$

b) Select standard value $C'_2 < C_2$

then $R_1 = 2\,T_1\,\beta/C_1\,f_{3dB}n$

and $R_2 = n\,T_2\,\beta/2\,C_2\,f_{fdB}$

where n =

$$1 + \sqrt{1 - \frac{4\,C'_2}{C_1} \cdot \frac{T_1}{T_2}\left\{1 - \frac{C_1}{C_2}\,(N-1)\right\}}$$

The above values are obtained using selected values of N and taking Table 1 of ref. 3:

T_1 = 0.45381
T_2 = 0.05248
N = 1.846
} first dual element

T_1 = 0.18798
T_2 = 0.37808
N = 1.83333
} second dual element

Example With f_{dB} = 155.2 and β = 1.093 then for the second 'dual' of the low-pass filter let C_1 = 220nF, and N = 1.83333: (a) Then m = 1.5386, and C_2 = 262nF. (b) Let C_2 = 220nF, then n = 1.8176 and R_1 = 6K621 and R_2 = 10K999

Appendix 3

Box design (taken from ref.5)
A. Equations

$V_b = 20.6\,V_{AS}\,(Q_T)^{3.3}\,(10)^{R_H/6}$ 1

$a = V_{AS}/V_b$ 2

$f_3 = f_s \cdot a^{0.44}$ 3

$f_b = f_s \cdot a^{0.31}$ 4

$l_v = 2350dv^2/f_b^2V_b - 0.73\,d_v$ 5

with V_b internal box volume (litres)

V_{AS} driver suspension compliance (litres)

f_3 3dB frequency of system (Hz)

f_b box resonant frequency (Hz)

f_s loudspeaker resonant frequency (Hz)

Q_T quality factor

R_H negative pass-band ripple (dB)

d_v internal vent diameter (mm)

l_v total length of vent (mm)

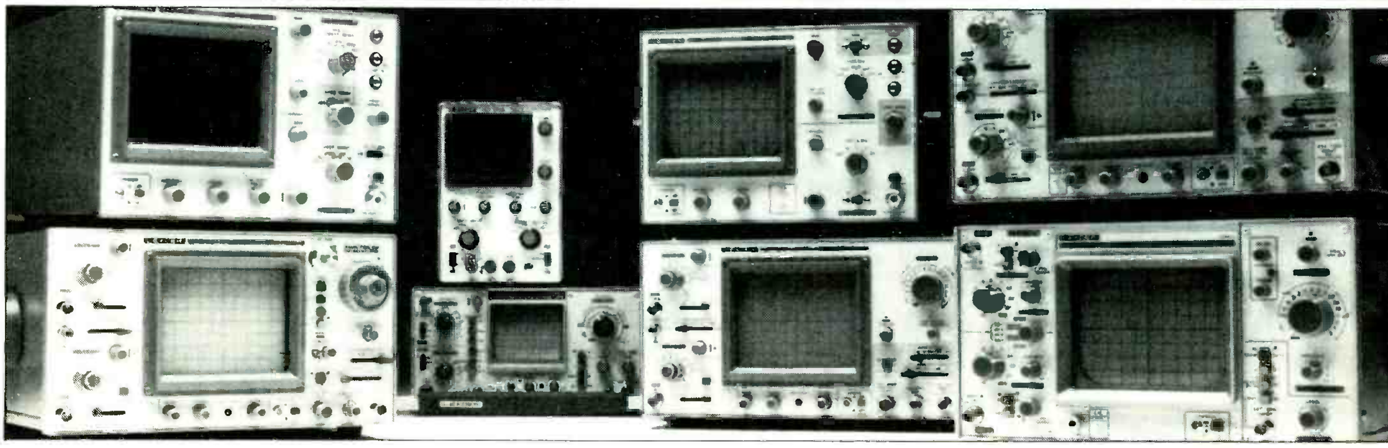
N.B. V_{AS}, f_s and Q_T obtained from loudspeaker specification and in this case = 202, 27 and 0.29 respectively.

B. Design process

- Establish value of R_H to meet required f_3. A value of 0.42dB was selected which gave V_b = 82 litres and f_3 = 40Hz from equations 1, 2 and 3.
- Establish vent length and volume. With a pipe whose internal diameter was 96mm, equation 5 gave the required length of 137mm. With an external diameter of 100mm the vent volume = 1.08 litres.
- Calculate the total inner box volume.

V_b	=	82l
Box losses (taken to be 8% V_b)	=	6.6l
Vent volume	=	1.08l
Amplifier + supply	=	0.94l
Speaker volume (approx. truncated cone)	=	3.20l
i.e. Total internal volume	=	93.8l

LEADER OSCILLOSCOPES



The Leader range of high performance oscilloscopes are designed to suit most requirements, offering comprehensive specification and long term reliability, yet remaining low cost.

LBO-514A is a dual trace, 15MHz bandwidth, 1mV sensitivity low cost general purpose oscilloscope

LBO-522 is a dual trace 20MHz bandwidth 500μV sensitivity oscilloscope, featuring X-Y variable hold off plus full TV triggering

LBO-523 is a dual trace 35MHz oscilloscope offering similar features to the LBO-522 plus internal graticule dome-mesh tube with 7kV acceleration (pda)

LBO-524 is a 35MHz dual trace oscilloscope similar to the LBO-523 plus the added facility of delayed sweep timebase

LBO-525L is a 50MHz dual trace oscilloscope offering comprehensive triggering and timebase facilities

LBO-516 is a 100MHz dual trace oscilloscope offering optimum performance at a competitive price

LBO-518 is a 100MHz quad channel oscilloscope with eight trace capabilities, offering comprehensive triggering and timebase options

LBO-5825 is a digital storage oscilloscope with a real time speed of 35MHz

LBO-308S is a battery/mains dual trace 20MHz small compact oscilloscope offering all the features normally found in a bench scope

thandar
ELECTRONICS LIMITED

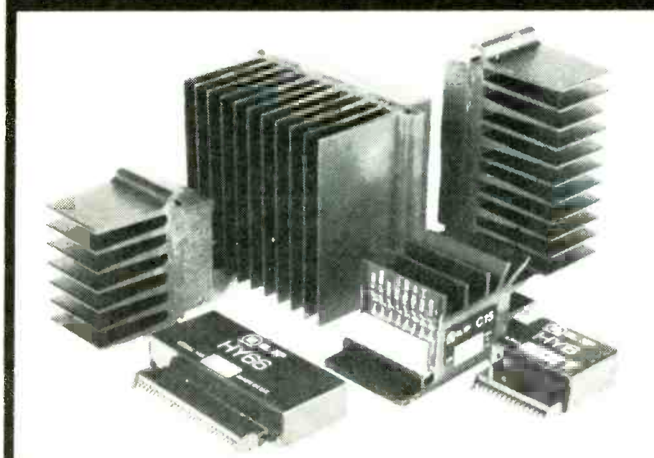
For further information contact:
Thandar Electronics Limited,
London Road, St. Ives, Huntingdon,
Cambridgeshire PE17 4HJ, England.
Telephone (0480) 64646 Telex 32250 Test.

THE LOGICAL CHOICE

CIRCLE 5 FOR FURTHER DETAILS.

AMPLIFIERS

WHY ILP? Years of experience in audio, unique designs, world wide sales and outlets, reliable delivery and friendly service........



BIPOLAR MODULES

Ideal for Hi Fi, Full load line protection integral Heatsink, slew rate 15v/μs

Distortion less than 0.01%

Type	Output Power Watts (rms)	Load Impedance Ω	Price
HY30	15	4-8	£8.45
HY60	30	4-8	£9.95
HY6060	30 + 30	4-8	£19.45
HY124	60	4	£20.95
HY128	60	8	£20.95
HY244	120	4	£26.95
HY248	120	8	£26.95
HY364	180	4	£39.95
HY368	180	8	£39.95

MOSFET MODULES

Ideal for Disco's, public address and applications with complex loads (line transformers etc.). Integral Heatsink slew rate 20v/μs distortion less than 0.01%

Type	Output Power Watts (rms)	Load Impedance Ω	Price
MOS128	60	4-8	£30.45
MOS248	120	4-8	£39.95
MOS364	180	4	£45.95

PREAMPLIFIER MODULES

All modules are supplied with in line connectors but require potentiometers, switches etc. If used with our power amps they are powered from the appropriate Power Supply.

Type	Application	Functions	Price
HY6	Mono Pre Amp	Full Hi Fi facilities	£7.95
HY66	Stereo Pre-Amp	Full Hi Fi facilites	£14.95
HY73	Guitar Pre-Amp	Two Guitars plus Microphone	£15.95
HY78	Stereo Pre-Amp	As HY66 less tone controls	£14.45

MOUNTING BOARDS: For ease of construction we recommend the B6 for HY6 **£0.95** B66 for HY66-78 **£1.45.**

POWER SUPPLY UNITS

Type	For Use With	Price
PSU212	1 or 2 HY30	£11.95
PSU412	1 or 2 HY60, 1 HY6060, 1 HY124	£13.95
PSU422	1 HY128	£15.95
PSU432	1 MOS128	£16.95
PSU512	2 HY128, 1 HY244	£17.45
PSU522	2 HY124	£17.45
PSU532	2 MOS128	£17.95
PSU542	1 HY248	£17.95
PSU552	1 MOS248	£19.95
PSU712	2 HY244	£21.95
PSU722	2 HY248	£22.95
PSU732	1 HY364	£22.95
PSU742	1 HY368	£24.45
PSU752	2 MOS248, 1 MOS368	£24.45

All the above are for 240v operation.

FOR FREE DATA PACK PLEASE WRITE TO OUR SALES DEPT.

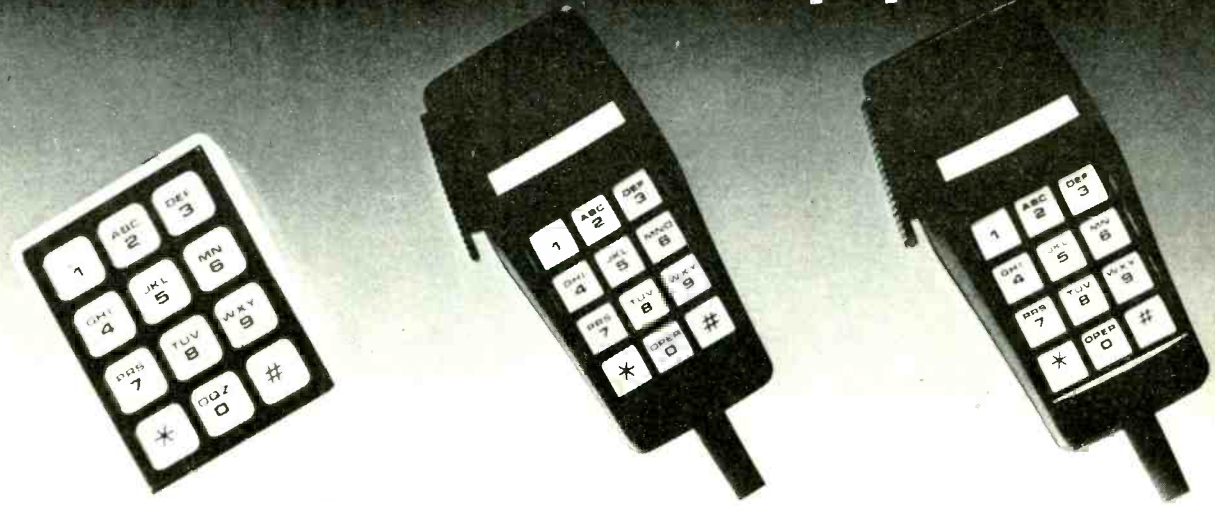
Post to: ILP Electronics Ltd., Dept. 6
Graham Bell House, Roper Close,
Canterbury, Kent. CT2 7EP
Tel: (0227) 454778 Telex: 965780

VISA Access

ILP

CIRCLE 28 FOR FURTHER DETAILS.

Three new names from IQD-
the leaders in DTMF equipment.



CODEPAD MICROPAD SELCALL

IQD offers the most advanced DTMF signalling equipment on the market.
IQD Codepad: the best in portable tone diallers, available in three models.
IQD Micropad: a microphone with not only the standard functions, but many additional features including an illuminated keyboard version.
IQD Selcall: a superior DTMF signalling unit with an extensive program facility giving you selective access to 99 sub-stations.

Telephone (0460) 74433 for further information.

IQD Ltd
North Street
Crewkerne
Somerset TA18 7AR
England
Facsimile (0460) 72578
Telex 46283

CIRCLE 29 FOR FURTHER DETAILS.

R.WITHERS COMMUNICATIONS

If you have not heard of (R. Withers Communications) we are main distributors or agents for the following, Yaesu, Icom, Kenwood, M.Modules, Jaybeam, Toevna, Revco Antennas. Cleartone, Mutek, Drae, F.D.K. Tonna, Welz, Zycomm, Neve Radiotelephones.
We are also stockist (British Telecom Approved) of a wide range of cordless telephones and telephone systems. We are also agents for hundreds of other radio communications equipment known the world over, we also manufacture our own range of VHF—UHF beam antennas which are also used by leading broadcast companies for wireless mic applications. We supply a large range of power transistors & modules to the trade. These we import ourselves directly from Japan. Listed below are just some of the many services we offer.

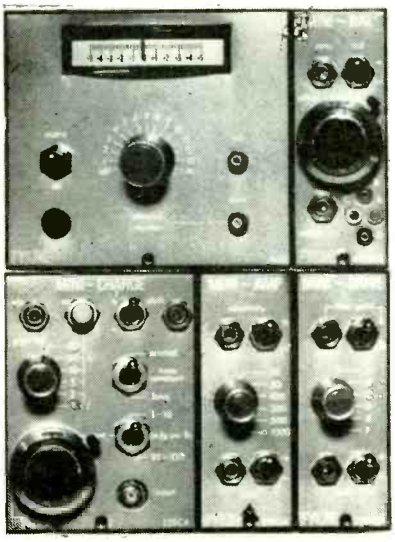
- ★ Supply & repair of all amateur & business radio equipment
- ★ Complete check of your transiever on a spectrum analyser (with comprehensive report) for the all in price of £12.50 subject to an appointment being made
- ★ Supply & complete installations of business radio systems including competitive maintainance contracts, local authorities included
- ★ Supply of 10 metre converted radios LCL, DNT, ICOM.
- ★ Only supplier of modified Revco RS 2000 50-520 MHz continuous coverage scanning receiver modified by (R. Withers Comms)
- ★ Probably the largest seller of second hand radio equipment in the country because of our commission sale agreement (3 month warranty) plus equipment facility
- ★ The fastest growing retail & wholesale company in the British Isles. Send for details of any of the equipment or services we offer whether you are in the profession of just an interested party an s.a.e. will speed up your enquiry
- ★ For all your communication needs give R.W.C. a try we promise you will not be disappointed.
- ★ The largest selection of radio allied services offered under one roof, with no expense spared on test equipment and qualified staff...

584 Hagley Road West, Oldbury, Warley
B68 0BS (Quinton, Birmingham)
Tel: 021-421 8201/2 (24 hr answerphone)
Overseas customers welcome. We speak German & Japanese.
Import/Export no problem. Please telephone during working hours!
or TELEX 334303 TXAGWM-G

CIRCLE 32 FOR FURTHER DETAILS.

FYLDE

TRANSDUCER and RECORDER
AMPLIFIERS and SYSTEMS



reliable high performance & practical controls.
individually powered modules—mains or dc option
single cases and up to 17 modules in standard 19" crates
small size—low weight—realistic prices.

FYLDE
Fylde Electronic Laboratories Limited.
49/51 Fylde Road Preston
PR1 2XQ
Telephone 0772 57560

CIRCLE 34 FOR FURTHER DETAILS.

NEW-LOOK SPECTRUM MANAGEMENT?

The report in the *Financial Times* on December 24 that the Government is already actively pursuing the possibility of charging higher "commercial" fees for the use of the radio spectrum clearly has important implications for all users of radio frequencies. The DTI has already invited consultants to tender for a feasibility study. Possible changes were foreshadowed in last-minute changes to the British Telecom prospectus, including the warning to investors that the Government was considering "some form of pricing for the radio spectrum in place of, or in addition to the present licence fee basis." The profits of BT as a main user of the spectrum would clearly be adversely affected by what would amount to introducing a new form of revenue collection. It could amount, in effect, to a new tax on communications, broadcasting, radio navigation, amateur radio etc. At present DTI licence fees are intended to cover little more than the cost of administration and the less-than-effective regulation of the spectrum. Government departments, particularly the Defence services, are major users of the spectrum.

The ethics of selling a natural resource such as the radio spectrum to the highest bidders seems questionable, akin to the infamous window tax of history that sought to make householders pay for access to light. While it might, or might not, encourage more use of spectrum-conservation techniques, it could have a devastating effect on some services. What, for example, would be the cost of a transmitting licence for television transmission with its 8MHz channel bandwidth? Would licences differentiate between fees payable for Morse, s.s.b., a.m., f.m., broad-band data etc.? Would there be individual DTI licences for cordless telephones, cellular radio etc.?

In the USA, an attempt a few years ago to introduce revenue-raising licence fees for the use of the radio spectrum failed, but there are reports that the FCC are being urged to try again.

Annex M of the Merriman Report of 1983 discussed the use of price mechanisms in spectrum management, based on papers from the Radio Regulatory Department (then part of the Home Office) and two other Government bodies. The Committee itself recommended the progressive development of more general techniques in costing spectrum use to encourage more use of the less congested frequency bands and to encourage the use of less congested frequency bands and to encourage the use of less bandwidth-demanding equipment. While few would quarrel with such aims, the fact remains that increased charges could be used in pursuit of Government policies having little to do with efficient spectrum management.

EXTERNAL VOICES

Bert Gallon, chief engineer, BBC external broadcasting, interviewed on the weekly "Waveguide" programme, has stated that construction of new overseas relay transmitter complexes at Hong Kong and at Mahe in the Seychelles is due to begin shortly. The stations should become operational in 1987 and 1988 respectively. This will give the Hong Kong base a life of only ten years before the return of the colony to China, though the BBC are hopeful that it may prove possible to continue to use the transmitters, when Hong Kong becomes Chinese territory.

The two new 500kW. Telefunken h.f. transmitters at Rampisham, Dorset — the highest power h.f. transmitters so far commissioned by the BBC are now in full operation. This follows severe delays while the manufacturers investigated problems with the high-power valves and aerial switching.

Search for a successor to the wartime h.f. transmitter complex at Skelton, Cumbria is now divided between Bearley, near Stratford-on-Avon and Orfordness, Sussex.

Seven new studios have been completed at Bush House where the BBC has taken over the entire building. These are acoustically suitable for stereo recording and the BBC contemplate producing music and drama programmes in stereo, for rebroadcasting on their v.h.f. outlets in Berlin and Singapore and by the increasing number of overseas broadcasters who relay some BBC programmes on their domestic services. Relay bases are now served by high-quality digital feeds using the Intelsat Indian Ocean and Atlantic Ocean satellites.

Bert Gallon sees no prospects of any early use of direct broadcasting of sound radio from satellites, pointing both to international agreements that rule out the use of d.b.s. for programmes deliberately targeted at other countries, lack of any suitable frequency allocation and the high cost of transmission and reception. He forecast that there would be little reduction in the use of h.f. for external broadcasting during the next ten years.

Although BBC World Service is carried on m.f. and l.f. for many hours each day — and attracts a roughly 4 per cent share of the UK radio audience — there seems little prospect of any formal recognition of its domestic audience, as this would require the renegotiation of performers fees and, more importantly, might affect the Foreign & Commonwealth Grant-in-Aid on which all external broadcasting depends.

MIDGLEY'S INVENTIONS

Increasing specialization, even within the electronics discipline with its growing barriers of mutual incomprehension between the users of advanced analogue and digital techniques, has led inevitably to the phasing out of the general-purpose inventor/entrepreneur prepared to use mechanical, electrical and electronic techniques in his search for product innovation.

Already it is being forgotten how much electronics owes to the ingenuity of those who trained as mechanical or electrical engineers but turned their fertile minds to radio reception in the 1920's. So prolific were some of the pioneers in a variety of disciplines that it is very difficult, even for those interested in the history of technology, to assess their contributions.

I suspect that relatively few readers could immediately place A.H. Midgley (1881-1961). Yet as a recent exhibition, "A British genius — the inventions of Albert Midgley" at the enterprising Watford Museum, amply demonstrated, Midgley made a lasting mark in a string of inventions (212 UK patents) including starting motors and lighting systems for vehicles; timing mechanisms and fuses for weapons in two World Wars; the pioneering of multi-electrode thermionic valves made to his design by Captain S.R. Mullard in 1927 for his "One-Det" "one-valve" loudspeaker receiver; a 1931 master patent for the production of musical tones by electrical means; the Kinestron cinema organs: the development of high-quality loudspeakers and amplifiers for electronic organs and domestic hi-fi systems; the electronic guitar; even the first British tape recorder marketed by Boosey & Hawkes and based on the German wartime development of h.f. biasing. His often tempestuous career included work with C.A. Vandervell and a string of enterprises that bought him into conflict with powerful industrial rivals and former associates, yet the evidence that he had a remarkably fertile and truly inventive mind seems overwhelming. In the early 1920s he was awarded the then substantial sum of £14,000 "Award to Inventors" for the Allways Fuse used in bombs and Mills grenades. But little other professional recognition seems to have come his way until now, 24 years after his death, with the Watford exibition. Perhaps this was because is work was firmly directed towards the invention and development of saleable products rather then "pure" research.

CABLE & DBS

American cable-television penetration at mid-1984 has been estimated at about 42 per cent of television households, representing about 35.7-million homes. The providers of premium subscription channels, such as Home Box Office, continue to complain of large numbers of illegal viewers by means of unauthorised cable taps, reception of microwave (2.5GHz) multiplex distribution systems, and 4GHz reception from distribution satellites. There appears to be a significant market in decoders that overcome the relatively crude encryption systems in use in the USA. HBO however is supplying some 10,000 descrambler units for the Video Cipher 2 system for satellite distribution to cable network operators.

An experimental optical fibre network is operational in Biarritz, France, providing 15 channels and a videophone service to some 1500 subscribers. TDF is increasing the amount of subtitling for the hearing-impaired to about 12 hours per week, and has placed a bulk order for 30,000 Antiope decoders. The UK, however, would appear to remain well ahead in the field of broadcast teletext with decoders still significantly below the cost of the comparable Antiope units. The launch of the pre-operational French direct-broadcasting satellite has been put back to allow more time to develop the high-power travelling-wave-tube package following the problems when it was used in the Japanese satellite launched in January, 1984. The alternative German t.w.t. has still to be tested in orbit.

Amateur Radio

STUCK WITH IT!

In the December issue I drew attention to the effect of the falling pound/yen and pound/dollar exchange rates on the cost of amateur radio equipment in the UK — indeed costs have gone up still further since then. The policy of the major Japanese firms in appointing in the UK "authorised distributors" capable of servicing and maintaining their equipment has also tended to maintain retail prices, without the many "special offers" and discounts found on similar equipments of the USA. One result has been that a significant number of British amateurs have found it cheaper to buy equipment overseas and then bring it into the UK as a personal import. Then, if necessary, modifying it to suit UK standards, regulations or practices.

What could prove a major disincentive to this practice and which also has implications for the more experimentally-minded amateur is arising from the new forms of hybrid construction, including the use of chip-type, surface-mounted assemblies, now in growing use for this class of equipment. This follows its successful use in recent years for consumer electronics such as the Sony "Walkman" etc.

For the customer, the use of these techniques has the advantage of countering the rising cost in Japan of conventional printed-board assembly, offering consistent performance and excellent reliability as well as the possibility of packing even more complexity into very compact units.

There is little doubt that the new forms of automatic assembly and hybrid microelectronics have come to stay. But equally there is no doubt at all that it is no longer a simple matter to introduce *any* modifications, or to troubleshoot and repair such equipment without access to specialised techniques.

For example, the chip components no longer carry any identification; the parts are held in place not only by dip soldering but by epoxy adhesives which are subsequently oven-hardened and then further hardened by the heat from the dip soldering. There is thus virtually no way in which an owner can himself remove or change components, even for what has in the past been the relatively simple modification of v.h.f./u.h.f. channel spacings etc. In some equipments not even the factory can modify equipment once it has been dip soldered.

Thus are thus, as Kjell W. Strom, SM6CP1, the Yaesu European manager based in Italy, points out, both advantages in better value for money, higher reliability etc. in the manufacturing techniques but also some significant loss in flexibiity — and possible disappointment for those importing their own equipment. It means that the "black boxes" no longer can form the basis of an experimental rig.

The rush to counter rising costs by adopting new manufacturing processes is also leading to a succession of new models, rather than progressive modification of established models. The Yaesu FT101 transceiver and FRG7 receiver for example were marketed for many years in various versions staying on the assembly lines "until their metal stamping tools were completely worn down" to quote Kjell Strom.

RSGB IN-FIGHTING

The 1984 annual general meeting of the RSGB proved, in some ways, a rather disheartening occasion with an undue amount of the time taken up with procedural wrangles over matters that never became clear to the majority of those present. Simmering beneath the surface was a split between Council members over the election of Mrs Joan Heathershaw, G4CHH as the 1985 President, reversing an earlier (disputed) appointment "by acclamation" of Ingemar Lundegard, G3GJW, to the post. This all rather overshadowed the news that the RSGB has obtained from the DTI the concession (for one year from April 1, 1985) that Class B licensees may apply to the society for a letter of variation to their licence permitting the use of Morse code on frequencies above 144MHz with a view to on-air training, etc. The AGM also saw an award presented by IARU Region 1 and the RSGB's "Calcutta Key" to C.E. Godsmark, G5CO.

The Marconi Medal was awarded to a group of West German amateurs, who as DFOEME, have specialized in 2.3GHz "moon-bounce" work using an impressive 10-metre diameter parabolic reflector dish aerial. The RSGB has changed the name of its headquarters building at Potters Bar from Alma House to Lambda House.

IN BRIEF

The New Year's Honours List brought a well-deserved British Empire Medal to Mrs Frances Woolley, G3LWY, for her services to the Radio Amateur Invalid and Blind Club of which she has been honorary Secretary for many years. . . British amateurs continue to encounter difficulties that appear to be due more to interference problems than to questions of environment when applying for planning permission to erect masts and towers, though in several cases recently local authority refusals have been overturned on appeal. . . The "Sir Walter Raleigh" which will circumnavigate the world during the next four years for "Operation Raleigh" will operate on the amateur bands as GB2SWR/MM. . . The Post Office is now providing amateurs, as they renew their licences, with a new "Amateur Radio Validation Document" to provide a wallet-sized means of proving current validity of the licence and for notifying the Post Office of any change of address, etc. . . NASA has confirmed that Tony England, W0ORE, will operate from the Space Shuttle during the 51-F mission now tentatively scheduled for July 1985. . . The West Kent Amateur Radio Society is planning an expedition this summer with a view to attempt to make a 144MHz direct two-way contact across the Atlantic, a feat that has so far defeated the efforts of many amateurs.

An attempt is to be made to revive the meetings of the Radio Amateurs 'Old Timers' Association. Although the weekly 3.5MHz on-air net (3570kHz, Tuesday, 11 a.m.) continues there have been no meetings since the death of "Uncle Vic" Corsham, G2UV. The possibility of a meeting in the Midlands this Spring is being mooted. . . The three remaining operational Russian amateur satellites in orbit, TS5, RS7 and RS8 are each active on only two days of the week in order to limit the now failing power sub-systems. One satellite is switched on each day except Wednesday when there is no operation. . .

PAT HAWKER, G3VA

VISIT OR PHONE

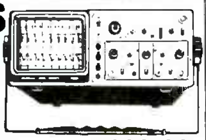
OPEN 6 DAYS A WEEK ALL STOCKS ON DISPLAY

HENRY'S AUDIO ELECTRONICS

EQUIPMENT • COMMUNICATIONS • COMPUTERS • COMPONENTS

ALL PRICES EXCLUDE VAT

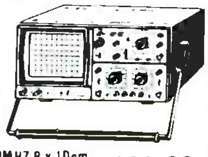
SCOPES



(UK C/P £6.00 or £15.00 Securicor)

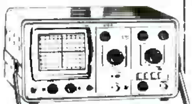
HITACHI
2 year warranty
ALL MODELS WITH 2 PROBES (Not V212)
V212 Dual 20 MHZ 6" CRT Probes see below **£299.00**
V222 As 212 plus DC offset, etc **£395.00**
V223F Dual 20MHZ Sweep delay 5½ **£445.00**
All other models available.

HAMEG



2 years warranty
HM103 Single trace 10MHZ 6 x 7cm display component tester £167.00
HM 203/5 Dual 20MHZ 8 x 10cm display component tester, etc. etc. **£264.00**
HM204-2 Dual 20MHZ, sweep delay, lmV, component tester, etc. **£365.00**
Also HM605 Dual 60MHZ **£515.00**

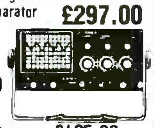
SCOPE PROBES



X1—X10 switched. £10.00 for all scopes.

CROTECH
3030 Single trace 15MHZ component tester 9½cm display **£179.00**
3035 Single trace 15MHZ 13cm (5") display component tester **£198.00**
3132 Dual 20MHZ trig to 40MHZ, 2mV/div 130mm (5") display, algebraical add/sub Reg DC O/P's + 5V AD ± 12V. Built-in component comparator **£297.00**

SCOPEX

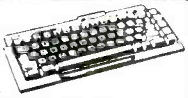


14D15 Dual 15 MHZ 5" tube TV SYNCH Z MOD **£325.00**
F6 As above plus fitted 0.2HZ to 200 KHZ Function Generator **£425.00**

THANDAR

2 year warranty
SC110A 10MHZ battery portable 32 x 26mm display with batteries **£165.00**
(UK post, etc. £1.50)
OPTIONS Carry case £5.95
AC adaptor/charger £6.95 Nicad pack £11.00

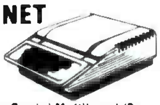
ASC11 KEYBOARDS



69S05 Compact, 64 key + 5 function keys. Hall effect keyboard with reprogrammable (2716) ASCII output decoder EPROM Steel key frame for good rigidity. Negative going strobe. Requires +5 volt +12 volt supplies (UK C/P £1.00) £21.70

2070 COMPACT 58 KEY ASC11 KEYBOARD
Contactless capacitive high reliability keys. Full 128 ASCII codes Steel key frame for positive rigidity. 1mS strobe, single +5 volt supply. Repeat key, control and caps. lock. £28.26 (UK C/P £1.00)

ITT 2020 CABINET



Professional computer case with keyboard cutout. 18" x 15.5" x 4.5" (front slopes). Ideal for single board computers like the Nascom or Gemini Multiboard (3 cards, etc). Very heavy gauge (.25") plastic with metal base. Attractive silver grey finish. (UK C/P £1.78) £19.95

DIGITAL MULTIMETERS

HAND HELD MODELS
Controls S=Slide R=Rotary PB=Push button
All feature AC/DC volts, DC amps (many with AC amps) ohms etc. UK C/P 65p) *WITH CARRY CASE
*KD25C 12 range 0.2A DC 2 Meg ohm(S) £24.30
*KD305 14 range 10A DC2 Meg ohm(S) £25.91
*KD30C 26 range 1A AC/DC 20 Meg ohm(R) £31.13
*METEX 3500 30 range 10A AC/DC 20 Meg ohm (R) £36.75
* METEX 3510, 30 range 10A AC/DC, 20 meg ohm plus Hfe tester plus cont. tester (R) £40.45
6010 28 range 10A AC/DC 20 Meg ohm(PB) £37.83
*KD55C 28 range 10A AC/DC 20 Meg ohm(R) £38.70
*KD615 18 range 10A DC 2 Meg ohm plus Hfe tester (R) £34.74
7030 As 6010 but 0.1% basic (PB) £46.91
HC 5010 31 range 10A AC/DC Cont buzzer 20M ohm (R) £43.43
*DM3350 Autorange plus cont. tester 18 range 10A AC/DC 2 Meg ohm (R) £43.44
*DM2350 Mini autorange plus cont. tester 19 range 10A AC/DC (20A Max) 2 Meg ohm (PB) £60.83
*3100 Pen type auto ranging AC/DC V 20 Meg ohm + buzzer £39.75
SOAR ME540 Manual/Autoranging plus cont buzzer. 19 range 10A AC/DC 20 Meg ohm (R) £41.54
METRIX HAND/BENCH PORTABLES (ITT) (Size 188 x 86 x 50mm Rotary controls)
MX522 3½ digit LCD 21 ranges 10A AC/DC 2 Meg ohm Basic 0.5% (R) £67.00
MX562 3½ digit LCD 29 ranges 10A AC/DC 20 Meg ohm Basic 0.2% Plus continuity tester (R) £95.00
MX563 True RMS 3½ digit 30 ranges 10A AC/DC 20 Meg ohm, 20HZ to 30KHZ 0.1% basic(R) £155.00
MX575 4½ digit True RMS 21 ranges 10A AC/DC, up to 50KHZ 0.05% basic (R) £175.00

ANALOGUE MULTIMETERS

General range (*mirror scale) (UK C/P 65p)
HC1015 15 range pocket 10K/Volt 1 meg ohm £7.78
HM102BZ* 22 range 20K/Volt 10A DC plus cont. Buzzer 10 Meg ohm £12.61
ETU3000 20 range 30K/V 12A DC 12 meg ohm £18.26
NH56R* 22 range 10K/Volt 6 Meg ohm £11.26
830A* 26 range 30K/Volt 10AC/DC 10 Meg ohm £21.70
360TR* 23 range bench 100K/Volt, large scale, 10A AV/DC plus Hfe tester. 10 Meg ohm £39.13
AT2100* 31 range de luxe 100K/Volt 10A AC/DC, 100 Meg ohm £30.39
AT1020* 18 range de luxe 20K/Volt plus Hfe tester, 5 Meg ohm £19.57
YN360TR* 19 range 20K/Volt plus Hfe tester 1 Meg ohm £13.87
KRT5001* Range doubler 35 range total 10K/Volt 10A DC 20 Meg ohm £19.09
ST303TR* 22 range 20K/Volt plus Hfe tester 12A DC 1 Meg ohm £18.26
Metrix (ITT) Professional series in stock, ask for leaflet.

COMPUTER POWER SUPPLY

Switched mode. Stabilised. Self protecting S/C protected, etc. 220/240V AC + 5V 3.3A +12V 2.4A 40% cycle -5V 0.5A -12V 0.5A. Suitable Apple replacement (UK C/P £1.50) £50.00

VARIABLE POWER SUPPLIES

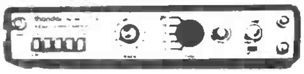
220/240V AC input (UK C/P £1.00)
PP241 single meter A/V switch 0/30V 1 amp £33.00
PP243 3 amp version £52.13
230N Twin meter 0/30V 1A £97.00
330N 3 amp version £175.00
2302 Dual 0/30V 0/2A twin meter plus fixed 5V 1A also pulse generator. £230.00

COMPONENTS ■ TOOLS ■ ACCESSORIES
LARGE RANGE IN STOCK
Tel: 01-723 1008 for small or large quantities.

LCD COUNTERS

(UK C/P & INS 65p)
THANDAR battery portable 8 digit LCD counters. Size 255 x 150 x 50mm. Complete with batteries.
Optional: Carry case £5.95 AC adaptor £6.95
TF040 10HZ to 40MHZ, 1HZ Res. 49mV sensitivity. £120.00
TF200 10HZ to 200MHZ, 1ppm res. 10mV sensitivity, many features. A&B inputs, etc. £165.00
TP600 600MHZ prescaler (Powered by computer) £45.00
TP1000 1000MHZ (1GHZ) Prescaler with power supply £65.00
PFM200A Pocket 20HZ to 200MHZ LED counter 0.1HZ res. 10mV. sensitivity £69.50
NEW TF600 LED 600 MHZ counter £132.50

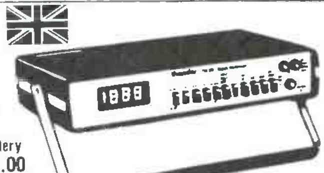
GENERATORS



Function and Pulse (UK C/P 65p)
THANDAR bench mains portable. Size 255 x 150 x 50mm
Options: Carry case £5.95
TG101 0.02HZ to 200KHZ function, sine, square, triangle. Variable DC offset. TTL O/P Ext. sweep mode. Variable 600 ohm 10V pp £105.00

TG102 0.2HZ to 2MHZ function. Sine, square, triangle. Variable DC offset. TTL O/P. Ext. sweep mode variable 600 ohm O/P. 10V PP £155.00
TG105 5HZ to 5MHZ pulse. TTL and Sync O/P. Variable 50 ohm O/P. Free run, gated or trig. modes. £105.00
T500 series in stock.

LCD & LED MULTIMETERS

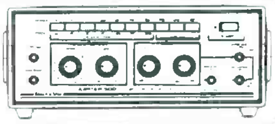


(UK C/P 65p)
THANDAR BENCH PORTABLES Size 255 x 150 x 50mm Option: Carry case £6.84
TM355 3½ digit LED. 29 ranges. 0.25% basic 100mV res. 10A AC/DC, 20M ohm £85.00
(AC adaptor option £6.95)
TM356 3½ digit LCD 29 ranges as TM355. 3000 hour battery life (supplied) £95.00
TM351 3½ digit LCD. 29 ranges. 0.1% basic. Ranges as above. 2000 hour battery life. £115.00

LED COUNTERS

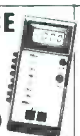
(UK C/P 65p) (AC adaptor included)
METEOR mains or battery portable 8 digit LED counters. Size 219 x 240 x 98mm. 5mV sensitivity 0.1HZ resolution
100 5HZ to 100MHZ £99.00
600 5HZ to 600MHZ A&B inputs £126.00
1000 5HZ to 1000MHZ (1GHZ) A&B inputs £175.00
Options: 6 NICADS £10.60 RF pickup Aerial £8.50

FUNCTION GENERATOR



(UK C/P 65p)
JUPITER 500 Function generator 0.1HZ to 500KHZ or better. Sine, square, triangle O/P to ± 30 volts. TTL O/P. DC offset ± 15V variable. Ext AM and sweep facilities 220/240V AC operated. £110.00

DIGITAL CAPACITANCE METER



DM6013 0.1 pf to 2000 mfd LCD 8 ranges 3½ digit. £60.43 (UK C/P 65p)
CM200 Bench version 4½ digit LCD 1 pf to 2500 mfd 6 range £89.00 (UK C/P £1.00)

AC CLAMPMETER

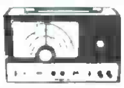
0/300A 0/600V AC 0/1K ohm
Total 9 ranges with carry case and lead
ST300 £30.87 (UK C/P 65p)
YF501 Electric insulation tester £71.74

DIGITAL THERMOMETER

Pocket size LCD thermometers complete with battery. Accept any type K probe (UK C/P 65p)
TH301 LCD -50° to +750°C 1°C resolution with thermocouple £59.50

LEAFLETS AVAILABLE FOR MOST ITEMS SEND LARGE SAE (UK 25p) for latest catalogue.

AUDIO AND RF GENERATORS



(UK C/P £1.00)
AUDIO
LEADER LAG27 5 band sine/square O/P 0/5V RMS Dist 0.05% 20HZ to 1MHZ £93.00
LEADER LAG120A 5 band 10HZ to 1MHZ to 0.3V RMS into 600 ohm 0.05% dist sine/square £155.00
LEADER LAG125 5 band 10HZ to 1MHZ to 0.3V RMS into 600 ohm sine/square/burst signals 0.03% dist £330.00
TRIO AG202A 4 band 20HZ to 200KHZ 10V RMS O/P 0.5% dist CR OSC 0/10V pp O/P £89.00
TRIO AG203 5 band 10HZ to 1MHZ 0.1% dist 0/7V RMS O/P £139.00
RF
TRIO SG402 6 range 100KHZ to 30MHZ RF 0.1V RMS Int/ext mod £72.00
LEADER LSG17 6 band 100KHZ to 150MHZ (96 to 450MHZ to Harmonics) RF 0.1V RMS Int/ext Mod AF 1KHZ 1 volt (1MHZ Xtal optional £3.00) £115.00

TR DIP METER

1.5 to 200MHZ 6 band (UK C/P 65p) £48.70

SUPPLIERS OF ELECTRONICS FOR EVERY PURPOSE | Official orders welcome. (Subject to confirmation) | ALL PRICES EXCLUDE VAT

ASK HENRY'S FIRST

ORDER BY POST OR PHONE
Access VISA AMERICAN EXPRESS
Up to £1000 instant credit
Available through Lombard Tricity Finance

301 Edgware Road, London, W2
Test Equipment, Audio, Communications 01-724 3564
404 Edgware Road, London, W2
Computers 01-402 6822 • Equipment 01-724 0323 • Components 01-723 1008

CALL IN AND SEE FOR YOURSELF All mail to Cubegate Ltd. 1st Floor, 406 Edgware Road, London W2 1ED

CIRCLE 19 FOR FURTHER DETAILS.

Vigilant **micon** HF Communications Receivers

MICROPROCESSOR CONTROLLED RECEIVERS

Type SR 530 USB/CW/AM/Telex – 10 Hz Steps (Marine)
Type SR 532 USB/LSB/AM/CW – 10 Hz Steps (Static/Transportable)
Type SR 531 USB/LSB/AM/CW – 100 Hz Steps (Static/Transportable)

DESIGNED AND MANUFACTURED TO HIGHEST INTERNATIONAL SPECS

Freq. Range : 50 KHz to 30 MHz
Increments : 10 Hz or 100 Hz Steps
Stability : ± 1 Part in 10^7/°C
Tuning : Keypad and Spin Wheel
Power Supplies : 110/240V AC and 24V DC
FULLY MODULAR 'PLUG IN' CONSTRUCTION

Memory : 200 Channels Freq/Mode/Filter
Scanning : Full memory or discreet parts
Automatic or Manual Stop
Manual step on or Reverse
Dwell : Variable from Keypad 1 to 9 seconds
KEYPAD FUNCTIONS INDICATED BY DISPLAYS

NOW AVAILABLE AT HIGHLY COMPETITIVE PRICES

Send for Technical Brochure to:
Vigilant Communications Ltd.
Unit 5, Pontiac Works, Fernbank Road, Ascot, Berks SL5 8JH, England

Tel: (0344) 885656
Telex: 849769 Vigcom G

CIRCLE 27 FOR FURTHER DETAILS.

MARTIN ASSOCIATES sales

Parthia
Beckhampton,
Nr. Marlborough, Wilts.
Tel. Avebury (067 23) 219

USED ELECTRONIC EQUIPMENT

METERS			
Fluke	8100A	3½ Digit D.M.M.	£30.00
H-P	3406A	R.F. Voltmeter Freq. 10kHz-1.2GHz Sample Hold	£995.00
Keithley	135	4½ digit Handheld DMM Almost new	£145.00
Morconi	TF2604	Electronic Voltmeter 20Hz-1.5GHz	£160.00
OSCILLOSCOPES			
Solartron	A100	Dual Trace DC-100MHz. 10mV/div	£250.00
Solartron	CD1400	Dual Beam DC-15MHz	£85.00
Tektronix	422	Dual Trace DC-15MHz Portable c/w Batteries	£225.00
Tektronix	454A	Dual Trace DC-150MHz Delayed Sweep 5mV/div	£450.00
Tektronix	549	Storage Bistable Split Screen Max Writing speed 5cm/uSec 1A4 Plug in	£350.00
ANALYSERS			
Dymar	1771	A.F. Wave Analyser Freq. 0-50kHz 30uV-300V	£50.00
Dranetz	626	AC Universal Mains Disturbance Analyser c/w Single & 3 phase plug ins.	£6500.00
Fluke	1090A/001	Microprocesser Trouble Shooter with 8065 & Z80 Interface pods RS232	£4895.00
OVENS			
Gallenkamp	OV700	Humidity Oven 100°C Pen recorder	£850.00
Towerson & Mercer	40A621	Vacuum oven Amb-200°C 10.75" dia x 12"D NEW	£185.00
BRIDGES			
MARCONI	TF868B	Universal LCR Bridge 1% 1&10kHz	£150.00
Wayne Kerr	S261/R261	Source and Detecter 50MHz-250MHz	£95.00
GENERATORS			
Schaffner	NSG 200E	Line Interference Simulator Main Frame	
	NSG 223A	with High Energy Pulse Module NEW	£2185.00
Tektronix	148	Television Insertion Test Generator	£3500.00
MISCELLANEOUS			
DEC	RK05-AB	Digital Disk Cleaner for RK05-08/11/AC cartridges	£145.00
Disa	55D05	Digital Anenometer for fluid measurement etc.	£120.00
Coulter	550/551	Digital Contamination Monitor & Probe for determining particle in the environment	£250.00

THE ABOVE IS A SAMPLE OF OUR STOCK   SEND S.A.E. FOR CURRENT LIST   ALL ITEMS SUBJECT TO AVAILABILITY, CARRIAGE & V.A.T.

CIRCLE 57 FOR FURTHER DETAILS.

Andelos 68000 SYSTEM

Powerful 68000 runs at 10MHz without wait states. Up to 32KB EPROM and 4 or 16KB fast static RAM. 24 line programmable parallel I/O port. RS232 programmable serial port. Comprehensive monitor in 2764 Eproms. Optional plug-in Eprom programmer card. Cross Assemblers for Z80 based microcomputers. Code can be developed, downline loaded to 68000, debugged, and then written into Eprom.

* 10MHz 68000 CPU Board..................from **£295+VAT**
* EPROM PROGRAMMER card..................**£95+VAT**
* CROSS ASSEMBLER for Z80 hosts... from**£55+VAT**

Andelos Systems   Telephone: (0635) 201150
Solina, Bucklebury Alley, Cold Ash, Newbury, Berkshire RG16 9NN

CIRCLE 114 FOR FURTHER DETAILS.

STEREO STABILIZER

- Rack mounting frequency shifter for howl reduction in public address and sound reinforcement
- Mono version, box types and circuit boards also available

SURREY ELECTRONICS LTD., The Forge, Lucks Green
Cranleigh, Surrey GU6 7BG
Telephone: 0483 275997

CIRCLE 8 FOR FURTHER DETAILS.

The new logic symbols — 1

by Ian Kampel, M.I.E.R.E.

The national standards of all major technological countries are changing to comply with a new international standard. This new standard will affect everyone concerned with digital electronics, and the implications of the change should not be underestimated — especially if digital electronics is your profession. Be warned: the new logic symbols are far more than mere substitutions for existing symbols — they take an entirely new approach to representing logic circuitry. Is it all for the better or for the worse? Read on!

This is the first of three articles intended to make readers aware of the new logic symbols. This first part concentrates on explaining why the symbols are to change, indicating the advantages and disadvantages, and explaining the basic principles. The second part will explain some of the more complex symbols and features such as the common-control box and dependency notation, and the third part will discuss trends and the way ahead using the new symbology.

The background

My own interest in what I here term the 'new' logic symbols stems from documentation work undertaken on Concorde many years ago for American use. These particular handbooks were written to the American ANSI Y32. 14-1973 Specification (equivalent to IEEE Std 91-1973), and although I had been in the field of technical documentation for some time, nevertheless they then represented a major deviation from any previous understanding I or my colleagues had of logic symbols. I must confess it did serve to baffle us initially.

In more recent years I have been involved in documentation work for Army Equipment Service Publications (AESPs) to British Standard 3939: Section 21 (Issue 2), Binary Logic Symbols, which went part way to conforming to the previously mentioned American standard, but led us into all kinds of difficulties because it was not a full specification: too many symbols were missing for it to be rigidly applied. If I say here that this British Standard uses rectangular symbols, I know that many will imagine they are familiar with it, assuming that it simply substitutes rectangular symbols for previously existing characteristically shaped curved symbols. In fact, this notion harks back to a still earlier standard, for Issue 2 of BS3939, Section 21, is far more sophisticated than that: it was, in fact, a half-way house towards the standard that I now wish to talk about, the standard that BS3939 is due to conform to very shortly.

The fact of the matter is that for over a decade there has been international co-operation in an active attempt to develop an internationally acceptable standard for logic symbols that would be recognised throughout the world and would be versatile enough to cope with the ever increasing complexity of modern digital circuits.

France, Germany, Netherlands, Japan, the UK and USA and many more now intend to bring their own national standards fully or broadly in line, which stresses the importance of this subject to every digital engineer. There are other countries actively involved in the discussions whose intentions are less well known, but in due course, may well also conform.

Anyone working for a large company has seen from personal experience that committees generally design camels with surplus humps and that international committees can never see beyond the humps. It is therefore no mean feat for a body to have reached the stage where all these countries are in broad agreement on a new standard. Such a body is the International Electrotechnical Commission (IEC), based in Geneva.

After a decade of discussion, a document entitled IEC Publication 617:12, Binary Logic Elements, has been published, and it is this document which is to be the basis of numerous revised national standards. Like the United Kingdom, many countries intend to publish 'Chinese copies' of this source document. The digital engineer is therefore probably the first in the field to get

Acknowledgements
The author is greatly indebted to Mr D.B.J. Hicks of the British Standards Institution, Messrs C.J. Stanford and L. van Rooij, General Secretary and Deputy General Secretary of the International Electrotechnical Commission, for their invaluable assistance in the research work for my book, Mr N. Warnock-Smith of Butterworth Scientific Ltd, for his kind co-operation in the use of illustrations from my book for this article, and Ms J. Molyneaux, who penned the excellent illustrations.

Mr Kampel has produced a book on this subject, entitled A Practical Introduction to the New Logic Symbols" (Butterworth Scientific, 1985). It is based on IEC Publication 617:12 —Ed.

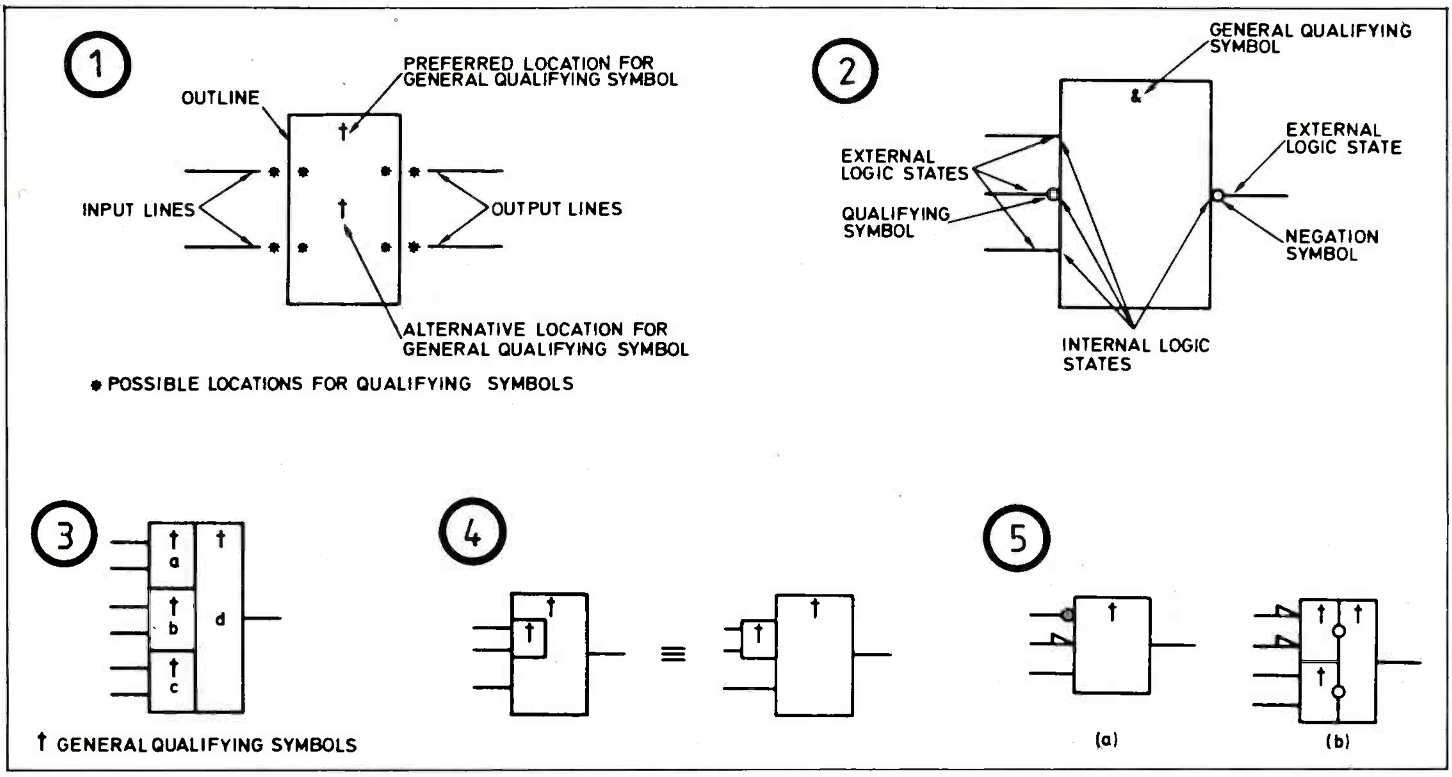


Fig.1. **Symbol composition. Length/width ratio is arbitrary.**

Fig.2. **Binary logic element — a Nand gate with one negated input.**

Fig.3. **Combination of symbols. Logic connections must only pass edges in direction of signal flow.**

Fig.4. **Embedded symbols.**

Fig.5. **Illegal (a) and legal (b) mixtures of polarity indicators and negation symbols.**

what amounts to his own international language.

I use the term 'language' advisedly, for the new logic symbols are really just that. Admittedly it is a sign-language, but like any true language, it does allow the user freedom of expression. That is where it differs so greatly from anything that has gone before.

New frontiers

The new logic symbols open up new frontiers and new levels of sophistication. They enable diagrams of complex logic circuits employing similar circuitry to be dramatically reduced in size and complexity, without any loss of detail. Furthermore, as I intend to show in the third article of this series, it enables circuits to be represented at different levels of detail with each and every level accurately depicting the overall logic functions. This can be usefully employed in industry, for a systems engineer can design a high-level circuit and pass this on to a project or equipment engineer; he, in his turn, can create a medium-level design showing more precisely the methods of implementation which he can pass down to a design engineer; the latter can then produce a component-level design. In all cases the new logic symbols may be employed, and in each level conversion, there can be no doubt as to what is required. All this can be achieved without words or even block diagrams!

Good news or bad news?

At this juncture you will no doubt have mixed reactions if all this is news to you. Is it good news or bad news for the profession? What was wrong with the popular 'curvy' (MIL-STD-806B) logic symbols which have proliferated so much in recent years? And before someone else points it out, I did prefer to use the latter standard (also to be seen in this journal), in my recent book: Practical Design of Digital Circuits (Newnes Technical Books, 1983). The reason for that choice, as explained in an appendix, was simply that these symbols were so familiar. Had I introduced the new logic symbols, it would have completely detracted from the principal aim of the book: to teach design principles. For do not underestimate the complexity of the new logic symbols: learning to use them is a subject in its own right.

Let me give you the bad news first. Yes, you do need to put your thinking cap on again in order to learn to use and interpret the new logic symbols, for unfortunately, complexity is the price you have to pay for sophistication. Military projects will increasingly call for the latest standard on circuit diagrams and in technical handbooks. Commercial products will increasingly require use of the new symbols to give the documentation immediate international status. But even more significant to any 'digital practitioner' is the fact that the American manufacturers of digital components are well embroiled in the transfer to the new symbols on their data sheets, and even the most determined ostrich will therefore be forced to learn the new language — or take early retirement on a reduced pension!

I was a design engineer for many years and I know such a change will not be popular. I am presently involved with design engineers on a day-to-day basis, and I still know the change is not popular. How could it be when such persons are already overworked, underpaid, and unappreciated? But that is where the argument must end, for I am talking of a *fait accompli*. It is here and it will stay. There has been too much commitment for retraction now. Your only concern should be how long it will be before it affects you. So far as the international committees are concerned, it is too bad that we're still trying to get to grips with decimalisation in Great Britain.

There is more bad news. From my own researches, it is plain that this matter will come as somewhat of a bombshell to the majority of engineers in this country, not to mention lecturers, whose duty it will be to educate themselves before their students take *them* to task. I say again, the new logic symbols are not mere substitutions for presently known alternative symbols — except at the simplest level.

To my mind, they represent the need for a new endorsement subject for those studying digital electronics.

Now for the good news. The new logic symbols are logical! They also offer a very clever means of simplifying circuitry in order that a circuit function can be more easily comprehended. Where a present-day block diagram and associated text is needed to explain a circuit function, the new logic symbols equally straighforwardly represent and *fully define* the circuit function without the absolute need for words. Where a complex device was previously represented by an annotated rectangle which required further reference to a data sheet to explain it, many such devices may now be fully defined by their symbol. There is also another great bonus. The new logic symbols can even remove problems associated with positive or negative logic conventions. What more could an engineer ask for? — save something simple!

The learning curve

Because of my involvement in the technical documentation industry, I have been aware of the forthcoming problem for some time. Apart from an engineer's revised national standard, there seems nowhere for him to turn to for practical help in this situation for, with the best will in the world, a standard cannot be regarded as bedtime (or even coffee-time) reading. Not that this is in any way meant to detract from the value of any given standard, for such is needed to clearly define requirements. By virtue of the need to unambiguously define, however, such works cannot be informal in their approach and are inherently different from the ideal teaching document which takes one idea at a time and develops it.

Brief notes on the new standard may be found in such publications as The TTL Data Book for Design Engineers (Texas Instruments), but when it is taken into account that such a treatise is far shorter than the actual standard, it is clear that it is far from exhaustive. It really does need a full-length book to do the subject justice.

Since the standards are weighty tomes, it might be supposed that I cannot tell all in three magazine articles. The aim here is therefore to give you a taste of the new logic symbols — to whet your appetite as it were — and, hopefully, to convince you that this is not something that can be ignored.

Symbol composition

Symbols are used to represent binary logic elements. As depicted in Fig. 1, a symbol comprises: an outline, a general qualifying symbol denoting the function of the binary logic element, and input and output lines. The outline is rectangular and the length: width ratio is arbitrary. The preferred location of the general qualifying symbol is at top centre of the outline, although a central location is also acceptable.

It is preferred to have input lines on the left of an outline and outputs on the right of an outline, so maintaining left-to-right flow. Unless otherwise unavoidable, inputs and outputs should be placed on opposite sides of an outline. In special cases where a horizontal symbol is approved (e.g. counters and shift registers — although vertical orientation is still preferable if possible), a top-to-bottom data flow is preferred.

Whilst a general qualifying symbol is normally required within an outline in order to specify the function of that element, there are circumstances where the function is completely defined by the qualifying symbols associated with inputs and outputs, thereby making a general qualifying symbol redundant.

Figure 2 depicts an example of a simple binary logic element: in a positive logic convention this represents a Nand gate with one negated input (the familiar circular qualifying symbol indicates negation — or inversion).

In order to reduce the space requirements on diagrams, separate symbols for basic functions may be abutted provided that there is no logic connection between logic elements where the common side/s of their outlines is in the direction of signal flow, and that there is at least one logic connection between the elements where the common side/s of their outline is perpendicular to the direction of signal flow.

This is made plain by the example given in Fig.3. It will be seen that there is 'at least one' logic connection between element d and each of elements a, b and c, although there is no logic connection between elements a and b or b and c.

Another way employed of gaining space is to embed one symbol inside another, as shown in

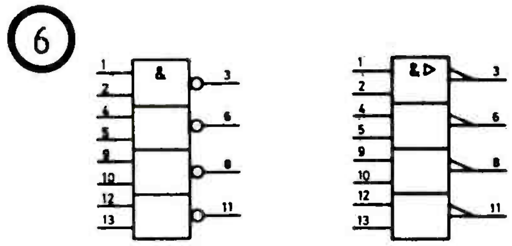


Fig.6. **Examples of combinative devices — 7400 and 7437.**

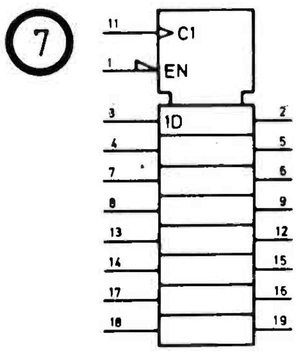


Fig.7. **Example of a more exotic symbol — octal flip-flop with common enable, the 74LS377.**

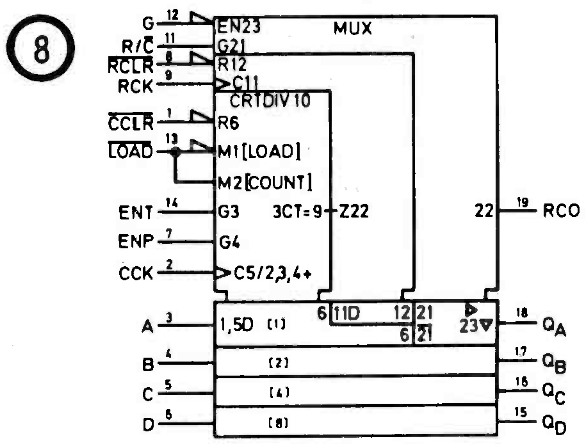


Fig.8. **Even more information in one symbol — the 74690 4-bit synchronous counter with output registers and multiplexed tri-state outputs.**

Fig.4. Any symbol may be placed inside another providing that the result is unambiguous and the relationship between the two is clearly defined either by position or by internal connection lines.

Logic convention

I think it fair to say that today there is a general preference for a positive-logic convention, which implies that the H (high) level of a physical quantity — such as voltage — represents the logic 1-state of a binary variable, and the L (low) level represents the logic 0-state. A negative-logic convention is the converse of this. Because the physical aspects of a circuit vary according to the convention being applied, it is essential that the convention is always clearly defined. Ideally it should be stated on every diagram, but in practical terms, it should be sufficient to state the convention in use within a single document or working environment. The only real justification for using a negative-logic convention is where a negative supply is used for logic devices.

Providing that the logic convention has been defined, the conventional circle may be used as a qualifying symbol to indicate negation. If the situation arises where both logic conventions are mixed — say at the interface between two manufacturers' equipments — then a more complex situation arises: one that causes endless confusion with previous methods of logic representation.

The new logic symbology overcomes this problem in a very elegant fashion by the use of polarity indicators.

A polarity indicater is a triangularly shaped qualifying symbol placed on an input or output line such that the apex points in the direction of signal flow. The polarity indicator on an input or output implies that the internal 1-state corresponds to an external L-level (i.e. low level). Thus the polarity indicator effectively converts between external physical voltage levels and internal logic states.

If the decision is taken to employ polarity indicators on a circuit diagram then logic conventions become superfluous — they no longer apply. By implication, if this is undertaken, there should be no negation symbols on any inputs or outputs, since their presence demands a logic convention.

The use of polarity indicators does not mean that negation symbols are a total anathema on diagrams, and this is a potential source of confusion. It must be remembered that you are dealing with pure logic within a binary logic element, and here polarity has no significance! So negation symbols are always employed within elements to indicate negation, even if polarity indicators are employed externally.

Figure 5 depicts legal and illegal use of polarity indicators. To the left of the diagram (a) a mixture of polarity indicator and negation qualifying symbols are shown: the presence of so much as a single polarity indicator on a diagram bans the use of the negation symbol on any inputs or outputs, since it implies no logic convention in use. To the right of the figure (b) is shown a legal mixture of the symbols: external polarity indicators show that a low voltage is required on the top two imputs to produce corresponding internal 1-states, whereas the two lower inputs require high levels on their inputs to produce internal logic 1-states. The internal negation symbols have their customary logic significance with respect to the common element, and the final output produces a high level for a logic 1-state.

Combinative devices

Figure 6 depicts two simple combinative devices, and serves to illustrate a number of points. Firstly it serves to show that the lowest level of representation with the new logic symbols is at device level: here are depicted the 7400 and 7437 devices, referred to as quad 2-input positive Nand gates and quad Nand buffer driver respectively. Note that the symbol for the 7400 employs external negation symbols and therefore this means that it is necessary to qualify the logic convention as positive — for in the negative logic convention we would have an Or gate with negated inputs. On the other hand, the 7437 is shown with polarity indicators on the outputs, signifying that two high inputs on any gate input produces a low on the output. The gates in both devices perform identical logic functions and are here represented in two different ways. It is necessary to become accustomed to interpretting diagrams of either form, and both will therefore be used in this series.

To avoid any confusion, it may be assumed that throughout this series, a positive logic convention is used when such is applicable (i.e. when no polarity indicators are used).

The next point to note about Fig. 6 is that it is unnecessary to repeat a general qualifying symbol in an array of identical elements. The '&' general qualifying symbol in the upper element of the 7400 device is taken to apply to all four elements. The same applies for the 7437, but here the buffer general qualifying symbol is included in the upper element to signify its driving capabilities.

This is also a useful point to highlight the fact that the polarity indicator has the inherent property to indicate signal flow. As such, its presence on a particular signal line can make the need for a directional arrow (required to indicate non-preferred directional signal flow) superfluous.

Conclusion

That concludes this basic introduction to the new logic symbols. In the next article I shall consider some of the more complex aspects including dependency notation and the common control block, but in order to illustrate the fact that the more complex logic symbols are far from direct substitutions of existing symbols, I leave you with a foretaste of two of the symbols to be discussed in future parts. Figure 7 depicts an octal flip-flop with common enable and Figure 8 shows a 4-bit synchronous counter with output registers and multiplexed three-state outputs. These symbols employ both dependency notation and the common-control box, but more of that in due course!

LITERATURE RECEIVED

'The biggest variety of semiconductors in any retail shop' is the proud boast of Cricklewood Electronics. It certainly seems to be bourne out in their stock list/catalogue which also lists the passive components, hardware, tools and other equipment that they stock. Telephone, mail-order and credit-card purchases are acceptable as well as callers to the retail shop at Cricklewood Electronics Ltd., 40 Cricklewood Broadway, London. NW2 3ET. EWW 259

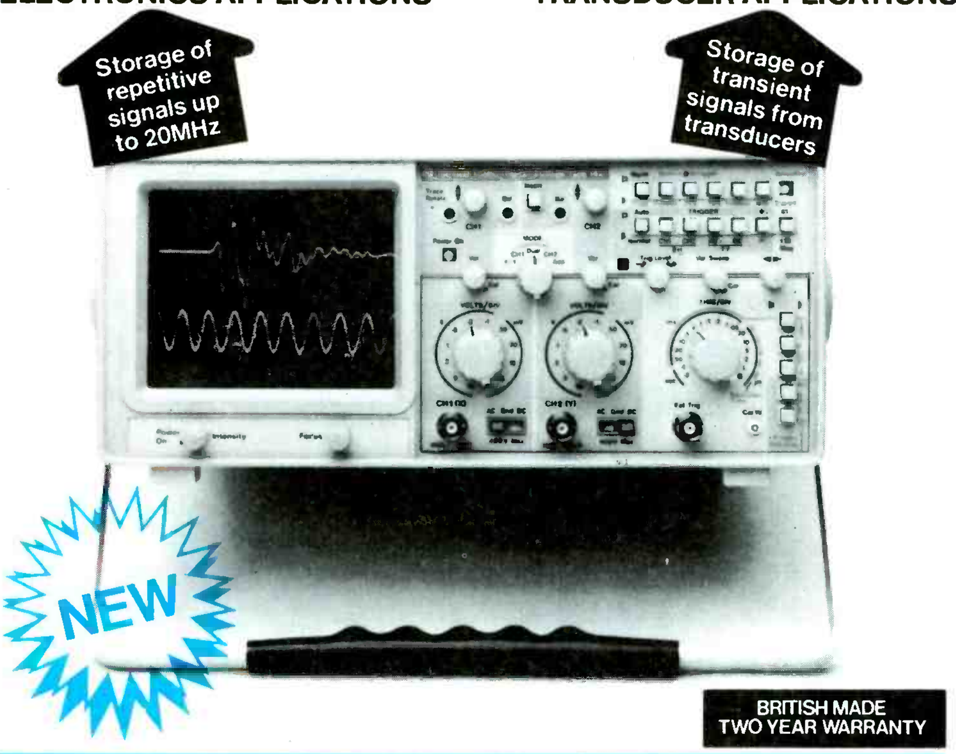
A handy reference guide to 50-23 surface-mounting transistors and diodes is available from Ferranti Electronics Ltd., Fields New Road, Chadderton, Oldham. OL9 0NP. EWW 259

A state-of-the-art home built preamplifier is available as a kit from B&J sound. The design is modular and may be tailored to meet specific requirements or for matching existing equipment. Kit lists are available along with details of a power supply and a guide to the selection components. Full constructional details are available for £6.90. B&J Sound, Kirkby Lane, Tattershall, Lincoln. LN4 4PD. EWW 260

A new series of Unix-based computers, built around National Semiconductors' 32000 family of processors and peripherals, is described in a brochure. The N932032 is a 3-bit processor which is combined with a N932082 memory management unit to give 'Virtual memory', a method of dividing the available memory into pages. Individual pages may be retained in the computer's internal memory or on disc and may be called as required. Using this system, the virtual and physical address spaces are divided into 32769 pages each of fixed size, 512 bytes. The series also includes the N932091 floating point unitto provide 32 and 64-bit floating point operations. The three chips are really a single unit and as v.l.s.i. methods improve, they could be combined into a single circuit. The brochure-also discusses the implementation of Genix a super-set of Unix. National Semiconductor (UK) Ltd., 301 Harpur Centre, Horne Lane, Bedford MK40 1TR. EWW 257

Gould... Innovation and Quality in Oscilloscopes

ELECTRONICS APPLICATIONS | **TRANSDUCER APPLICATIONS**



BRITISH MADE
TWO YEAR WARRANTY

Dual-Purpose Storage...

The Gould 1421 Digital Storage Oscilloscope (DSO).

A Dual-Purpose DSO for Electronics and Transducer applications. Compare the benefits of the low-cost 1421 and its suitability for two diverse application areas, with the performance of our competitors. The 1421 has a storage bandwidth up to 20MHz – in single and dual-channel modes.

Take a look at the heavyweight performance details of this compact, lightweight DSO:

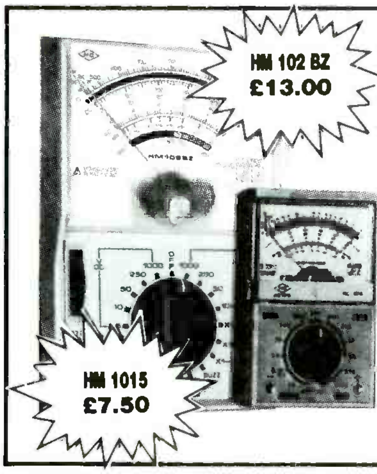
- No trace degradation with time.
- Storage of pre-trigger information.
- 2MHz 8-bit ADC for transient capture.
- 20MHz repetitive signal storage.
- 1k store per channel.
- ×10 post-storage expansion.
- Pen recorder output.
- Single channel trace hold for waveform comparison.
- Conventional 'scope operation up to 20MHz.

And all the usual benefits of a Gould Digital Storage 'Scope.

Ask for more details now from
Gould Instruments Ltd., Roebuck Road, Hainault, Ilford, Essex IG6 3UE.
Telephone: 01-500 1000. Telex 263785.

GOULD
Electronics

CIRCLE 23 FOR FURTHER DETAILS.



AFFORDABLE ACCURACY
QUALITY MULTIMETERS FROM ARMON

ANALOGUE

HM-102BZ
10ADC Range, 20KΩ/VDC, Buzzer, Battery Test Scale **£13.00**
19 measuring ranges

HM-102R
Low end voltage & current ranges, Jack for Audio o/p Voltages **£11.00**
20 measuring ranges.

HM-1015
Rugged, Pocket sized meter, for general purpose use **£7.50**
16 measuring ranges
Battery, Test Leads and Manual included with each model.

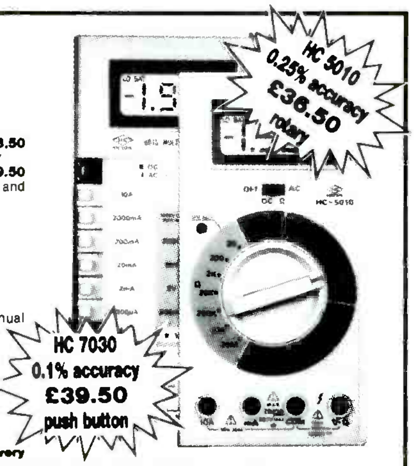
DIGITAL

HC—6010 0.5% Accuracy. Standard Model **£33.50**

HC—5010T 0.25% Accuracy. TR Test Facility **£39.50**

All models have full functions and ranges and feature:

3½ digit 0.5" LED display
Low battery indication
Auto zero & Auto polarity
ABS Plastic Casing & Tilt Stand
DC AC 10amp Range
Overload Protection on all ranges.
Battery, Spare Fuse, Test Leads and Manual



FULL DETAILS ON APPLICATION FROM:-

ARMON ELECTRONICS LTD

DEPT A HERON HOUSE, 109 WEMBLEY HILL ROAD, WEMBLEY, MIDDLESEX HA9 8AG
TELEPHONE 01-902 4321 TELEX 923985
PLEASE ADD 15% to your order for VAT. P&P Free of charge. Payment by cheque with order
Offer applicable to mainland UK only

Trade enquiries invited — **Please allow 28 days for delivery**

CIRCLE 46 FOR FURTHER DETAILS.

BRAND NEW ELECTRONIC COMPONENTS

- RESISTORS
- CAPACITORS
- TRANSISTORS
- POTENTIOMETERS
- PLUGS
- MULTIMETERS
- VOLTAGE REGULATORS
- I C SOCKETS
- DIODES
- PRESETS
- LEDS
- SOCKETS
- SWITCHES
- INTEGRATED CIRCUITS

Write or Phone for full Trade Catalogue
HARRISON ELECTRONICS
22 MILTON ROAD, WESTCLIFF-ON-SEA, ESSEX SS0 7JX Tel: (0702) 332338

CIRCLE 51 FOR FURTHER DETAILS.

SEMI-CUSTOM INSTRUMENTATION & CONTROL SYSTEM FOR AUTOMATION, RESEARCH & EDUCATION.

This system is designed primarily for easy implementation. It does not require special transmission lines, programming or high quality power supplies.

Any computer equiped with RS232-V24 or RS423 can be used.

Results from measurements are sent to and from the computer in real units, using only the PRINT and INPUT statements.

The semi-custom facility that we offer, is a new concept which gives you the ability to acquire a unit with the facilities that only you want, from a wide range of functions, thus giving you the best value for money for equipment of this kind. We fit the modules of your choice inside our basic station and we adjust the software of the built-in microprocessor to respond accordingly. The price of the software is included in the price of the modules making it very easy for you to calculate the cost. The multidrop facility allows for considerable system expansion.

Modules to choose from include Digital volmeter, D/A converter, AC or DC sense and control, temperature, pressure, strain, liquid flow, medical amplifiers, counters, real time clock etc.

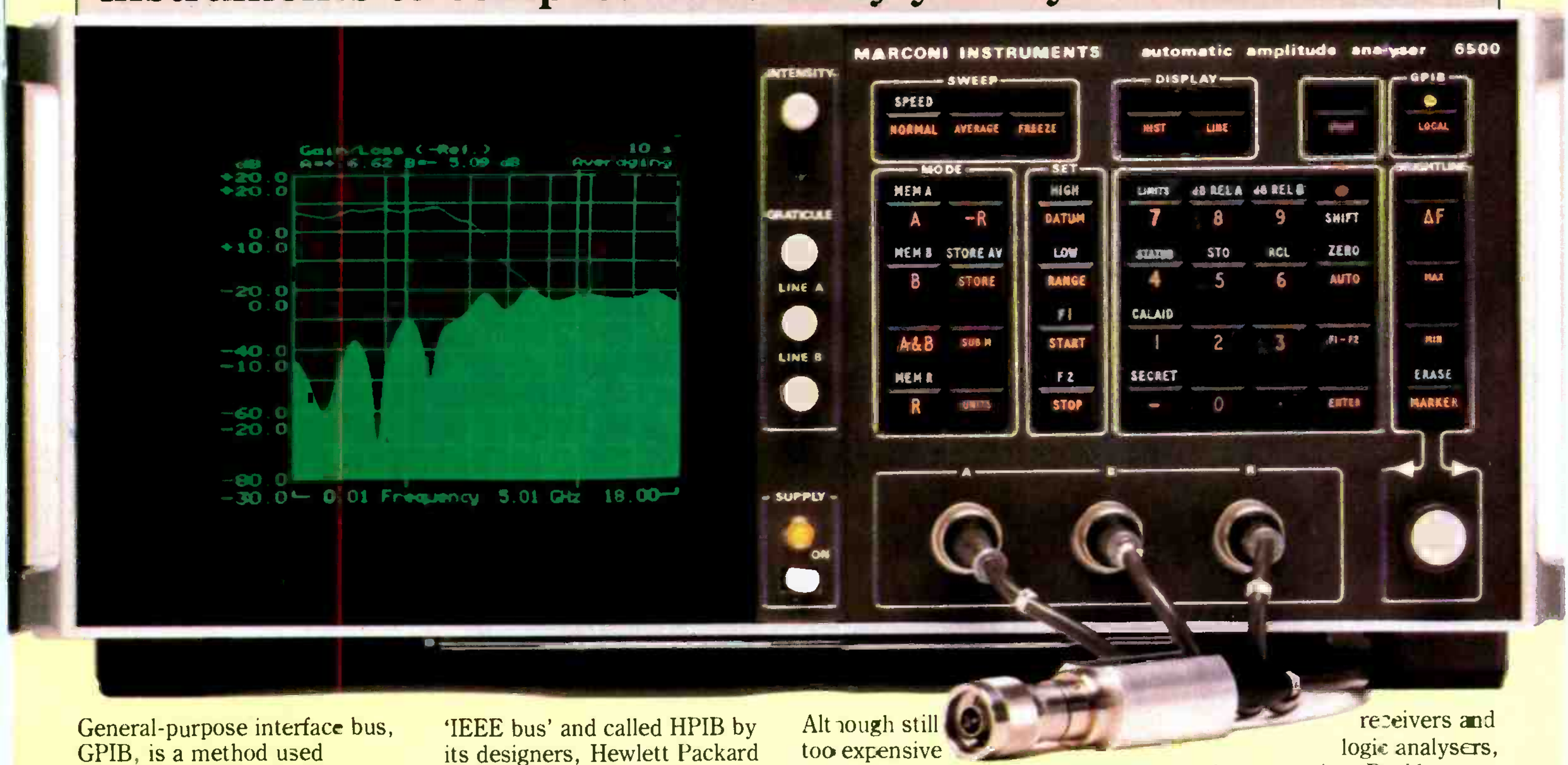
The stations are housed in DIN rail and/or surface mounting cabinets and prices start from £250.

DEDICATED MICROPROCESSORS LTD. Unit B2, Acton Business Centre, School Road, North Acton, London NW10 6TD. Tel. 01-965 2841

CIRCLE 11 FOR FURTHER DETAILS.

Introducing GPIB

Having first been considered some 20 years ago, GPIB could probably be improved upon but it is so well established that it is likely to remain the foremost standard for connecting instruments to computers for many years yet.



General-purpose interface bus, GPIB, is a method used throughout the world for linking instruments and computers. Providing a means for both setting up instruments and reading information from them directly back into a computer ready for processing, the bus's main applications are in research and development and in automatic testing, measurement and quality control systems. Controlling instrumentation by computer means

— faster processing
— reduced risk of human error
— increased accuracy through computer correction techniques
— elimination of tedious repetitive tasks
— convenient data storage and hard copy

Internationally, GPIB is defined by the IEC625-1 standard and in America by ANSI MC1.1 and IEEE488-1978. It is often misnamed the 'IEEE bus' and called HPIB by its designers, Hewlett Packard who started its development in 1965. The bus is also covered by a British standard, BS 6146.

Carrying eight-bit parallel data and using eight control/handshaking signals, GPIB is generally much faster than a serial link and, being designed for a specific task, it has an edge over other common microcomputer buses where computer-controlled instrumentation is concerned. But as with all such standards, it is not the ideal solution for all applications; the main reason for using it now, some 20 years after its conception, is the large number of GPIB-compatible instruments and controllers available.

Cost of implementing the bus is high. One short-cut is to use a microcomputer with an add-on interface such as those available for the BBC microcomputer, QL, Apple, IBM PC and DEC Rainbow. Although still too expensive for most enthusiasts, these relatively cheap add-ons bring automatic measurement and quality control — or at least the bus to provide them — within the reach of even the smallest of organizations. Equally cheap instruments and software, not to mention cables, may be a little harder to come by.

There are a few general-purpose microcomputers like the Commodore Pet, 64, 4000 8000 700, RML Link 480Z, Sharp MZ80K and IBS750 that have built-in GPIB interfaces and there are some mainly for design and research, like the HP Technical Computers range, that are designed with GPIB control in mind. Lastly, there are computers and controllers whose hardware and software is designed solely for use in GPIB applications.

GPIB-compatible instruments, ranging from tape drives to communications receivers and logic analysers, are also expensive. Besides having the digital control and interface circuits necessary for computer control, the majority of bus-controllable instruments also have manual controls and readouts which increase their cost. We are still at the stage where most instruments are designed for manual use with GPIB compatibility available as an add-on.

Incompatibility

The standards mentioned above only specify electrical and mechanical parameters for linking units together — they don't say what data passing through the bus should look like. Sadly, this means that there is no guarantee that a system happily controlling a GPIB instrument from one manufacturer will work with a similar instrument from another source. Suggestions for code and format convention — like

GPIB control signals

Signal	Description
DAV	Data valid, talker tells listener that data is available
NRFD	Not ready for data, from unready listener
NDAC	Not data accepted, from listener while getting data
IFC	Interface clear, from controller to set all devices to a known state
ATN	Attention, from controller to alert bus devices before handshake of a message on the data bus
SRQ	Service request, from any device needing service from the controller
REN	Remote enable, from controller to put devices under bus control
EOI	End or identify, from talker to indicate that current data byte is the last one

IEEE 728, BS6146 part 2 and IEC 625-2 have only recently appeared.

On the brighter side, GPIB signal functions are defined, which means that one should be able to resolve compatibility problems by rewriting the programs used to control the instruments. Because of these incompatibilities, many GPIB product manufacturers freely provide documentation and application notes relating to their own protocols and data formats. There are no active elements in the bus itself, i.e. all signals passing along the bus are produced within the instrument or a computer with a GPIB controller, which makes the task easier.

The bus

There are three terms used to describe devices connected to the GPIB — talkers, listeners and controllers. Instruments are either talkers or listeners or both. Because these terms are normally associated with humans, you may find it a little unfriendly that GPIB talkers and listeners do so to the bus and not to the user.

A controller talks and listens but it also dictates what goes where on the bus. There may be more than one controller on a bus but only one is allowed to act at a time. Controllers vary from a dedicated piece of apparatus with special software, in which case the user will need to know little of how the bus works, to a microcomputer with a GPIB interface which the user has to program in a high or low-level language.

In the most basic system there may be just a talker and a listener. At the other end of the scale, although the standard only allows for 15 devices to be connected to the bus on a cable of up to 20m, there are products called bus extenders and multiplexers which share out an allocation. Not all devices connected to the bus need be measuring instruments; there are converters, for say RS232 to GPIB, floppy-disc drives and printers to mention but a few.

Essentially, the bus carries an eight-bit parallel data word, three data-transfer control signals and five interface management signals. All control signals are at t.t.l. level and active low. The bidirectional data bus not only carries data bus also address and status information at rates of up to 250kbyte/s (higher rates are possible under certain circumstances). Incompatibilities between products from different manufacturers — and, according to Tektronix even between different instruments from the same manufacturer — arise through differences in the form of the data. For example, some systems may use Ascii and others hexadecimal-form data. The table gives some idea of what the bus control signals are.

There are large-scale integrated circuits, such as the Texas 9914, which reduce the complexity of implementing GPIB and are gradually bringing down the price of both instruments and controllers. Using such an i.c., the GPIB section of a computer need only consist of three i.cs, two of which are bus drivers. Software and the cost of instruments for use on the bus are the biggest headaches for most.

Finally, note that two types of connector are found on GPIB instruments, a 24-way type on IEEE488-based equipment or a 25-way type defined in the IEC standard.

GPIB Instruments

Datron's Autocal precision multimeters

Prices are given here only as a guide and should be checked with suppliers. Value-added tax is not included.

Adret Electronique make several GPIB instruments for use in telecommunications: two signal generators, models 730A and 740A, covering 300Hz-180MHz and 100kHz to 1.12GHz respectively; a universal r.f. generator of high spectral purity for up to 1.3GHz with pulse modulation capability, for use with radionavigation systems; a 15-200kHz standard frequency receiver; a 2kHz-18GHz signal source attenuation calibrator, with a dynamic range of −130dBm to +20dBm; and a programmable voltage and current reference standard. Racal-Dana Instruments Ltd., Duke Street, Windsor, Berkshire SL4 1SB. EWW210

Aim Instruments offer at present just one GPIB model, a low-distortion sine-wave oscillator covering 9Hz to 330kHz. The LDO501 (£985) has ten non-volatile memories, a quadrature output and a liquid crystal display. It can also be controlled from an RS232 interface. Aim Instruments, Edison Road Industrial Estate, St Ives, Huntingdon, Cambridgeshire PE17 4NF. EWW211

Amplicon's 4½-digit panel meter is claimed to be the first to have an integral IEEE interface. Features of the model 87 include led display, 160dB common mode rejection and 0.01% accuracy. With the interface included the basic price is £210. Other models offer 3½-digit display and liquid crystal display. Amplicon Electronics Ltd., Richmond Road, Brighton, East Sussex BN2 3RL. EWW212

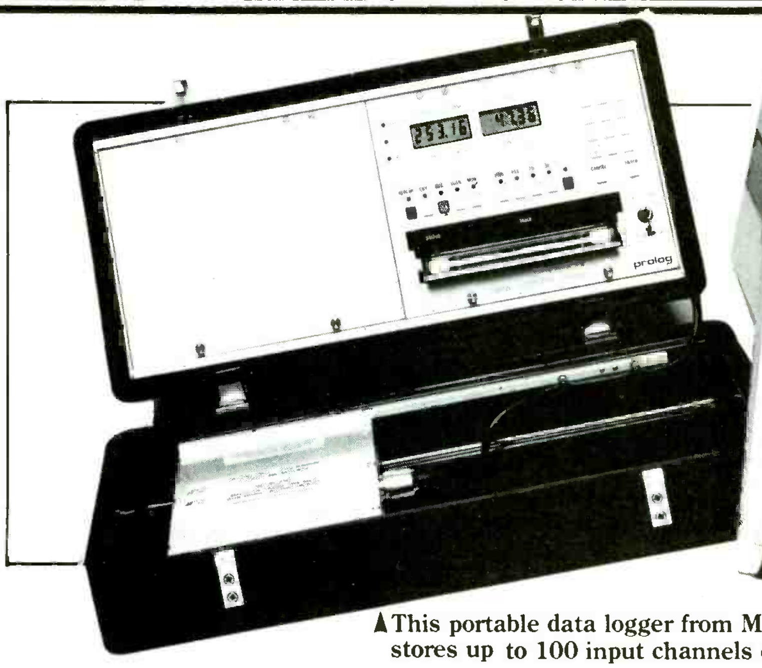
Ando make instruments for use in optical fibre communications. Model AQ-1301 is a light source which can be swept from 0.6 to 1.6 micrometres and is intended for measuring characteristics of optical transmission systems. There is a choice of three optical power meters of differing sensitivities, all of them suitable for normal or laser light. Other models include an optical wavelength meter for measuring the centre-wavelengths of emission devices, an optical fibre reflectometer (model AQ-1720), an optical spectrum analyzer (AQ-1417B) and two optical loss measurement systems. Aspen Electronics Ltd., 2-3 Kildare Close, Eastcote, Ruislip, Middlesex HA4 9UR. EWW213

Bird: the model 4381-832 RF Power Analyst digital wattmeter is available with a GPIB interface from Aspen Electronics Ltd., 2-3 Kildare Close, Eastcote, Ruislip, Middlesex HA4 9UR. EWW214

Boonton produce several instruments suitable for GPIB control. For radio frequencies, there is an autoranging millivoltmeter covering 10kHz to 1.2GHz and giving readings in mV, dBmV and dBm; a single or dual-channel microwattmeter for 100kHz-50GHz which stores calibration data for up to eight sensors; and an f.m./a.m. modulation meter. Also available: a 1MHz automatic bridge and an adaptor for interfacing any Boonton digital meter to GPIB. Euro Electronics Ltd., Lancaster Gate House, 319 Pinner Road, Harrow, Middlesex HA1 4HF. EWW215

Brown-Boveri make a microprocessor-controlled portable multimeter (model M2110-01) with a 4¾-digit liquid crystal display. It has seven operating modes, including one for testing capacitors between 10pF and 3mF; it handles direct current measurements up to 20A and on a.c. ranges it measures true r.m.s. values. British Brown-Boveri Ltd., Normelec Division, Grovelands House, Longford Road, Exhall, Coventry CV7 9ND. EWW216

Brüel & Kjær's catalogue lists some 16 instruments equipped with a GPIB interface and several others which can be connected via a special adaptor. The instruments include audio spectrum analyzers, fast Fourier transform analyzers, a filter set, a digital graphics recorder, an X-Y plotter, a digital cassette recorder, a portable thermal printer and diagnostic



The 40C50 logic analyzer from Dolch Logic Instruments

▲This portable data logger from Microdata stores up to 100 input channels on a standard tape cartridge

ultrasound equipment. Brüel & Kjær (U.K.) Ltd., Cross Lances Road, Hounslow, Middlesex TW2 2AE. EWW217

Burleigh Instruments make a meter which can measure the wavelength of any c.w. laser operating between 0.4 and 4 micrometres. Lambda Photometrics Ltd., Lambda House, Batford Mill, Harpenden, Hertfordshire AL5 5BZ. EWW218

CEC make a GPIB-compatible signal conditioning system which, they say, can improve test sysyems and save the user money. The PSC-8000 is of modular construction, with up to 12 channels per 19in. mainframe. Each channel has plug-in modules for interfacing to strain gauges, thermocouples or other sensors. CEC Instrumentation Ltd., Lennox Road, Basingstoke, Hampshire RG22 4AW. EWW219

Chase offer a pair of high-performance receivers covering 25-300MHz and 25-1000MHz, for applications such as field-strength measuring, interference measuring and radio monitoring. The sets can be used as selective r.f. voltmeters, even in the presence of strong r.f. fields. Accessories include dipole, log-periodic and biconical aerials. Chase also supply a controller for r.f.i. and e.m.c.-measuring equipment, model EC5000. This has a 6in. monochrome display monitor and one or two 3½in disc drives. The operating system and Basic language are compatible with the BBC Micro. Chase Electrics Ltd., St Leonard's House, St Leonard's Road, London SW14 7LY. EWW220

CIL produce a variety of instruments with GPIB capability. The Multi-Monitor TA880 is a voltmeter, millivolt source, temperature indicator, thermocouple simulator and strain indicator all rolled into one. Other models include multi-channel a-to-d converters with 12 and 16 bit accuracy (prices from £475), a thermocouple converter, a multi-function control and measurement interface and a GPIB bus analyzer. CIL also offer a GPIB interface card for the Apple computer (£130). CIL Microsystems Ltd., Decoy Road, Worthing, Sussex BN14 8ND. EWW221

Clarke-Hess's wideband volt-ampere-watt meters provide true r.m.s. measurements independent of wave-shape and power factor. Model 255, the cheapest, costs £1,885 with GPIB interface. Lyons Instruments Ltd., Ware Road, Hoddesdon, Hertfordshire EN11 9DX. EWW222

Cushman make an automatic test set for mobile radio equipment, model CE6488. Racal-Dana Instruments Ltd., Duke Street, Windsor, Berkshire SL4 1SB. EWW223

Datacapture offer a compact portable time-related measurement system. The Datablock DB4000 accepts a variety of sensor inputs, can memorise hundreds of thousands of measurements to an accuracy of 0.025% and can store data indefinitely on plug-in exchangeable memory boards. It can measure and display up to 16 inputs at once. Prices start at £3,385, including GPIB interface and software. Datacapture 1984, 21 Bridge Street, Hemel Hempstead, Hertfordshire HP1 1EG. EWW224

Datalab have developed a range of filters especially suited to high-speed data acquisition and waveform analysis systems. The DLF-100 is a series of finite impulse response decimating filters, which the company say will make new data acquisition architectures possible and will improve performance of existing systems. Also available is a range of waveform recorders. Model 912 (about £5,000 with GPIB interface) has two channels, a split timebase mode, signal capture at up to 5MHz, a 4Kbyte memory, expansion possibilities and an output to drive an X-Y plotter. Accessories are available. The modular 2000 series offers up to 30 channels with wide dynamic range and sampling rates of up to 50kHz: prices depend on facilities, typical systems costing £60,000 or more. Data Laboratories Ltd., 28 Wates Way, Mitcham, Surrey CR4 4HR. EWW225

Data Proof produce a scanner for comparing standard cells using the method recommended by the U.S. National Bureau of Standards. Model 160A (for up to 16 cells) costs £4,280 and model 320A (up to 32 cells) £7,340. Lyons Instruments Ltd., Ware Road, Hoddesdon, Hertfordshire EN11 9DX. EWW226

Datron's Autocal digital multimeters feature bus control of almost every function except mains on/off. Prices range from £1,095 to about £3,000 according to the optional extras fitted. These meters can be calibrated *in situ* using Datron's two automatic calibrators, which are claimed to provide levels of accuracy previously obtainable only in temperature-controlled laboratories. The 4000 (d.c.) costs from £8,495 and the 4200 (a.c.) from £15,995. Datron Instruments Ltd., Hurricane Way, Norwich Airport, Norwich NR6 6JB. EWW227

DI-AN Microsystems provide through their DMS550 system a way of interfacing GPIB controllers to sensors and actuators both digital and analogue. Data transfer is possible at up to 250kHz. A mother-board accommodates the user-configurable i/o modules: there is a range of ten at present. DI-AN Microsystems Ltd., Mersey House, Battersea Road, Heaton Mersey, Stockport, Cheshire SK4 3EA. EWW228

Difa's Sicos signal conditioning system is built up of modules such as programmable filters and precision amplifiers. A choice of filter characteristics is available and the frame can house up to 64 channels. If only two channels are required, there is a lower-priced alternative in the PDF3700 (from £1,900). Telonic Instruments Ltd., Boyn Valley Road, Maidenhead, Berkshire, SL6 4EG. EWW229

Dolch make a series of GPIB-controllable logic analyzers having up to 64 channels and covering frequencies to 300MHz. Accessories include a probe for tracing and recording GPIB activity. Dolch Logic Instruments Ltd., Foresters House, 4 London Street, Andover, Hampshire SP10 2PA. EWW230

E.D.A. expect to launch in May or June a 10Mbyte Winchester disc drive which will allow any computer with a GPIB interface to access the disc without the need for a separate interface card or operating system. Price is likely to be £1,800. Already available is E.D.A.'s GPIB interface for the Apple II computer (£250). E.D.A. (Software) Ltd., 10 Victory Road, Chertsey, Surrey. EWW231

E.I.P. specialize in microwave test and measurement instruments. The model 928 is a combined sweeper and microwave source covering 1-18GHz, with a c.r.t. display. Model 545 is a microprocessor-based 10Hz-18GHz counter with 12-digit led display; and model 548A is similar, but with an upper limit of 110GHz. The source locking counters model 575 (up to 18GHz) and model 578 (up to 110GHz) can convert any conventional swept-frequency signal source into a synthesizer. Also available is the model 451 925MHz-18GHz pulse counter. Racal-Dana Instruments Ltd., Duke Street, Windsor, Berkshire SL4 1SB. EWW232

Electronic Development Corporation manufacture an a.c. calibrator covering 10Hz to 111kHz with amplitudes from 0.1mV to 111V (model 4500, £7,245) and a companion d.c. calibrator (model 520A, £3,410). Lyons Instruments Ltd., Ware Road, Hoddesdon, Hertfordshire EN11 9DX. EWW233

Exact Electronics produce a 20MHz programmable pulse and function generator with a very wide selection of waveforms and operating modes. It also has a self-calibration facility and non-volatile memory capable of storing 20 complete front panel settings. Racal-Dana Instruments Ltd., Duke Street, Windsor, Berkshire SL4 1SB. EWW234

Farnell Instruments: items with GPIB control include the low-cost DTS-12B two-channel 12MHz digital storage oscilloscope (£980); a programmable auto-ranging bench power supply providing more than 1kW at up to 60V and up to 50A (AP60/50, £1,700); auto-ranging signal generators for 10Hz to 1GHz or 2GHz (from £4,300); the SSG520 10-520MHz synthesized signal generator, designed especially for maintenance of mobile communications equipment (from £3,000); and a test set for radio transmitters of up to 100W output (model TTS20, from about £3,900). Farnell Instruments Ltd.,

Sandbeck Way, Wetherby, West Yorkshire LS22 4DH. EWW235

Fluke's large catalogue includes some 80 instruments with GPIB control. Among these are power sources, thermometers, signal generators, counters, calibrators, p.c.b. testers, data loggers, instrument controllers, disc drives, printers and an X-Y plotter. A recent addition to the range is the 8840A digital multimeter (from £735 with GPIB interface fitted): this has a 5½-digit vacuum fluorescent display, fast auto-ranging and a built-in self-test routine. Fluke (GB) Ltd., Colonial Way, Watford, Hertfordshire WD2 4TT. EWW236

Frequency Devices' model 9016 programmable multi-channel filter system is a 19in. enclosure with a vacuum fluorescent digital display and space for up to 16 filter cards. At present cards are available in a choice of three low-pass transfer functions. Price is £4,690. Lyons Instruments Ltd., Ware Road, Hoddesdon, Hertfordshire EN11 9DX. EWW237

GenRad produce a range of automatic test equipment, among which are systems for board testing and for examining and sorting digital and linear components. GenRad Ltd., Norreys Drive, Maidenhead, Berkshire SL6 4BP. EWW238

Giga Instrumentation manufacture a pair of 1-18GHz microwave generators (models GR1100/1300) for testing radar sets. The YIG tuned oscillator can be set to within 100kHz and the internal pulse modulator provides 60dB of carrier suppression. Other products are the GU1200/1300 signal generators for 10MHz-26.5GHz, also featuring a YIG oscillator, and the GP2000 programmable sweep generator for the same range. Racal-Dana Instruments Ltd., Duke Street, Windsor, Berkshire SL4 1SB. EWW239

Global Specialties make a nine-digit, two-channel 225MHz computing counter-timer with a 1.2GHz prescaler (model 6007/T); an eight-digit counter-timer with direct input to 520MHz (model 6006T); a universal 4½-digit wattmeter (model UDW4501) for up to 50kHz, with a dynamic range of 100nW to 7.5kW; and a family of low-cost true-r.m.s. digital multimeters. All are available with GPIB interface. Global Specialties Corporation, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ. EWW240

Gould have a range of digital storage oscilloscopes with prices beginning at £2,950. For this you get a dual-trace oscilloscope (model 4035) with 20MHz bandwidth, a 1K word store on each channel, a plotter interface and a cursor measurement facility with alphanumeric readout of time and voltage. An optional keypad (£340) allows further manipulation of stored traces. At £4,995 is model 5110 which gives 100MHz bandwidth, keyboard menu control and battery-backed memory for eight panel settings and 16 waveforms. These instruments can act as talkers as well as listeners and can transmit waveforms to the bus for analysis or for data acquisition. Gould Instruments Ltd., 2-8 Roebuck Road, Hainault, Ilford, Essex IG6 3UE. EWW241

Guildline make a digital platinum resistance thermometer covering −200°C to +240°C with a resolution of 0.001° and an accuracy of 0.01°C. The model 9540 costs £2,760. A digital wattmeter, model 7200, gives direct digital measurement of power, voltage, current and energy, with 50 p.p.m. accuracy at all power levels, for £22,870. Lyons Instruments Ltd., Ware Road, Hoddesdon, Hertfordshire EN11 9DX. EWW242

Gulton's Computrak 6100 programmable recorder plots as many as six channels at once on its built-in thermal printer, adding chart grids, time and text annotations automatically. A data summary print-out gives a permanent record of the system configuration. Also available are three free-standing thermal printers. Gulton Ltd., Maple Works, Old Shoreham Road, Hove, East Sussex BN3 7EY. EWW243

Harlyn Automation manufacture instrumentation and control peripherals for use in automated data logging. The 3700 series MAPS data logger system includes three mainframes (all with integral GPIB interface) and an extensive choice of plug-in modules. The R6B mainframe, a 19in rack-mountable unit for up to six modules, with 1MHz clock, costs £650. Modules include a 10-channel 2-pole scanner with reed relays at around £295, and an eight-decade battery-backed event counter for £350. Harlyn Automation (Congleton) Ltd., 27 North Street, Congleton, Cheshire CW12 1HF. EWW244

Hendry Electronics specialize in programmable variable power supplies. Units in their range can handle maximum loads of up to 2000VA. Prices begin at £473 for a basic plug-in 30VA card, with GPIB control costing £591 extra for a single-channel interface. There is also a high-power mil. spec. range. Hendry Electronics Ltd., 2 Fitzalan Road, Arundel, West Sussex BN18 9JS. EWW245

Hewlett-Packard invented the GPIB (or rather, HPIB) and their instrumentation range is accordingly all-embracing. Their 688-page catalogue lists more than 180 instruments with bus capability, plus 27 ready-made HPIB measurement systems — applications of which include data logging, data acquisition and control, network analysis, spectrum analysis, frequency stability measurement, signal generator calibration, transceiver testing, testing of circuits and components, pressure recording and telecommunications network surveillance. Hewlett-Packard Ltd., Nine Mile Ride, Easthamstead, Wokingham, Berkshire RG11 3LL. EWW246

Hitachi's range of oscilloscopes includes the VC-6041, which costs £4,897 with GPIB interface and can store 40MHz waveforms with its two 4000-word digital storage channels. A time-axis averaging function allows the user to average-out noise on input signals. An instrument with a more specialized purpose is the MF-68 automatic telecomparator system. Linked to a television camera and an optical microscope, this uses the tv signal to make line-width measurements on i.c. wafers and masks, magnetic heads and so on. Hitachi Denshi (U.K.) Ltd., Garrick Industrial Centre, Garrick Road, London NW9 9AP. EWW247

ICS offer a speech synthesizer. The standard vocabulary includes nearly 300 entries which are spoken in what the makers describe as a natural masculine voice. Manual and automatic controls are provided for editing and formatting the spoken messages. Other products are bus switches and expanders and a variety of bus input and output modules; for example, a low-cost bus interface for programmable power supplies. Amplicon Electronics, Ltd., Richmond Road, Brighton, East Sussex BN2 3RL. EWW248

Infratek produce a three-phase volt-ampere-watt meter which gives true r.m.s. measurements from 0 to 10kHz to an accuracy of 0.5%. Ranging is automatic or manual and extends to 1kV, 30A and 90kVA (optional accessories push the current limit even further). Seltek Instruments Ltd., The Old Pied Bull, High Street, Stanstead Abbotts, Hertfordshire SG12 8AB. EWW249

Intepro Systems' instruments for the automatic testing of regulated power supplies incorporate modular hardware and software and can be configured and reconfigured easily by the user. Units are available to suit power supplies of 100W to 1kW and more. Omnitest Ltd., Highcliffe House, 411-413 Lymington Road, Highcliffe, Christchurch, Dorset BH23 5EN. EWW250

Interface Technology make a range of digital testing equipment, among which is the model 488 IEEE bus monitor and controller (around £6200). This can be triggered on a specific device address and can record up to 511 transactions, including data and control line status. Microsystem Services, P.O. Box 37, Lincoln Road, Cressex Industrial Estate, High Wycombe, Buckinghamshire HP12 3XJ. EWW251

Itronic-Fuchs manufacture a GPIB-controlled pneumatic switch system. Eight switch modules are housed in a compact unit, providing up to 64 lines of control. Expansion to 256 lines is possible. A typical application is the testing of computer keyboards using pneumatically-controlled artificial fingers. Omnitest Ltd., Highcliffe House, 411-413 Lymington Road Highcliffe, Christchurch, Dorset BH23 5EN. EWW252

Iwatsu's range includes the SAS-8130 and SM2100B high-speed waveform analyzers, with sampling heads available for frequencies up to 12.4GHz; the SS5802 triple-trace 10MHz digital storage oscilloscope; a 100MHz storage oscilloscope (TS-8123) incorporating a special scan converter tube and having equivalent clock rate of 25GHz; the SC7501 12-channel data-logging

This waveform acquisition and processing package from Tektronix is aimed at applications such as fibre optic testing

CIL - THE CHOICE

TA 880
Multi monitor IEEE RS232 for temperature, voltage, strain indicator and simulator
circle no **96**

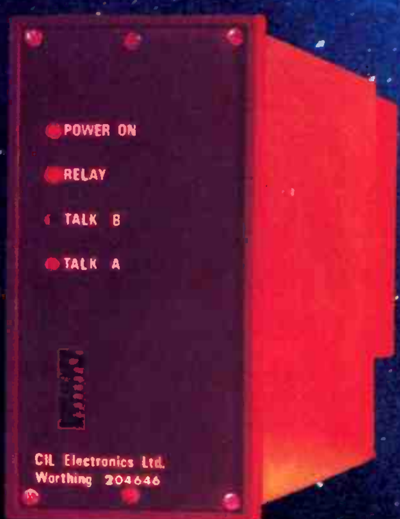
DTR 1000
Up to 10 sec. at 20 KHz audio transient recorder for analysis and playback – IEEE RS232 circle no **99**

SGA 1100
Multi purpose signal conditioning system for strain and temperature measurements circle no **102**

DTR 1681
IEEE and RS232 digital voltmeter with 16K BASIC option for AC and DC to ± 0.01% circle no **97**

DTR 1680
Dual IEEE and RS232 digital voltmeter with 16K BASIC option for AC and DC to ± 0.01%
circle no **100**

DTR 1682
Front panel programmable 16K BASIC 64K RAM IEEE and RS232 digital voltmeter circle no **103**



MFI 1010
Programmed to become a specified instrument or system via RS232 for industry circle no **98**

DTR 3000
Signal processing computer with data acquisition and audio large scale storage circle no **101**

DTR 2000
Pocket computer programmable with various industrial datalogging applications.
circle no **104**

CIL Electronics Ltd
Decoy Road, Worthing, Sussex BN14 8ND Telex: 87515 WISCO G CIL
Tel: Worthing (0903) 204646

FOR THE FUTURE

PCI 6380
Intelligent IEEE or RS232 interface with 8 analogue inputs, 4 outputs, 4 relay contacts — circle no **105**

PCI 1280
High speed 16 bit A-D conversion for computers with IEEE or RS232 links — circle no **108**

PCI 2080
8 channel relay closure unit to operate from the IEEE or RS232 links — circle no **111**

PCI 3080
8 channel D-A converter designed to operate from the IEEE or RS232 links — circle no **106**

PCI 1002
12 channel IEEE compatible thermocouple converter based on the PCI 1000 — circle no **109**

PCI 1000
Low cost 16 channel 12 bit IEEE analogue to digital converter — circle no **112**

PCI 5080
IEEE-488 Bus analyzer record/playback facilities and transparent to BUS — circle no **107**

DTR 1580
High speed (20μS) large storage intelligent 16 bit A-D for IEEE and RS232 — circle no **110**

PUPPI & PUSSI
Low cost multifunction interfaces for Commodore 20 to 80 series and SX64 — circle no **113**

CIL Microsystems Ltd
Decoy Road, Worthing, Sussex BN14 8ND Telex: 87515 WISCO G ATT CIL
Tel: Worthing (0903) 210474

multimeter with built-in thermal printer; and an A3-size graphics plotter (SR6602) with one pen or six. STC Instrument Services, Edinburgh Way, Harlow, Essex CM20 2DF. EWW253

Keithley offer a large choice of GPIB instruments: among them are the model 195A six-function programmable multimeter (ranges include temperature in °F or °C) at £895; a programmable electrometer and voltage source which can handle over 14 decades of current measurements and 17 of resistance (model 617); a nanovoltmeter (model 181, £3,395), an autoranging picoammeter (485, £1,020) and a microvolt multimeter (197, upwards of £700); a multi-function programmable current and voltage source which can source or sink up to 100W (model 228); the 705 and 706 system scanners with 50 and 100-channel capacity and a range of seven switching cards; and the DAS Series 500 workstation for data acquisition and control. Keithley Instruments Ltd., 1 Boulton Road, Reading, Berkshire RG2 0NL. EWW254

Kemo claim to offer the widest range of variable filters manufactured in Europe, with cut-off frequencies between 0.001Hz and 1MHz and bandpass response down to d.c. In most instruments each filter channel may be switched into either high-pass or low-pass mode. Many models are now available with Cauer response for anti-aliasing applications in digital systems. Kemo Ltd., 9-12 Goodwood Parade, Elmers End, Beckenham, Kent BR3 3QZ. EWW255

Kikusui's products include storage oscilloscopes, programmable a.t.e. power sources and high-reliability power supplies. Oscilloscope prices begin at around £1,700 (including GPIB interface). The DSS6522 two-channel model (£2,845), with a conversion speed of 500ns, offers post-storage expansion, an analogue X-Y output and a four-trace display. Telonic Instruments Ltd., Boyn Valley Road, Maidenhead, Berkshire SL6 4EG. EWW256

LeCroy Research specialize in instruments for use in scientific research, in high-energy physics especially. Available in modular form, these units include fast data loggers, amplifiers, triggering units, memory modules and transient waveform recorders capable of sampling at up to 200 million samples per second. GPIB software is available. LeCroy Research Systems Ltd., Elms Court, Botley, Oxford OX2 9LP. EWW257

Marconi Instruments. Products from Marconi with GPIB compatibility as standard or as an option are the following: a.m./f.m. r.f. generators for up to 1040MHz; a modulation meter for up to 2GHz (model 2305); a radio communication test set (model 2955); four d.f.ms for frequencies up to 2GHz; a 10Hz-20GHz microwave counter with 0.1Hz resolution (model 2440); several items of p.c.m. test equipment; a true r.m.s. voltmeter; and the 6500 automatic microwave amplitude analyzer, to which new firmware and hardware enhancements have been added. Marconi Instruments Ltd., Longacres, St Albans, Hertfordshire AL4 0JN. EWW258

Microdata offer a variety of data acquisition and logging systems. These can be housed in racks or laboratory instrument cabinets, in portable cases or in sealed suitcase-style enclosures for harsh environments. Plug-in input cards accept signals from any commonly-used analogue or digital transducer. Up to 100 input channels are possible with some models. Microdata Ltd., Monitor House, Station Road, Radlett, Hertfordshire WD7 8JX. EWW259

MS (Mess + System Technik) produce a comprehensive system for data acquisition, logging and process control. The ADP65 is capable of handling 1000 analogue and 320 bitwise digital inputs, 30 analogue and 160 digital outputs plus 100 counter channels. Also available: the MDP82 series of signal and data i/o modules, an intelligent data recorder using standard audio cassettes and a high-speed cassette recorder capable of data rates up to 9600baud. Seltek Instruments Ltd., The Old Pied Bull, High Street, Stanstead Abbotts, Hertfordshire SG12 8AB. EWW260

National Instruments specialize in computer-to-GPIB interfaces. Cards and software are available for the IBM p.c. and DEC Rainbow, for VME bus, Multibus, S-100, STD and SBX buses and for DEC Q-bus and Unibus. The company also makes a GPIB tester, controller and extenders. Amplicon Electronics Ltd., Richmond Road, Brighton, East Sussex BN2 3RL. EWW261

Norma Messtechnik: products include a 120MHz five-mode counter (D3655) and the System 4000 family, comprising a precision digital multimeter, a true r.m.s. multimeter, a twin channel meter, a precision wattmeter and a metallized-paper data printer with built-in timer. STC Instrument Services, Edinburgh Way, Harlow, Essex CM20 2DF. EWW262

Panasonic Industrial's principal GPIB products are a 50MHz dual-trace storage oscilloscope with linear interpolation, a yes/no decision mode and a 2K memory (model VP-5730P), a fast Fourier transform analyzer covering 0-40kHz and with a data memory of 64Kwords (VS-3310P) and a 32-channel logic analyzer for microprocessor development, with clock speeds of up to 20MHz or 100MHz (VP-3620P and VP-3662P). There are two graphics plotters: a six-colour A4-size model (VP-6801P40) and an eight-colour A3 version with a plotting speed of 450mm/s (VP-6802). Panasonic Industrial U.K. Ltd., 280-290 Bath Road, Slough, Berkshire SL1 6JG. EWW263

Philips have an extensive range of GPIB instruments. Examples are timers, counters and r.f. synthesizers for frequencies up to 1GHz; an l.f. synthesizer (PM5190, £1,495); automatic digital multimeters (from £495 for the $4\frac{1}{2}$ digit PM2519/51); storage oscilloscopes (from £3,250 for the PM3305C); a video generator (PM5549); a digital cassette recorder (PM4202, £740); an eight-pen intelligent plotter (PM8151, from £3,255); and a programmable power supply (PM1367, £905). Pye Unicam Ltd., York Street, Cambridge CB1 2PX. EWW264

Testing mobile radio equipment with intruments by Racal-Dana

Photodyne produce a fibre optic multimeter and other fibre-probing instruments. Several can be interfaced to the GPIB through a special adapter. Lambda Photometrics Ltd., Lambda House, Batford Mill, Harpenden, Hertfordshire AL5 5BZ. EWW265

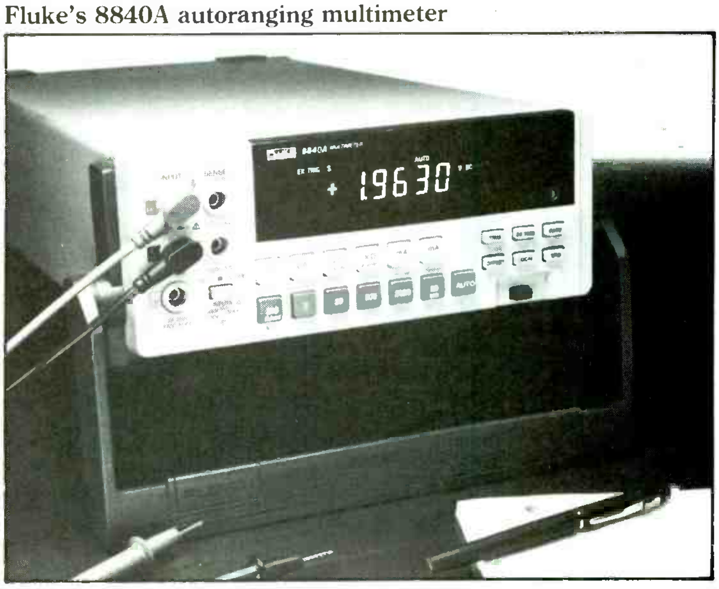
Photon Kinetics manufacture an automatic optical fibre analysis system (model FOA-2000) for production and research. Lambda Photometrics Ltd., Lambda House, Batford Mill, Harpenden, Hertfordshire AL5 5BZ. EWW266

PPM make some versatile switching systems for calibration, data logging and process control. These can be supplied as individual units or as complete systems. Bus commands can be executed immediately or held as stored sequences. Chassis units are fitted with modules selected from a wide range of input and output devices. Software is available too. The company also imports instruments by Rotek, Ballantine and Valhalla, some of which it incorporates into its own systems. A typical automatic calibration set-up costs £15,000 to £20,000. PPM Ltd., Hermitage Road, St John's, Woking, Surrey GU21 1TZ. EWW267 EWW267

Racal-Dana have a full range of GPIB components, which currently include $4\frac{1}{2}$ and $5\frac{1}{2}$-digit multimeters; a $6\frac{1}{2}$-digit true r.m.s. a.c. measurement system; a 10kHz-2GHz r.f. level meter; counter-timers for frequencies up to 3GHz, some computing versions among them; r.f. generators covering 10kHz-104MHz or 3GHz; 48-channel spectrum analyzers; function and pulse generators; a timing generator with real-time clock; a series of switching systems with driver and relay modules covering signal levels up to 1kW and frequencies to 18GHz; a GPIB analyzer; and two 20-column thermal printer-plotters, one with a built-in clock. Racal-Dana Instruments Ltd., Duke Street, Windsor, Berkshire SL4 1SB. EWW268

Rohde & Schwarz issue a measuring equipment catalogue which this year runs to over 430 pages and includes signal generators for frequencies up to 2.7GHz, test receivers and modulation analyzers, radiotelephone test sets, a set-up for testing r.f. cables, r.f. step attenuators, sweep generators, vector and network analyzers, logic analyzers, a group-delay measuring set, meters of all kinds, relay matrices for audio and r.f., a digital thermometer, a temperature controller, a dot-matrix printer and a 16-function pneumatic interface. Rohde & Schwarz U.K. Ltd.,

Fluke's 8840A autoranging multimeter



The PM3305 35MHz storage oscilloscope from Philips

Roebuck Road, Chessington, Surrey KT9 1LP. EWW269

Scientific Atlanta have introduced a signal analyzer (model SD380) based on a mainframe which accomodates expansion up to four channels and options such as data storage on $3\frac{1}{2}$in. disc, speed compensation for easy interpretation of machine signatures. Features include real-time digital zoom, 3-D cascaded waterfall display. Scientific Atlanta Ltd., Horton Manor, Stanwell Road, Horton, Slough SL3 9PA. EWW270

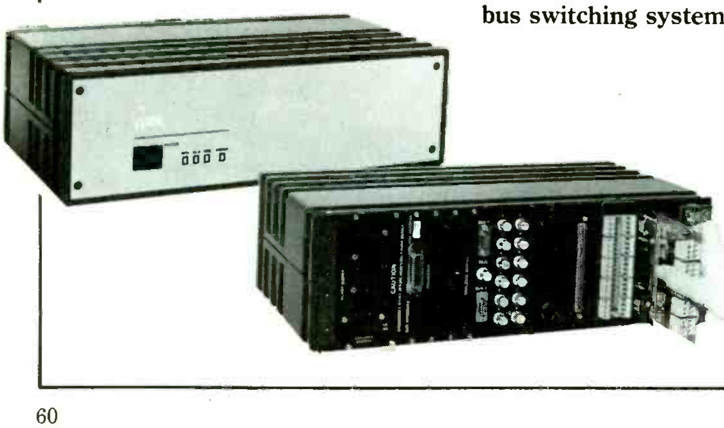
Siemens manufacture a large family of instruments: a choice of three multimeters and four power meters, pulse and function generators, a generator-comparator for waveform curves storing up to 512 × 1024 points, a digital word generator/comparator operating at up to 2MHz, transient recorders with up to 64 channels, two frequency counters, a data line analyzer for telephony, a fibre-optic reflectometer for locating fibre breaks and measuring the loss of splices, d.c. voltage calibrators and programmable power supplies, a 30-channel chart recorder, two X-Y plotters and a thermal printer. Siemens Ltd., Windmill Road, Sunbury-on-Thames, Middlesex TW16 7HS. EWW271

Solartron make many GPIB instruments. Digital multimeters and precision voltmeters are available with displays of up to $8\frac{1}{2}$ digits. A logic analyzer (7610 series) has up to 48 channels with a 1Kbit memory for each, multiple timebases and the option of a 400MHz input module. The model 1200 signal processor is an advanced spectrum analyzer offering a logarithmic display format and a cepstrum analysis function. A data logger, the Orion Delta 3530D, can run eight tasks with different levels of priority, handles up to 200 channels (600 with slaves) and has a powerful data processing ability. The 4040 communications test set is designed to meet all radiotelephone test requirements from audio to u.h.f. For radio testing and surveillance monitoring the Minilock measuring receiver can sweep and measure in the range 10kHz to 1GHz. Also in the range are storage oscilloscopes, signal generators, a five-colour plotter and a p.c.m. data transmission test set. Solartron Instruments, Victoria Road, Farnborough, Hampshire GU14 7PW. EWW272

Systron-Donner's extensive range of instruments includes many with GPIB control as standard or as an option. Among these are a modular optical communications system capable of handling video, an MSF-synchronized clock, counter-timers and signal generators covering frequencies from 100Hz or so to 26GHz, pulse generators, waveform analyzers and programmable power supplies for laboratory or stystems applications. Systron-Donner Ltd., St Mary's Road, Leamington Spa, Warwickshire CV3 1QN. EWW273

Takeda Riken produce a range of spectrum analyzers, from fast Fourier transform analyzers for acoustic and servo-system applications to portable r.f. analyzers covering frequencies up to 20GHz. Also available are a floppy-disc digital data recorder, some microwave frequency counters and signal generators for audio and radio frequencies. Chase Electrics Ltd, St Leonard's House, St Leonard's Road, London SW14 7LY. EWW274

PPM's model 8000 bus switching system



Technical Projects manufacture a versatile test set for rapid audio measurements. The 401D, which is aimed especially at the broadcast industry, measures level, noise, frequency, harmonic distortion and spurious signals and there are add-ons for phase measurement, rumble, wow and flutter and so on. Display is on a fast-acting analogue peak programme meter. The optional GPIB interface controls all front-panel fuunctions and provides a digital output of the analogue meter reading. Technical Projects Ltd., Unit 2, Samuel White's Industrial Estate, Medina Road, Cowes, Isle of Wight PO3 7LP. EWW275

Tektronix: this manufacturer's GPIB range is very broad, with components or ready-packaged systems covering virtually every need in testing, measurement or signal acquisition. A special feature is consistency of command and data formats to make configuring and debugging simpler. One recent addition is the TM5000 family, built around two mainframes which can be fitted with any of seven intruments — counter-timers, a multimeter, a function generator and so on. For setting up a system the EZ-Test software generator package (about £1,000) enables the user quickly to create his own test software without having to learn a special programming language. Tektronix U.K. Ltd., P.O. Box 69, Harpenden, Hertfordshire AL5 4UP. EWW276

Telonic-Berkeley have recently introduced their TCD series tunable bandpass filters. These are available in three or five section versions covering any one octave in the range 32MHz to 3GHz. Telonic Instruments Ltd., Boyn Valley Road, Maidenhead, Berkshire SL6 4EG. EWW277

Thorn EMI Datatech make several GPIB-compatible instruments: a frequency response analyzer (model SE2450) with a graphics option giving Nicholls, Nyquist or Bode plots on the screen; a programmable transient recording system (BE256) with a choice of memory sizes and sampling rates of up to 50MHz; an eight-channel transient recorder with built-in screen display and menu control (SE2550); and a signal conditioner (SE1700) with a capacity of up to 256 channels. A pair of converter units make it possible to link GPIB to other interface systems (SE2750) or to analogue signals (2A-488). Thorn EMI Datatech Ltd., Spur Road, Feltham, Middlesex TW14 0TD. EWW278

Thurlby Electronics are to launch in April a range of programmable bench power supplies with high-resolution control: prices start at £395 for a 0-30V, 0-2A supply. Already available is a digital multimeter with computing and data storage functions, model 1905a, which with IEEE interface costs £495. The IEEE bus itself can be examined with Thurlby's LA-160 logic analyzer, which is usable with any conventional oscilloscope, comes with 16 or 32 data channels and has a 2000 word data acquisition memory with powerful search-and-compare facilities. The 10MHz version is priced very competitively at £395 plus £45 for the LC-03 GPIB connector. Thurlby Electronics Ltd., New Road, St Ives, Huntingdon, Cambridgeshire PE17 4BG. EWW279

Tri-Phenix manufacture a programmable pulse generator offering repetition rates of up to 20MHz and pulse widths down to 100ps. Price is £5,755. Also available is a radar range simulator for testing radar systems, model PX219, at £9,855: this generates a return pulse capable of being dynamically controlled to simulate movement of the target. Lyons Instruments Ltd., Ware Road, Hoddesdon, Hertfordshire EN11 9DX. EWW280

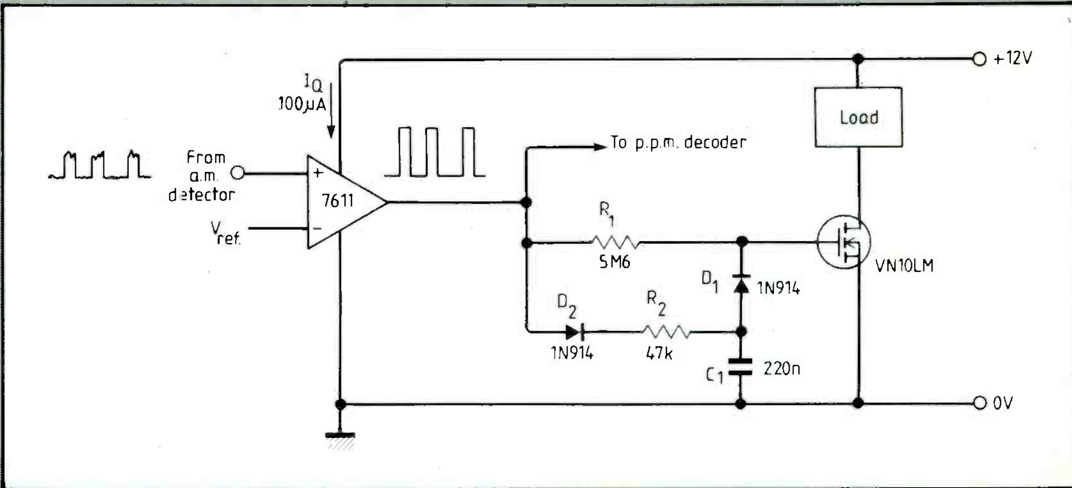
Wandel & Goltermann describe their large range of instruments for the telecommunications industry in a catalogue of nearly 400 pages. GPIB-compatible units include signal generators, level meters and spectrum and network analyzers; sets for measuring noise and distortion on radio links and satellite systems; a data line test set; p.c.m. digital signal generators, analysers and test sets; a harmonic analyzer for a.c. power lines; and a remote switching system for frequencies up to 160MHz. W & G Instruments Ltd., Progress House, 412 Greenford Road, Greenford, Middlesex UB6 9AH. EWW281

Wavetek: most items in the current range are GPIB-compatible. Examples are spectrum analyzers with up to four channels, one of them with built-in disc storage and even an integral word-processor; function and waveform generators for frequencies up to 50MHz; a.m./f.m. r.f. generators; signal processing filters; signal switchers for up to 26.5GHz; microwave generators and measurement systems. Wavetek Electronics Ltd., Tag Lane, Reading, Berkshire RG10 9LT. EWW282

Wayne Kerr manufacture several GPIB-controllable instruments for testing components. The 4210 automatic LCR meter, with a basic accuracy of 0.1%, has percentage-deviation and binning facilities for automatic component grading, is able to polarize capacitors and can identify the type of component plugged into it. The B905 automatic precision bridge has auto-ranging, auto-trimming and displays results on two five-digit l.c.ds. The 6425 precision component analyzer has six-figure resolution and features a display screen with software-labelled function keys for use when manual control is required. Wayne Kerr Instruments Ltd., Durban Road, Bognor Regis, Sussex PO22 9RL. EWW283

Zehntel produce a range of systems for production testing of analogue and digital printed circuit boards. Two of these, the 810 and the low-cost 310, can be enhanced by interfacing to GPIB instruments which then have access to the systems' test points. Zehntel Ltd., Sentry House, 500 Avebury Boulevard, Saxon Gate West, Central Milton Keynes MK9 2NJ. EWW284

VMOS squelch for pulse receivers



This circuit uses the baseband p.p.m. (pulse-position modulation) output of a battery-powered v.h.f. a.m. telecommand receiver to switch on high current post-detector stages. Design requirements call for fast attack on receipt of the first 50ms pulse in a five-bit sequence, followed by a hold time of at least 1.5s to permit command activation.

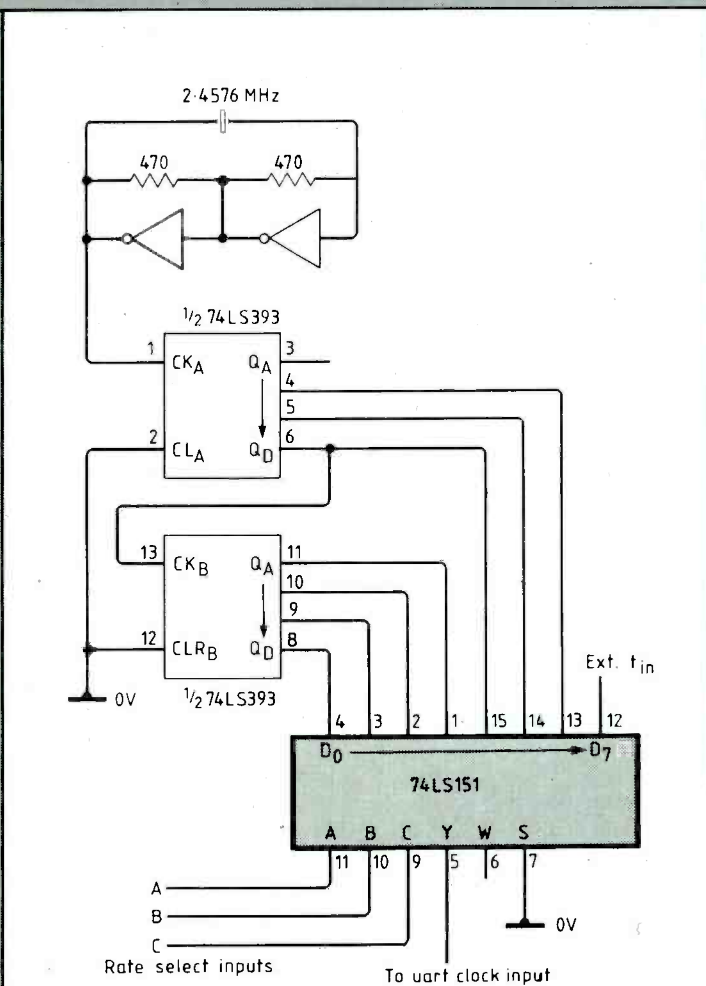
Using a cmos op-amp with buffer transistor gives low standby current drain while allowing up to 250mA to be switched. Time between a high output from the comparator and the buffer transistor switching on is determined by R_1 and gate capacitance of the transistor. A fully-on gate threshold of 2.5V and gate capacitance of 100pF give an attack time of 0.13ms.

Capacitor C_1, isolated from the gate by D_1 during turn on, is charged towards the supply rail through R_2 and D_2 for the pulse duration. When the comparator output goes low at the end of a received pulse, C_1 discharges through R_1 and D_1, with the time constant R_1C_1 determining time elapsed before load power down (around 1.8s).

If D_1 is replaced by a short-circuit, attack time is increased to around 2.4ms. In this case a lower drive-pulse slew rate can be tolerated so the op-amp quiescent current may be reduced to 10μA for low-power applications.

N.E. Evans
Ulster Polytechnic
Co. Antrim

Bit-rate generator

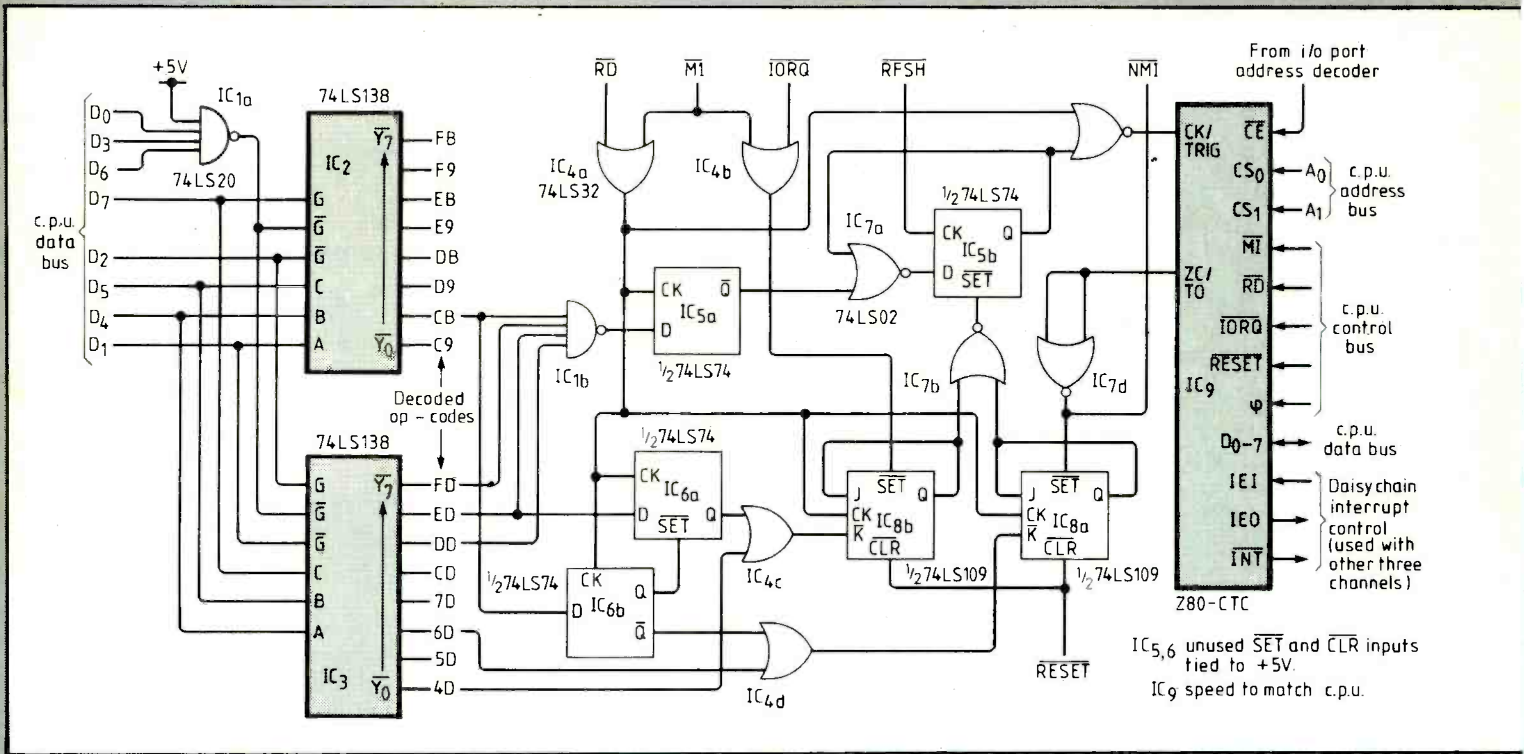


Originally designed for use with a 6850 a.c.i.a., this circuit provides a cheap programmable bit-rate generator for most uarts with ×16 or ×64 clock inputs.

Two four-bit counters in the LS393 are cascaded to form an eight-bit counter for dividing the crystal frequency down to those shown in the table. The seven lowest frequencies from the counter are fed to the LS151 eight-input data selector whose D_7 input may be used for an alternative clock signal. Data select inputs of this i.c. can either be connected to switches or to a computer i/o port for software control of the data rate.

P.J. Griffiths
Uppingham
Leicestershire

Inputs C	B	A	Frequency (Hz) f/1	f/16	f/64
0	0	0	9600	600	150
0	0	1	19.2k	1200	300
0	1	0	38.4k	2400	600
0	1	1	76.8k	4800	1200
1	0	0	153.6k	9600	2400
1	0	1	307.2k	19.2k	4800
1	1	0	614.4k	38.4k	9600
1	1	1	external clock		



Instruction counter for Z80 simulator

One function of a microprocessor simulator is to run a preset number of instructions of a program being debugged and then stop so that register and memory contents may be examined using a monitor program. In Z80 systems, the breakpoint is often implemented in software by replacing an instruction in the test program with a Restart instruction (a single-byte Call to a fixed address).

For this approach, the test program needs to be in ram and working out exactly where to place the Restart code is complicated by the varying length of Z80 instructions. Also, a bug in the test program could prevent the restart code from being reached. In this design, the test program does not need to be tampered with, so that routines in rom may also be single-stepped for demonstration purposes. (The usual wait-state generation technique for single-stepping precludes the use of dynamic rams.)

A programmable counter provides the breakpoint by counting M1 (op-code fetch) cycles and generating a non-maskable interrupt (NMI) when the preset number of instructions has been executed. Correction is automatically made for two-byte op-codes — those beginning with CB, DD, ED or FD — which have two M1 cycles. Counting is suspended during interrupt servicing so that, for example, display handling interrupts can be allowed to run without affecting the test.

Sixteen op-codes are decoded by IC$_{1-3}$. If CB, DD, ED or FD is detected on the data bus at the end of an M1 cycle, the $\overline{Q}$ output of IC$_{5a}$ is clocked low by the trailing edge of the $\overline{RD}$ pulse. The $\overline{RFSH}$ refresh pulse, which always occurs after an M1 cycle, clocks IC$_{5b}$ whose Q output goes high and prevents the second $\overline{M1}$ pulse from reaching the CTC (counter/timer circuit). Output Q is fed back through IC$_{7a}$ to ensure that the next instruction is not also inhibited should the second byte be CB, DD, ED or FD.

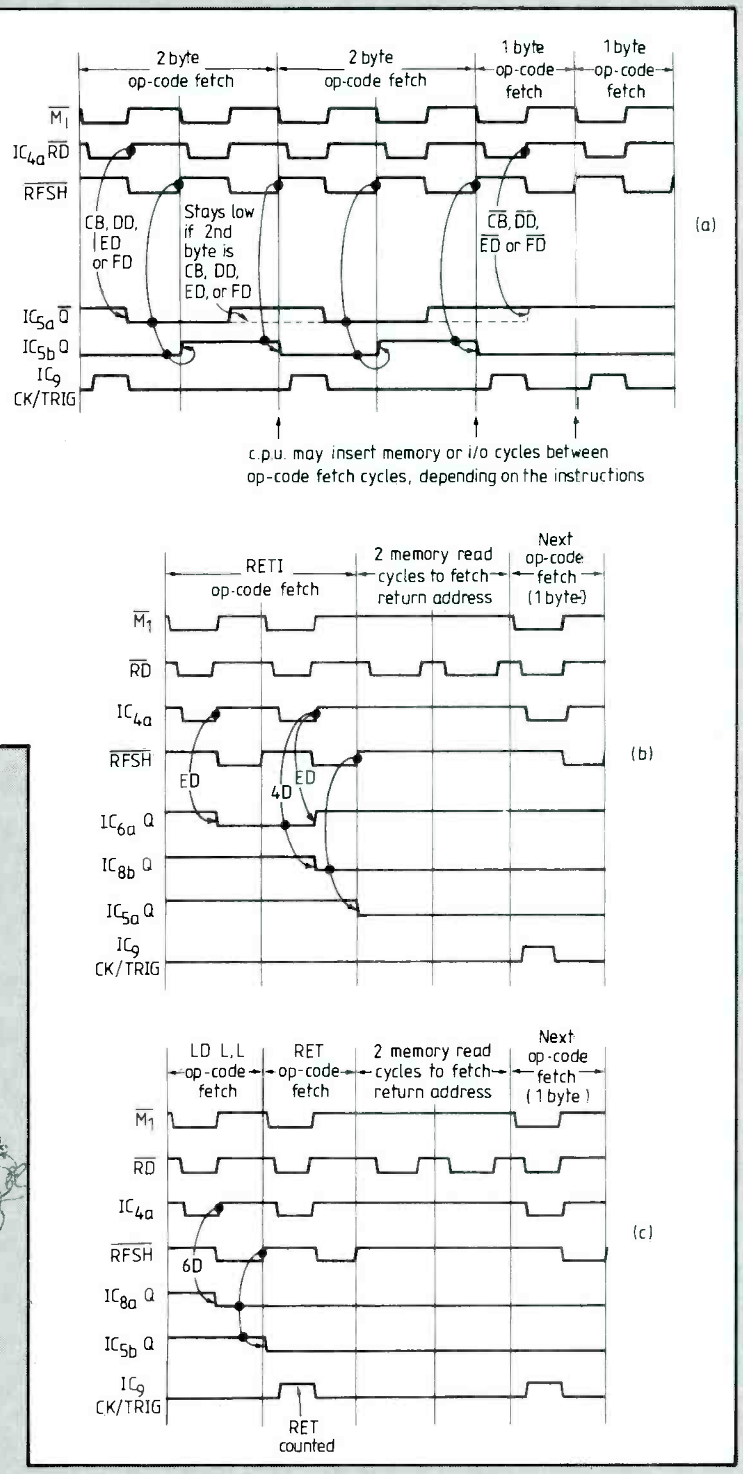
When the CTC down-counter reaches zero, it sends a short positive pulse on its ZC/T0 pin. This pulse is inverted to provide the c.p.u. $\overline{NMI}$ signal. It also sets the Q output of IC$_{8a}$ high which in turn sets the Q output of IC$_{5b}$ high to inhibit further counting. Using the non-maskable interrupt means that the circuit works whatever bugs there may be in the test program. The CTC channel used has its normal interrupts disabled.

The NMI service routine dumps all the register contents into a reserved ram area and then enters the monitor program which allows ram to be examined and altered as required. A continue command to the monitor reloads the CTC and copies the register storage ram back into the registers. A normally unused instruction, LD L,L (op-code 6D), is executed to clear IC$_{8a}$ and hence remove $\overline{SET}$ from IC$_{5b}$.

Finally, a return instruction is executed. This retrieves the address of the next instruction from the stack, where it was placed when the NMI was recognized, and the test program continues from the point where it was interrupted. The RET op-code is counted by the CTC, but the monitor allows for this by adding one to the number of instructions to be run. Up to 255 instructions may be run.

Instruction counting is prevented during interrupt servicing by IC$_{8b}$, whose Q output is set high when an interrupt acknowledge cycle is detected ($\overline{M1}$ and $\overline{IORQ}$ both low). Output Q of IC$_{6a}$ goes low when op-code ED is detected, and if the second byte is 4D, i.e. if the instruction is RETI, then IC$_{8b}$ is toggled, the $\overline{SET}$ signal is removed from IC$_{5b}$ and counting continues from the next op-code.

Clearing of the two JK bistable elements of IC$_8$ occurs whenever the processor is



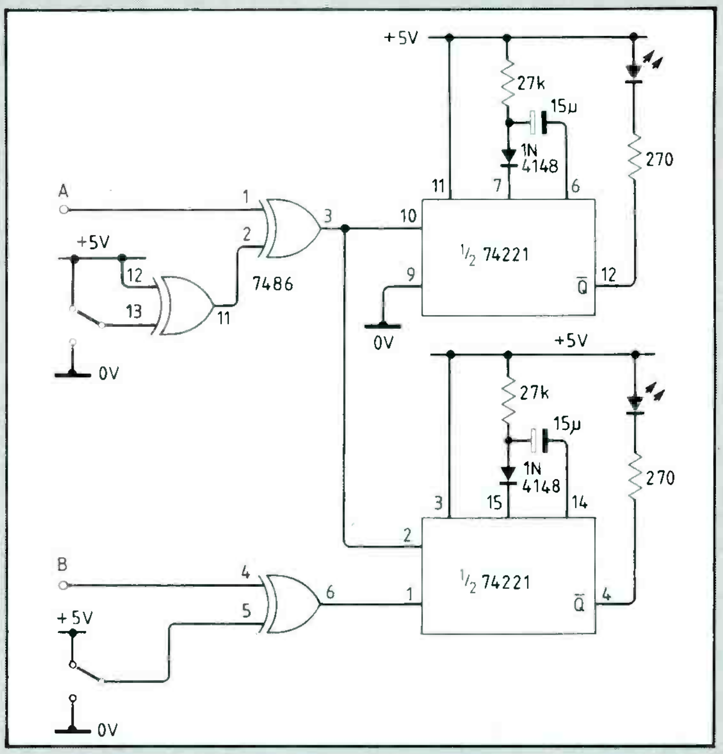
reset. Connections from Q to J ensure that the devices remain cleared until forced to change state by a low on the $\overline{SET}$ input.

Circuit IC_{6b} is cleared by a CB op-code. The low Q output inhibits latching of a following ED byte by IC_{6a} and hence prevents IC_{8b} from being toggled to its clear state by a SET 5, L instruction followed by LD C,L (op-codes CB ED, 4D). Similarly, the high $\overline{Q}$ output of IC_{6b} keeps the $\overline{K}$ input of IC_{8a} high after a CB byte so that IC_{8a} is not cleared by the second byte of the instruction BIT 5, L (op-code CB 6D).

In the timing diagram, (a) shows removal of the second op-code byte, (b) resumption of counting after a RETI instruction and (c) resumption of counting after an LD L,L instruction.

If no use can be found for the three remaining CTC channels, this device can be replaced by a chain of any desired number of LS163 presettable four-bit counters.

Peter Ferris
London



Strobe probe

This probe has proved invaluable in tracing relationships between read, write and chip-select lines on microprocessor-based circuit boards. It has two channels. Section A is the window input and its led lights to indicate that a window has occurred. Probe input is fed to section B. The led in this section pulses on if a signal at the B input occurs during the window at A.

Polarity of the window and probe inputs is selected by the respective switches. When a switch is high, its associated circuit responds to active-high inputs and *vice versa*.

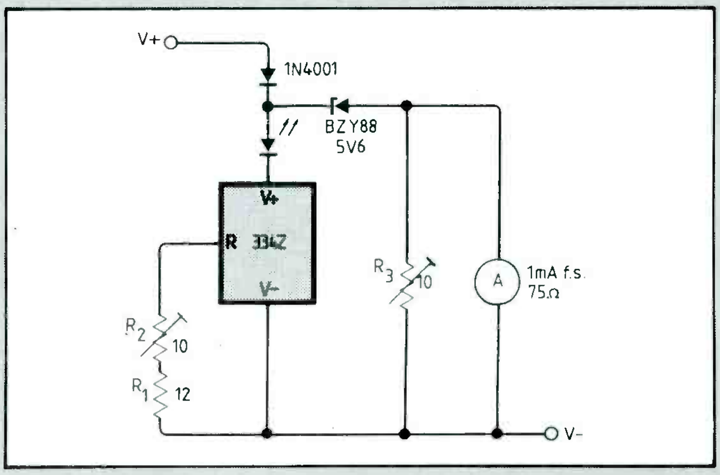
D.J. Ford
Welwyn Garden City
Hertfordshire

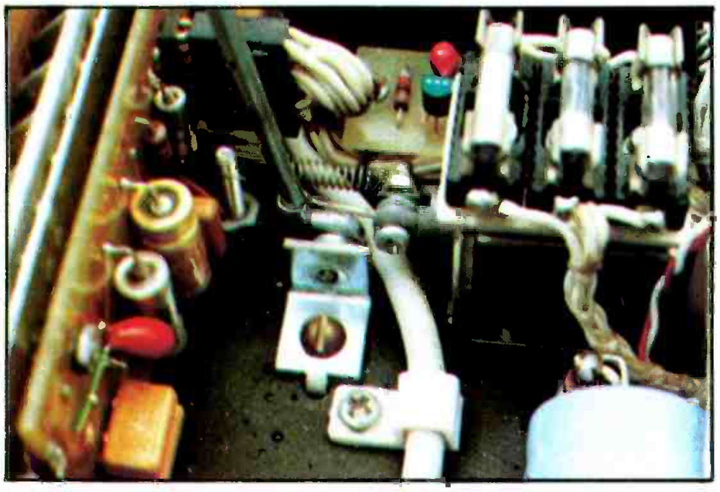
4-20mA indicator

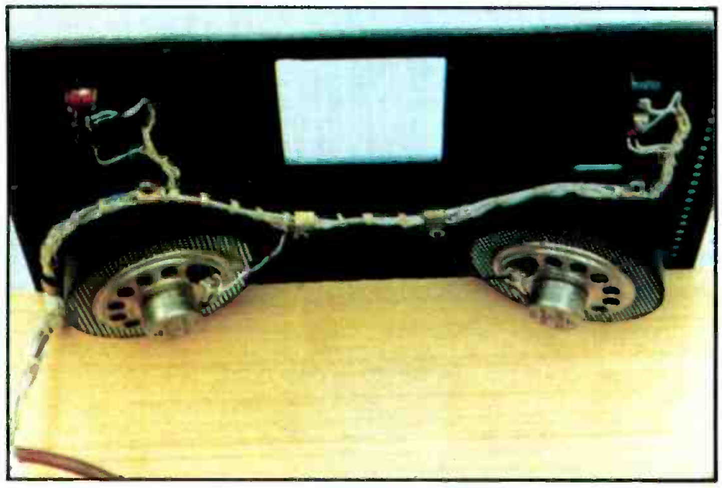
Output from industrial process instruments is often a constant-current signal in the range 4-20mA d.c. This simple device is a monitor for such signals. Its accuracy depends largely on the meter used and with careful calibration, an error of ±1% f.s. is possible.

Presence of a signal is indicated by the led. The three-terminal i.c. provides a 4mA offset which is set using the potentiometer to the left of it. Voltage drop provided by the zener diode ensures that there is sufficient voltage to operate the led and i.c. The second potentiometer is for setting to full-scale deflection at 20mA.

M.C. Polgreen
Birmingham





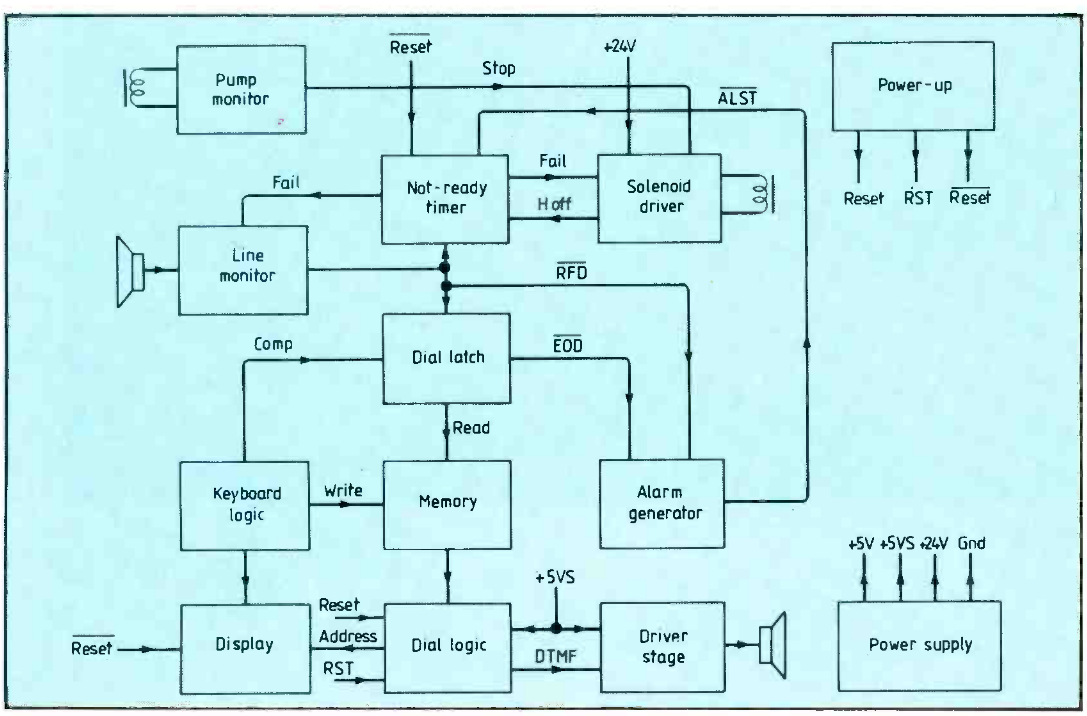


Two views to aid construction of Mr Andersen's design. Potential constructors should read the note on page 69.

Alarmphone

This second part of Per Andersen's article details the circuitry for the emergency autodialler that requires no line connection

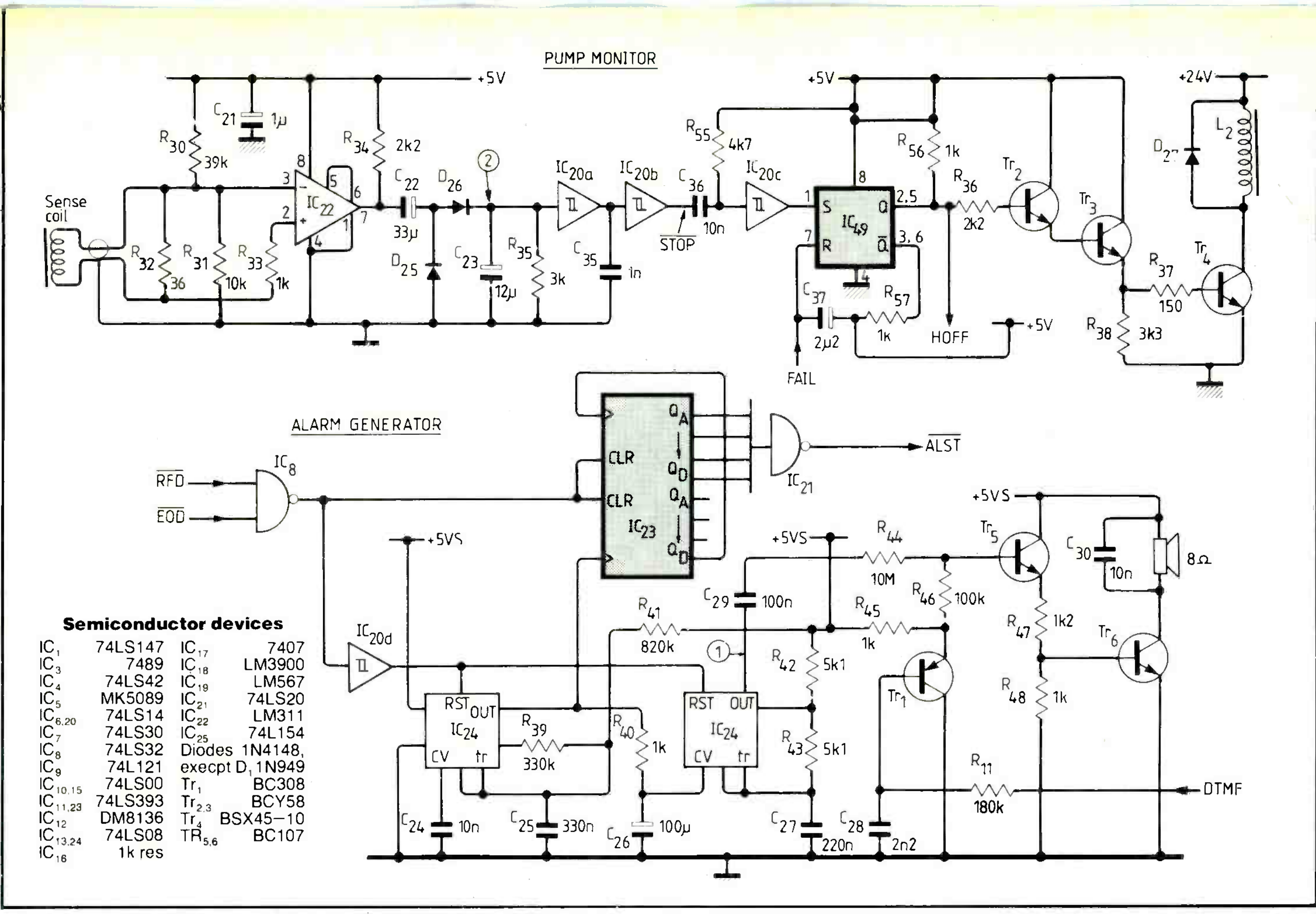
Block diagram shows how circuits on the opposite page and on page 68 relate.



When the motor is running, the L_1 coil in the pump monitor detects the magnetic field around it. Comparator IC_{22} converts this signal to a square wave that is rectified and taken through a couple of Schmitt trigger inverters to generate the stop signal ($\overline{STOP}$). This is 'or-ed' to the fail signal providing the term H_{off}. Under normal conditions $\overline{STOP}$ is high, and therefore the solenoid is not activated. When H_{off} is low, IC_{13a} is constantly triggered supporting a low fail signal to the line and pump monitors. On switch-on $\overline{RESET}$ set $\overline{RFD}$ high. However, when the motor stops, H_{off} goes high activating the solenoid and releasing IC_{13a}. The ready-tone is picked up and amplified around 70dB by $IC_{18a,b}$ presenting a signal of 1.5V r.m.s. at the input of the tone decoder, IC_{19}. The bandwidth and output delay values chosen require a steady signal for at least two seconds before the output of IC_{19} goes low. Circuit IC_{18c} is coupled as an inverter triggering the reset input of the bistable flip-flop IC_{18d}. Line $\overline{RFD}$ now goes low preventing IC_{13a} from generating the fail signal and triggering the set input of the dial latch. If the ready tone is not detected within six seconds, the not-ready timer runs out supplying the fail signal to IC_{18d}, forcing its output to stay high whatever happens at the resent input, and deactivation the solenoid.

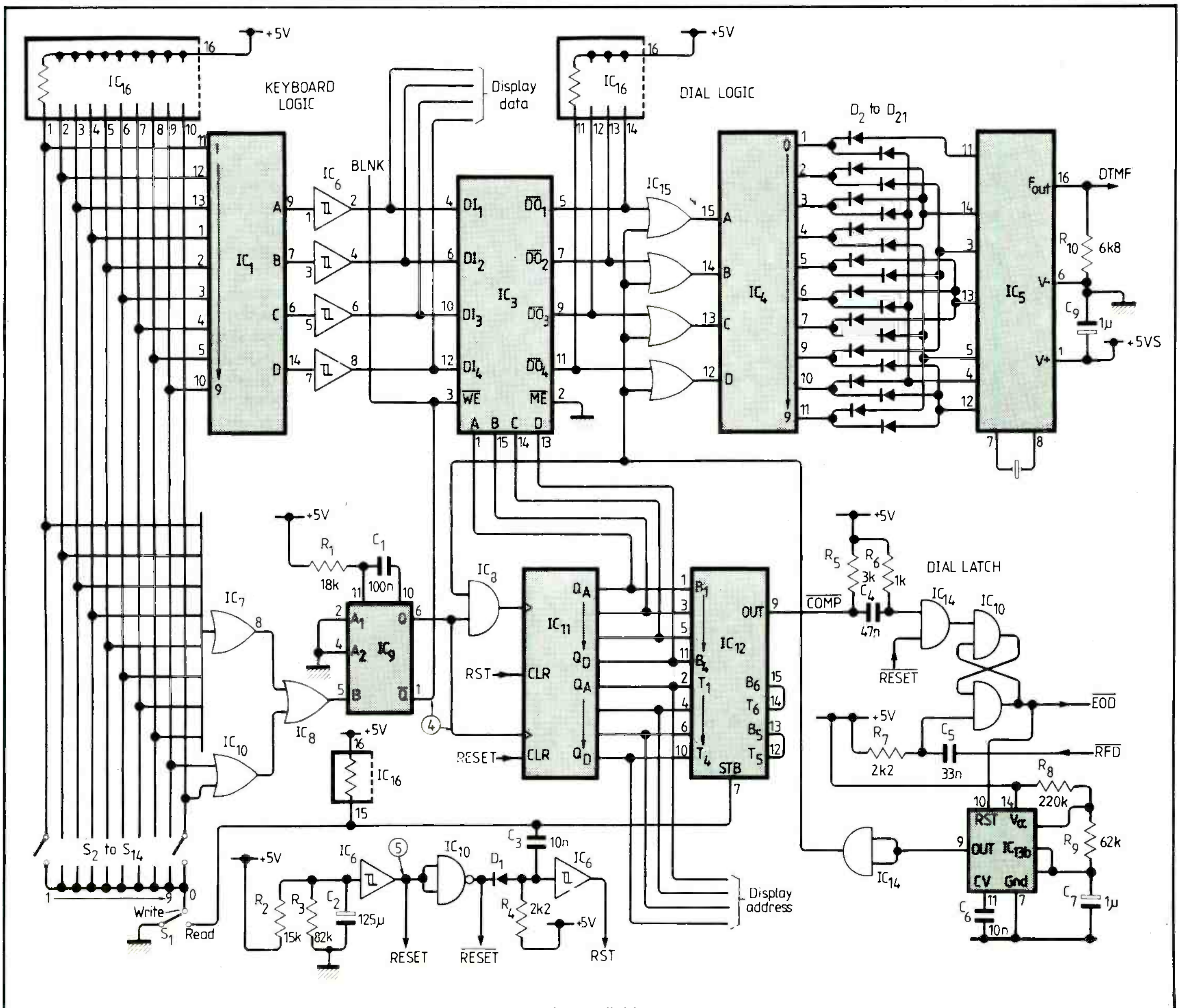
The high output of the dial latch starts the 1.2Hz generator, IC_{13b}, which controls the memory output buffer and address counter. The buffered signal is taken to the b.c.d.-to-d.t.m.f. tone converter consisting of IC_4, IC_5 and D_2-D_{21}, then to the driver stage and the transmitter/loudspeaker.

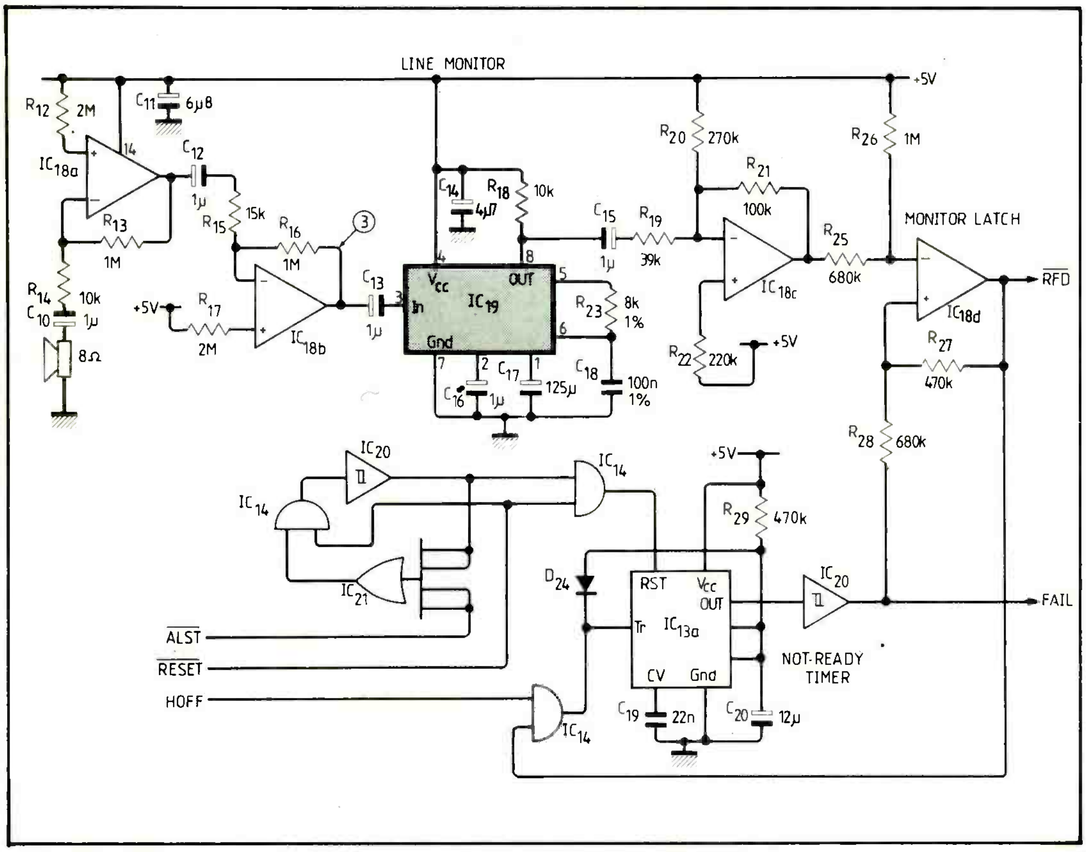
Comparator IC_{12} compares the outputs of the memory and display address counters and upon equality, which means when the encoded number is dialled, the output goes low triggering the dial latch to stop the 1.2Hz oscillator. The $\overline{EOD}$ and $\overline{RFD}$ signals are now 'and-ed' for starting the alarm generator, which will run $1\frac{1}{2}$ minutes determined by IC_{23}. At the end of the period the $\overline{ALST}$ signal takes the reset input of the



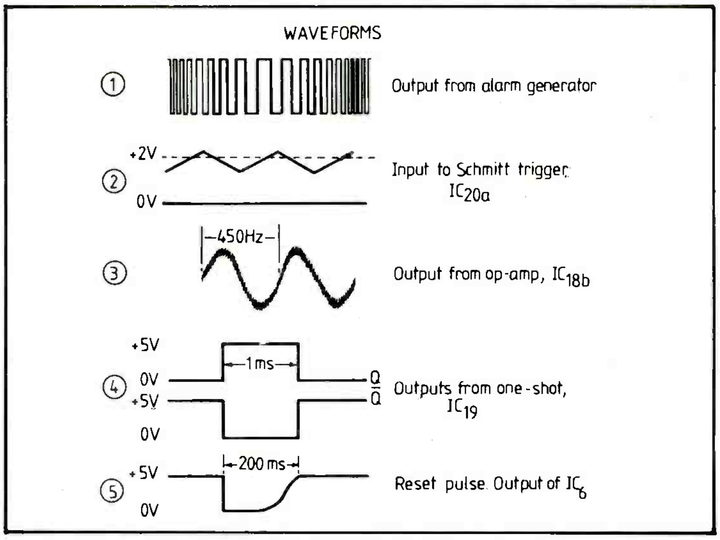
Semiconductor devices

IC_1	74LS147	IC_{17}	7407
IC_3	7489	IC_{18}	LM3900
IC_4	74LS42	IC_{19}	LM567
IC_5	MK5089	IC_{21}	74LS20
$IC_{6,20}$	74LS14	IC_{22}	LM311
IC_7	74LS30	IC_{25}	74L154
IC_8	74LS32	Diodes	1N4148,
IC_9	74L121	execpt D_1	1N949
$IC_{10,15}$	74LS00	Tr_1	BC308
$IC_{11,23}$	74LS393	$Tr_{2,3}$	BCY58
IC_{12}	DM8136	Tr_4	BSX45–10
$IC_{13,24}$	74LS08	$TR_{5,6}$	BC107
IC_{16}	1k res		

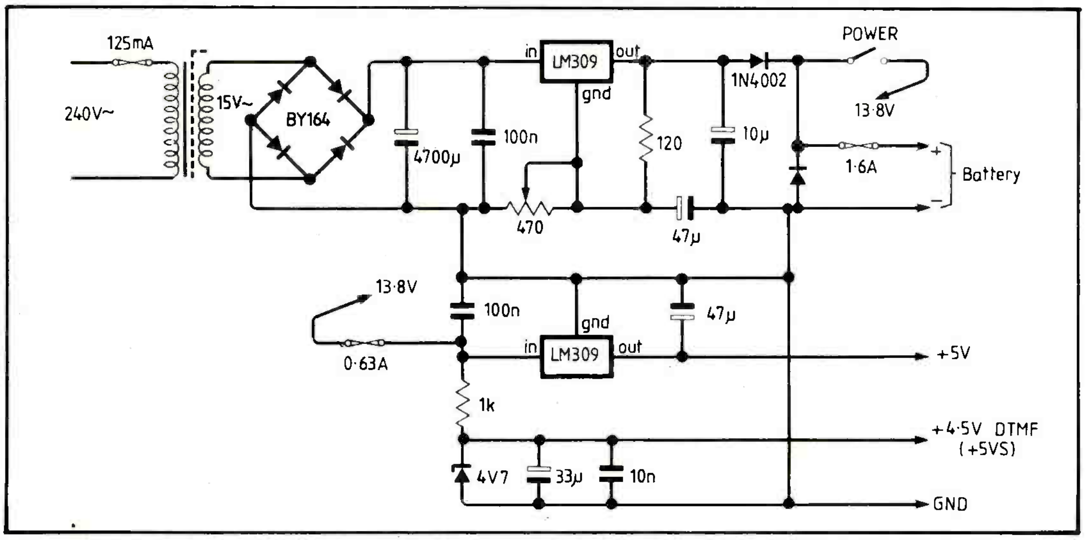




Circuitry requires a solenoid supply as well as 5V supplies; a battery charger is included in this version.



Waveforms at various points in circuit are identified in circuit above and on page 67 by encircled numbers.



not-ready timer low which generates the fail signal which sets the machine in the stand-by mode.

The alarm generator produces a sound similar to certain police sirens. This was chosen so that whoever answers the call, probably not you, is able to distinguish it from all the other telphone signals. The tone is easily made by taking the output of the first section of IC_{24} to the control voltage input of the second section thereby modulating it with this lower frequency.

To write the telephone number, which can have up to 16 digits, into the memory you simply take S_1 to the write position and key the number at the keyboard. As a control the number is read out on the display. On completion S_1 is taken to the read position. Keyboard data goes from IC_1 (10-to-4 line converter) via IC_2 (4-bit latch) to the memory, IC_3. Each time a key is depressed, a strobe pulse of around 1ms is generated from the outputs of IC_9. The negative strobe is used for the write signal to memory and for unblanking of used digits at the display. The positive strobe increments the memory and display address, counters for each depression of a key. When S_1 is taken back to the 'read' position the memory address counter is reset because of the capacitor C_3. The display address counter remains at the number of digits that previously was entered. A read cycle therefore goes on until equality of the two counters.

On switching on the machine the necessary reset pulses, which have a duration of about 200ms, are generated from IC_6 and IC_{10}. The reason for designing a display for the machine was the ability to control the number to be encoded. On a normal telephone you simply hang on and make a re-try if you get the wrong connection. In this case, you wouldn't know if the right number was dialled, because the connection was made when you were not at home. This is where the display comes in. As it was the most expensive unit in this construction, it is designed in a way that makes it easy to leave out if not wanted. Or it could very easily be reduced to eight* digits, if

* Or one digit, for that matter, with sequential readout. Mr Anderson has suggested the circuit on page 69 for this low-cost option. The original circuitry for an 8 or 16 digit display is available from the editorial office.—dep.ed.

Signal Explanation

$\overline{\mathrm{ALST}}$ To the line monitor from the alarm generator to notify that all functions were completed, and to generate the FAIL sign.

BLNK From the keyboard logic to the display to shift the blanking registers each time a key is depressed.

$\overline{\mathrm{COMP}}$ From the keyboard logic to the dial latch to let it know that all digits from the encoded number were dialed.

DTMF Tones from the tone dialer to the output stage.

$\overline{\mathrm{EOD}}$ The end-of-dial signal goes from the dial logic to the alarm generator to provide the alarm signal for the transmitter, when the dial sequence is finished.

FAIL From the line monitor to the pump monitor to deactivate the solenoid, when all functions are completed, or when the ready-tone did not occur within six seconds from the point where the receiver was lifted off the hook.

HOFF From the pump monitor to the line monitor to enable the six-second timer, whenever a pump malfunction took place.

$\overline{\mathrm{RFD}}$ Ready-for-dial goes from the line monitor to the dial latch to indicate that the ready-tone was detected. It also goes to the alarm generator, where it will be used in conjunction with the $\overline{\mathrm{EOD}}$ signal, to generate the alarm signal.

RST Clears the memory address counter upon power-up or when the function switch is taken to the read mode.

RESET Clears the display address counter upon power-up.

$\overline{\mathrm{RESET}}$ Sets the line monitor latch HI after power-up, and causes IC_{13b} to remain anactive until the $\overline{\mathrm{RFD}}$ signal is received. Clears the display blanking registers during power-up.

$\overline{\mathrm{STOP}}$ Message from the pump monitor to the solenoid driver to let it activate the solenoid and generate the HOFF signal.

this is enough for local telephone numbers. It was designed with 16 digits to make it fit to the memory capacity of the machine, and to allow viewing of the number dialled at any time.

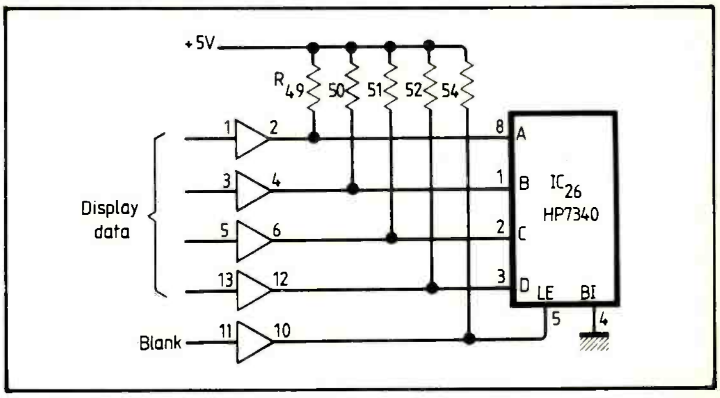
The four data lines to the display are buffered in IC_{17} and then taken to the display data bus. Position of the digits are determined by the 4-to-16 line decoder, which is controlled by the display address lines. The address is incremented by one each time a key is depressed, and this will enable the digits in turn from left to right. To keep unused digits blanked, the two 8-bit shift registers, IC_{42}, IC_{43}, are coupled as blanking latches controlling the BI-terminal on the displays. The latches are reset during power-up to provide a blank display before entering any digit.

As the instrument is battery powered the supply circuit is simple. Only a couple of voltage regulators with the necessary capacitors at the outputs are used. Of course a regular mains supply could be used to support the power in the stand-by mode, which will reduce the capacity of the battery essentially. In this case the battery is only needed for less than two minutes, which is the time it takes to make the dial and deliver the alarm tone. Proper switching from mains to battery will in such a case be required to secure storing of the memory contents.

It might be necessary to adjust the machine to different types of telephones, as these could have diverging input/output levels from the one the machine was developed for. But this will be fairly simple, as it is only a matter of changing the gain of the input amplifier and the driver stage. The only thing to consider is that the tone decoder needs an input of around 1.5 to 2Vr.m.s., and that the transmitted d.t.m.f. signal must not suffer from any kind of distortion.

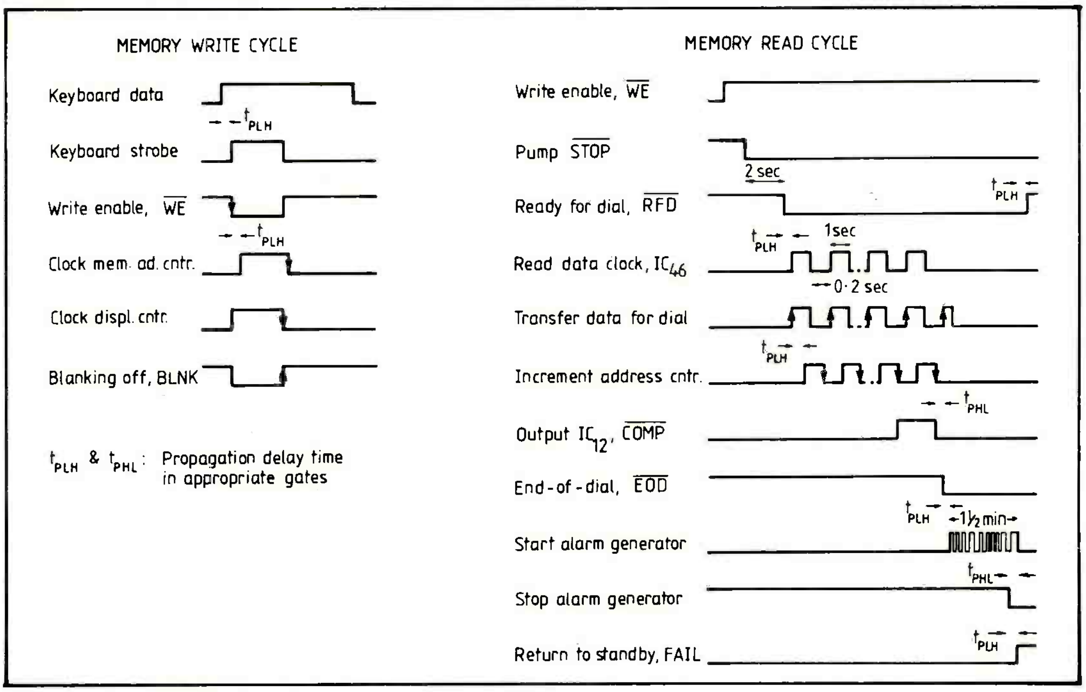
The sense coil is easily made, as it monitors 50Hz. In my case the coil from a scrapped relay was used with good results, but almost anything will do. Some of the functions in the circuit could be made in a simpler way, but they were designed partly to keep the expenses down, and partly because the components were available.

The d.t.m.f. circuitry is supplied from a separate regulator to secure optimum performance and correct functioning of the dial logic. As there are no adjustments in the machine, it should work immediately after careful assembling.



Author's original 8 or 16-digit display can be used to check the stored number; alternatively this sequential single-digit circuit offers a low-cost option. The inverters are type 7407.

Whilst many telephone exchanges in Europe will handle dtmf dialling, only a minority of UK public exchanges (unlike private branch exchanges) can at present. British Telecom expect that over two million subscribers will be able to use dtmf dialling by the end of 1986 as a result of continued expansion of System X. As with modem designs, such equipment must have BATB approval to be legal.



COMPACT DISC DIGITAL AUDIO

Principles of optical storage

by J.R. Watkinson

This second article in our new series details the physics of the readout process

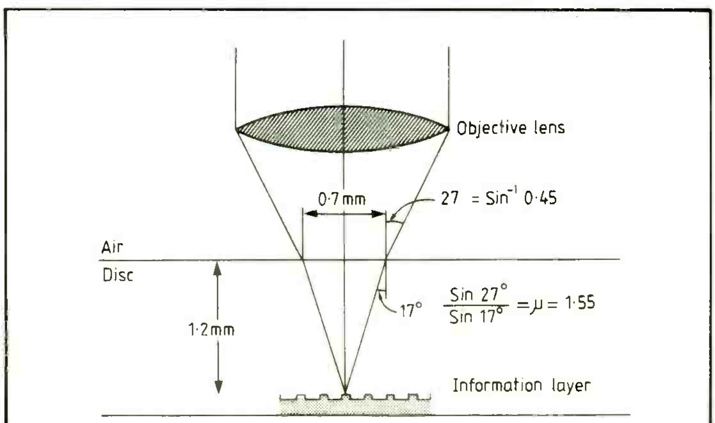


Fig. 1. **Objective lens of a C D pickup has a numerical aperture (n.a.) of 4.5, so the outermost rays will be inclined at about 27° to the normal, though refraction at the air/disc interface changes this to 17°. Light focused to a spot on the information layer enters the disc through a circle only 0.7mm dia. giving good resistance to surface contamination.**

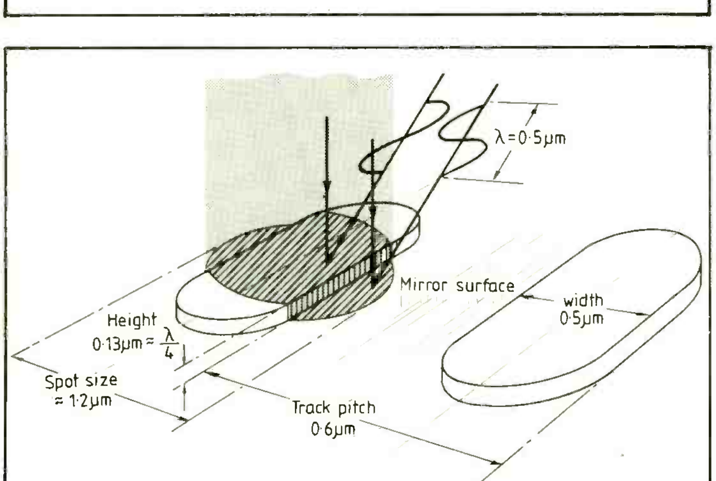


Fig. 2. **Step height is designed to produce a phase reversal in reflected light compared to light which has reflected from the mirror surface so that destructive interference reduces reflected power. Spot size here is symbolic only, the spot being a diffraction pattern.**

A fundamental goal of the compact disc is that it should not require any special working environment or handling skill. The bandwidth required by digital audio is such that high density storage is mandatory if reasonable playing time is to be obtained, and this implies short wavelengths. The advantage of optical playback is that the readout beam can be focused onto the medium from a distance, whereas magnetic recording requires intimate contact and implies a wear mechanism, a need for periodic cleaning, and susceptibility to contamination in the domestic environment of reading.

The first article (January issue) introduced the idea through the thickness of the disc. This approach causes the readout beam to enter and leave the disc through the largest possible area of the surface, see Fig. 1, which shows dimensions involved. Despite the minute spot size — around 1.2μm dia. — light enters through a 0.7mm dia. circle. Thus surface debris has to be three orders of magnitude larger than the readout spot before the beam is obscured. The size of the entry circle is a function of the refractive index of the disc material, the numerical aperture of the optical system and the thickness of the disc.

Because of readout through the thickness of the disc, surface scratches on the readout side are tolerated very well. In extreme cases of damage, the scratch can often be successfully removed with metal polish. Conversely, the label side of CD is much more vulnerable, as the lacquer coating is only 30μm thick. For this reason, writing on the label side is not recommended; pressure from a ballpoint pen could cause mechanical damage to the information layer, and solvents from marker pens have been known to penetrate the lacquer and corrupt the disc. A common party piece is to show off the error correction system by writing on the readout side with a felt tip pen. This is relayively harmless as the disc base material is impervious to most solvents.

The base material of CD is a polycarbonate plastics material produced by Bayer under the trade name of Makrolon. With excellent mechanical and optical stability over a wide temperature range, lends itself to precision moulding and metallization. It is commonly used for automotive indicator clusters for the same reasons.

An alternative material is polymethylmethacrylate (p.m.m.a.), one of the first optical plastics, known by the trade names of Perspex and Plexiglas, and which is used extensively in illuminated signs and aircraft canopies. Makrolon is preferred by some manufacturers because it is less hygroscopic than p.m.m.a.

In the readout process the depth of the steps is designed to be $\frac{1}{4}$ wavelength of the light used, Fig. 2, so that light reflected from the mirror surface travels $\lambda/2$ further than light reflected from the step surface, and so results in destructive interference. The principle is optimized for one wavelength, and so light source must be monochromatic.

The wavelength in the medium is determined by the refractive index; the specified light source has a wavelength in air of 780nm and the refractive index of 1.55 causes this to become 500nm within the disc. The step height is about one quarter of this figure at 0.11 to 0.13μm. As the incident light cannot return the way it came because of interference, it will exit at any angle that permits constructive interference as a diffraction pattern along a discradius.

Dimensions of the track structure are closely comparable with those of the Philips Laservision disc, on whose optical technology the compact disc is based. Both are diffraction-limited, i.e. the dimensions involved are as small as permitted by the wave nature of light.

It is not possible to focus light to a point even with a lens free from aberrations. When this is attempted, the result is an Airy disc whose size is a function of the wavelength and the numerical aperture of the objective.

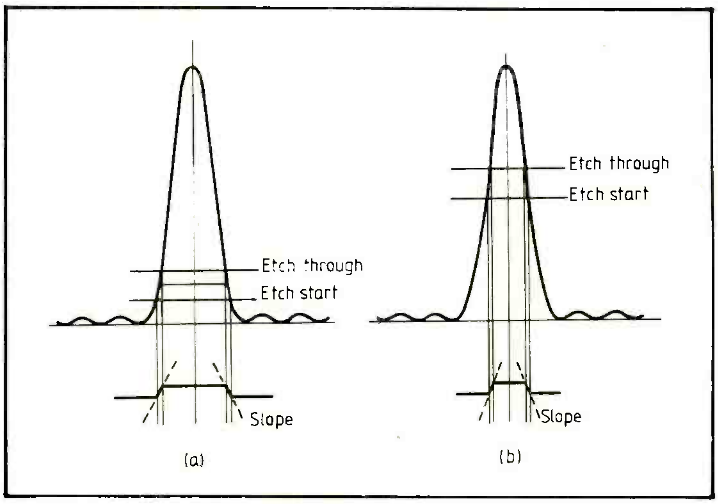


Fig. 3. **Two levels of exposure sensitivity of the resist determine the size and edge slope of the steps on the disc surface. A large exposure results in large step with gentle slope (a) while less exposure results in smaller bump with steeper and sloped sides (b).**

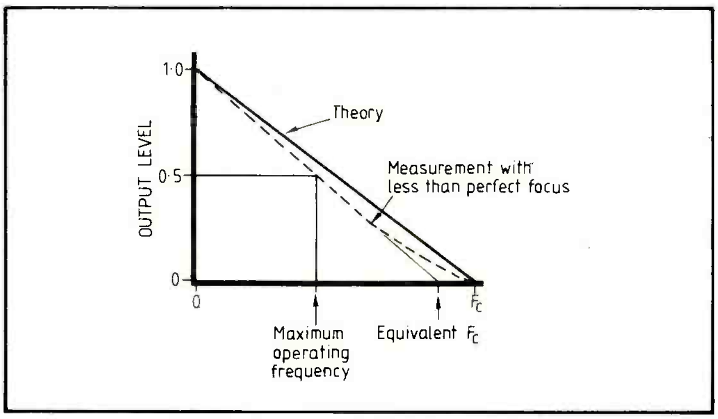


Fig. 4. **Amplitude response of laser pickup. Maximum operating frequency is about half of cut-off frequency F_c.**

When the master is cut, the effective spot size is about 0.4µm, determined by balancing the power of the cutting laser against the sensitivity of the resist. The resist has two sensitivity levels, a level where etching will just begin, and a level where etching will go through to the glass blank, Fig. 3. Increasing the exposure produces pits with gradually sloping edges, which release from the mould easily but are optically inferior to steeper edges. A compromise is reached by control of the exposure[1].

To achieve the very small effective spot size needed for cutting, the resist sensitivity is in the area of the half-power level of the Airy disc intensity function, and a krypton laser with the short wavelength of 350nm is used. This requires an aparture of about 0.7. It is the thickness of the resist that determines the height of the bumps on the finished disc, which should be $\frac{1}{4}$ the wavelength of the player laser in the disc material.

Optimum size for the playback spot is rather larger than that of the cutting spot: for destructive interference to cause complete cancellation in the reflected beam the energy reflected from the top of a step should equal the anti-phase energy reflected from the mirror surface. This simplistic condition is never obtained in practice, and typically the presence of a long bump reduces reflected power to about 25% of that obtained from the mirror surface. A larger spot in the player also eases the task of track following, permits the use of a low-cost visible wavelength laser and a smaller aperture, which in turn improves the depth of focus.

The specified wavelength of 780nm and n.a. of 0.45 produce an Airy function where the half power level is at a diameter of about 1µm. The first dark ring will be at a diameter of about 1.9µm.

Allowable crosstalk between tracks then determines the track pitch. The first ring outside the central disc carries some 7% of the total power, and limits crosstalk performance. Track spacing is chosen such that with a slightly defocused beam, and a slight tracking error, crosstalk due to the central spot seeing adjacent tracks is no worse than the limit. Since objective aberrations will increase spot size and crosstalk, the CD specification requires that the objective performance shall be within the Marechal criterion[2]. Clearly the n.a. and wavelength must also be closely specified.

The cutter spot size determines the reader spot size, which in turn controls the shortest wavelength of modulation along the track that can be read. The optical cut-off frequency, where the output falls to zero, is $2V \times (\text{n.a.})/\lambda$, where V is the linear track velocity. The minimum linear velocity of CD is 1.2m/s so the cut-off frequency becomes

$$f_c = 2 \times 0.45 \times 1.4/780 \times 10^{-9}$$
$$= 1.6\text{MHz}$$

The frequency response of the pickup falls linearly to the cut-off frequency and Fig.4 that actual measurements are only a little worse. It is necessary to limit the maximum operating frequency to about half the cut-off frequency otherwise immunity to noise and crosstalk is impaired. Maximum frequency is 720kHz, which represents an absolute minimum wavelength of 1.666µm, or a step length of 0.833µm when the minimum speed of 1.2m/s is use for a 75 minute disc.

Standard one-hour discs have a minimum step length of 0.972µm at a track velocity of 1.4m/s. The maximum frequency, 720kHz, the bit rate; these are different due to the channel code used and is discussed later.

Fig. 5 shows the structure of a maximum frequency recording and the relationship of the spot intensity function.

The next article deals with the mechanisms necessary for track following and focus.

References

1. Laser beam recording of video master discs. B.A.J. Jacobs *Applied Optics* July 1978.
2. Principles of Optics. Born and Wolf (Pergamon).

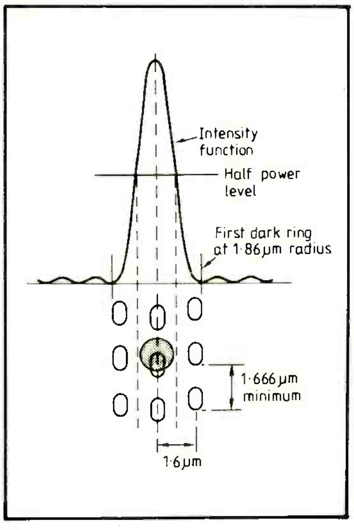


Fig. 5 **Structure of a maximum-frequency recording, related to the intensity function of an objective of 0.45 (n.a.) with 780µm light. Spacing puts adjacent tracks in dark rings, reducing crosstalk. As the spot has an intensity function, it is meaningless to specify spot diameter without some reference, such as an intensity level.**

CAUSALITY

The idea of causality as time delayed control is essential to logical reasoning (February Editorial). Reasoning is a process of the mind so it is true that causality, as "a necessary connexion", exists in the mind.

Conversely if the reasoning corresponds to events in reality then causality can be said to exist there just as much. This is the working hypothesis for scientific theorizing, and causality provides the essence inherent in mechanistic 'explanation', conferring a sense of 'understanding' in appreciation of this knowledge.

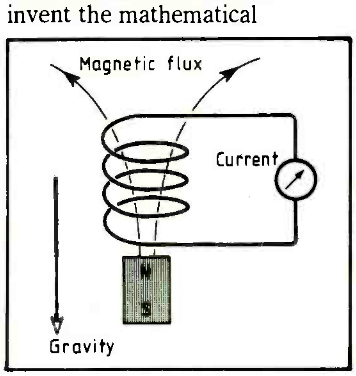
The problem of whether reality is logical is itself beyond reason: logic deals with relations between things that already have the attribute of 'existence'. When we come to ask how does anything at all exist we have progressed beyond the confined circular structure of logic into the realm of metaphysical speculation.

To demonstrate that causality does exist in reality external to any mental framework consider an idea that occurred to me of using Lenz's law of induction for a system of magnetic braking to support an elevator against free fall.

As the coil falls around the magnet (or vice versa) the motion through the lines of flux induces a current which in turn produces a field tending to oppose the motion.

The important aspect of the interaction in this abstract 'control system' is that the response tends to oppose the stimulus. It can never cancel it exactly simply because of the chain of causality. (There is similar behaviour in a virtual earth feedback amplifier, virtual being the 'operative word'.) So causality demonstrably exists in reality.

In formulating his mechanics, Newton found the need to invent the mathematical language of 'the calculus' of fluxions' to describe such time delay interactions. In the limit as the interaction time tends to zero we may use exact derivates and formulate our laws using differential equations which then remain valid only for pseudo instantaneous or asymptotic steady state interactions.



Conversely however, some people may be misled into saying that since the time interval tends to zero it is negligible. Then the "constant conjunction" means that the change of flux and induced e.m.f. are so essentially simultaneous as to be impossible to unravel. This is an ingenious erroneousness.

The incorrectness of this argument can be simply explained using a special case as an example so that the truth seems obvious. Consider the 'thought experiment of increasing the size of the coil so its separation from the magnet at its centre is enormous (such as the radial distance to the nearest star, about 4 light years). As an initial condition we may suppose the magnetic field has existed throughout all space for all time upto the (god-like) 'present'. When the coil moves relative to the magnet it cuts lines of flux instaneously in its environment and an e.m.f. is induced. However the information that the coil has moved and produced an e.m.f. and opposing magnetic field propagating out at the speed of light will take a definitely significant time (compared to a human lifetime) to read the magnet and reciprocally for this to react and oppose the relative motion. (With such action at a distance explicitly formulated it also becomes obvious that at each instant (God's point of view) forces cannot possibly be 'equal and opposite' and so we need a system of mechanics even more fundamental than Newton's).

When we can vary the degree of Humes "constant conjunction" then even the most stubborn of anti scientific psychodelic mind-destroyers ought to agree (out of common courtesy) that "there must truly be some causal connection in reality, that is, external to any mind: though as to the mechanism, that needs further elucidation."

For the example suggested in the editorial of current in a wire connected to an e.m.f., the interaction is too fast for human reaction or contemplation. The initial transient interaction could be time expanded and analysed in detail as it settles down to an assymptote which corresponds to the classical circuit laws.

P.J. Ratcliffe
Stevenage
Herts

CURRENT DUMPING

Mr McLoughlin's replies to the letters regarding his article on current dumping (Letters, 1984 February pp. 46, 49, 50) need a response, since we feel some of our statements have been misinterpreted.

We think that the "incautious comparisons with other arrangements", which "had to be withdrawn on grounds of instability" are important, for the success of an electronic technique such as current dumping often depends on the practicalities of typical circuits.

Should one think of current dumping as dominated by feedback or by feedforward error correction? We think most of us would agree that without feedback the majority of amplifiers would be impractical. However, current dumping establishes a new concept in amplifier design that is clearly different from normal feedback, and is clearly traceable to Black's original feedforward concepts. We have never stated that "feedforward alone is the only correct explanation of current dumping". On the contrary, we have always insisted that current dumping is a blend of both error feedforward and feedback (see our second paragraph), and we feel it is most improper to represent our views in such a biased manner.

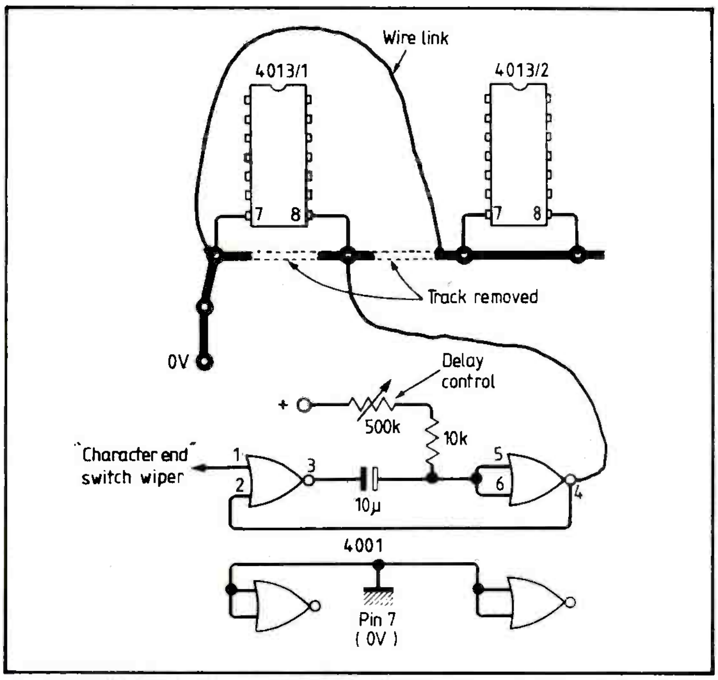
It is very clear from our AES article that the inductor characteristics refer to those inductors which we constructed for our model circuit. Thus "this damaging criticism of the Quad 405" is wholly inaccurate. There is nothing wrong with the inductor in the Quad 405. Mr McLoughlin's theoretical analyses of current dumping have descended to unjustified, unsubstantiated criticisms of the Quad 405 specific design. If he doesn't like the 405, he is at liberty to say so, but he should not say that "it is quite incapable of using the current dumping technique" without some experimental substantiation. Our model circuit does this, and we are convinced that the design does incorporate a feedforward novelty. There is a clearly discernible distortion null in the 405 (albeit not perfect) as the bridge components are varied, and the unmodified amplifier is fairly close to optimum. We are sceptical that a circuit of comparable performance and simplicity (with the dumpers biased off) can be produced without the feedforward technique. Mr McLoughlin states that the 405 operates by relying on the modification of the feedback at h.f. provided by the inductor L. He argues that "It is left to the usual negative feedback from E (his Fig. 12) to reduce" the dumper distortion. We would claim that there is no usual feedback from E, and that the feedback from *before* L is meant precisely to correct the signal *after* L. This is error cancellation and is not associated with normal feedback, although it is used with feedback. The 405 may not embody the technique perfectly, as many of the details show, but the primary claim that it uses an error cancelling technique is in no way compromised. One could insist on sticking to a feedback-only explanation, but once one sees how the concept is clearly traceable to feedforward error correction, then it seems to us only logical that subsequent descriptions are based on the two intertwined techniques.

J. Vanderkooy
S.P. Lipshitz
University of Waterloo
Ontario
Canada

MORSEMAKER

After completing a Morsemaker (June, 1985), it was found that some of the 4013 devices did not change state in a reliable manner, and the following modifications were required before the unit would function properly.

An additional 10n capacitor was connected in parallel with



that already existing between pin 3 and earth of i.c. 4013/2(a), directly to pins 3 and 7 on the underside of the printed-circuit board. Without this capacitor, "nonsense" characters consisting of dots only, appeared.

A 10n capacitor was connected between pins 11 and 7 of i.c. 4013/3(b) on the underside of the p.c.b. Without this capacitor, a few dots were generated, followed by a continous tone. Both capacitors are of the miniature, low-voltage ceramic type.

With the two capacitors in place, figures were generated correctly, but letters involving more than one changeover, e.g. CXPQY etc., were not produced, and also the "blocked" dit-dit-dah-dah frequently occurred. This was cured by removing the 10n capacitor from pin 3 of the dot-dash latch 4013/1(a). Randomising was also improved on this particular model by shorting-out the diode connected to pins 3,4,5, of i.c. 4025/5(b) which considerably reduced the number of consecutive 'repeats' in a string of characters.

Switching disturbances on the positive supply line had been previously observed on an oscilloscope, and found to be due to the effect of the series resistance of the safety diode on the supply voltage regulation. Whilst there was no apparent effect on the performance of this unit, it was considered desirable to augment the 2μ and 10n capacitors already incorporated across the supply lines with several 47μ 10V electrolytic capacitors to provide additional smoothing and de-coupling at various places on the p.c.b., particularly as the device is powered by a battery, which could develop internal resistance in the course of time, adding to that exhibited by the diode.

Finally, a useful addition to the Morsemaker is an adjustable delay between characters which enables the character generation speed to be increased so that rhythm is apparent, yet allows a slow reader respite between characters.

This was achieved by interposing a 'one-shot' between the wiper of the "character-end" switch and the SET pin 8 (previously isolated as described below), of control-latch i.c. 4013/1(b). The pulse from the switch activates the 'one-shot', causing the output to go high, this in turn holds the control-latch in the "character-end" mode for the duration of the 'one-shot' pulse. The 'one-shot' was formed by connecting two elements of a 4001 quad 2 input Norgate as shown in the sketch, the remaining i.c. inputs being connected to pin 7 (0V). Small portions of the printed-circuit track on either side of pin 8 of i.c. 4013/1 were carefully removed (leaving pin 8 isolated), pin 7 of i.c. 4013/2 being re-connected to pin 7 of i.c. 4013/1 via a wire link. Pin 8 of i.c. 4013/1(b) was then connected to pin 4 of the 'one-shot'. The extra i.c. and associated components were mounted on a small p.c.b., located near the main board from which is obtained the necessary power supply. The delay-control spindle was brought to the outside of the instrument case, for convenience.

R.J. Canaway
Maidenhead
Berks.

IT EDUCATION

In November, 1983, the commission of the European Community issued the following facts as part of its official journal no. C321, volume 26. "Some 6% of the Community's gross domestic product (GDP) is produced by Information Technology (IT) industries. A further 29% of GDP is produced by industries which apply IT in a major way. Another 20% of GDP is derived from other industrial sectors with a high information content". In other words, over half of the GDP of Europe is derived from, or is heavily dependent on, IT. By 1990, IT will be the world's largest manufacturing sector.

The new information technologies will be the key to industrial advance in our lifetime and national (i.e. UK) participation in these advances demands national development of the skills required to provide the labour and intellectual infrastructure to such advances. Trite it may be, but no less true, that we are undergoing a revolution in industrial methodology. Moreover, in parallel, the very fabric of our lives is being irreversibly influenced by IT; our shopping, recreation, home life and education are all affected — and will increasingly become more so. These facts and conclusions are not in dispute. It is how we as a nation are addressing this present and future that prompts me to write today.

For I believe that our primary and secondary school education system is not reflecting the importance of IT. IT is *not* about a computer in every school. IT *is* about many things, but, primarily: information processing and manipulation, communications, machine intelligence, man-machine interface, data base networks, citizen's privacy, word recognition and machine speech, software, microelectronics, advanced information processing, expert systems — one could go on and on.

Can it then be right that we as a nation spend more money and skilled resource on teaching French and German in schools than we do on IT? How much is that effort going to contribute to our GDP in five years time? How can we justify departments of Business Studies in schools but no departments of IT? Has anyone considered whether we should be giving over half of the school curriculum to IT education? Do we really believe that our present curriculum is enabling our children to deal rationally with the world as it is and as it will be? Do we really believe that a child's job prospects could be anything but improved by a far higher understanding of the technologies of the future?

Let us acknowledge that we, in Europe, are engaged in a battle with the Americans and the Japanese for mastery of the high addded-value industries of the future. Some we have lost irrecoverably e.g. mainframe computers. But, on the whole, much of the rest is up for grabs. And if this is true of Europe, how much more is it of the UK, with its tremendous dependency on exports?

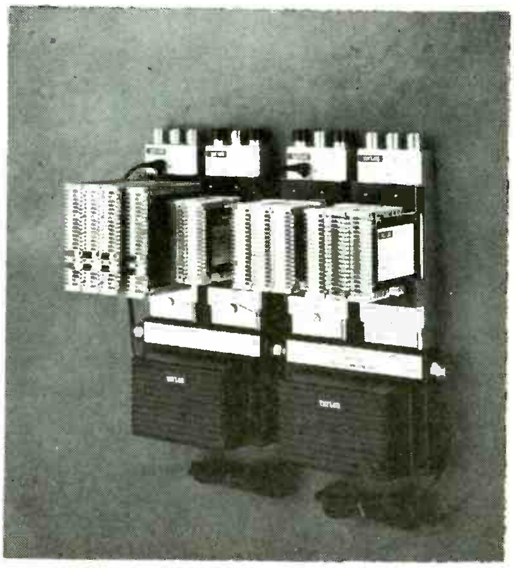
It is conceivable that some may regard the repositioning of IT in the curriculum as a deliberalising move; that the school may become less arts oriented. The latter is inevitable but the former need not be so, with sensitivity and care. One would not recommend the abolition of arts subjects, but rather their de-emphasising.

From my view in one of our advanced technology companies, some of the future can be seen — many others in the IT industries see likewise. Surely it is time for a dialogue to start between the educationalists and the IT industrialists? Our children's part in the future could be at stake.

Ian Bilsland
Graphic Information Systems
Limited

or

CABLE T.V. HEAD END AND REPEATER AMPLIFIERS



CHANNEL CONVERTERS

TCUU	UHF-UHF Single channel converter. Gain adjustable +2dB–16dB. Maximum output +26dBmV. Crystal controlled oscillator. Power requirement 14V 25mA. (Quote Channels required).
TCUV	As TCUU except UHF to VHF converter. (Quote Channels required).
TCVU	As TCUU except VHF to UHF converter. (Quote Channels required).

SINGLE CHANNEL AUTOMATIC GAIN CONTROL AMPLIFIERS

TAG4863	Gain 48dB, maximum output 63dBmV. Regulator + or − 8dB. Power requirement 14V 210mA.
TAG4063	Gain 40dB, maximum output 64dBmV. Regulator + or − 16dB. Power requirement 14V 210mA.

SINGLE CHANNEL AMPLIFIERS

TSS4663	Gain 28-46dB adjustable. Maximum output 63dBmV. Power requirement 14V 170mA.
TSS3062	Gain 12-30dB adjustable. Maximum output 62dBmV. Power requirement 14V 26mA.

DRIVER AMPLIFIERS

TS1030FM	FM driver amplifier. 10dB Gain. Maximum output 30dBmV. Power requirement 14V 10mA.
TS1030B3	Band III driver amplfier. 10dB gain. Maximum output 30dBmV. Power requirement 14V 10mA.
TS1030UHF	UHF driver amplifier. 10dB gain. Maximum output 30dBmV. Power requirement 14V 10mA.
TS1040S	Single channel UHF driver amplifier. 10dB gain. Maximum output 40dBmV. Power requirement 14V 10mA. (Quote channel required).

DISTRIBUTION AMPLIFIERS

TE2042	Domestic distribution amplifier. 1 input, 1 output. Gain 20dB. Maximum output 42dBmV.
TE1638	Domestic distribution amplifier. 1 input, 2 outputs. Gain 16dB. Maximum output: 2 at 38dBmV.
TS2046	40-860MHz. Gain 20dB UHF, 18dB VHF. Maximum output 46dBmV.
TS2846	40-860MHz. Gain 28dB UHF, 22dB VHF. Maximum output 46dBmV.
TS2845	Separate UHF/UHF inputs. Gain 28dB UHF, 22dB VHF. Maximum output 46dBmV.
TS2054	40-860MHz. Gain 20dB UHF, 18dB VHF. Maximum output 54dBmV.
TS2060	40-860MHz. Gain 20dB UHF, 18dB VHF. Maximum output 60dBmV.
TS5565	Gain 55dB UHF, 55dB VHF, 42dB FM. Maximum output 65dBmV.

REPEATER AMPLIFIERS

TSC3660	Repeater. Gain 16-36dB UHF, 10-30dB VHF. Maximum output 60dBmV.
TSC3665	Repeater. Gain 16-36dB UHF, 10-30dB VHF. Maximum output 65dBmV.
TSC3060	Repeater. Gain 10-30dB VHF. Maximum output 60dBmV.

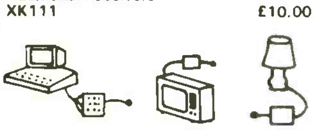
QUALITY AT LOW COST
TAYLOR BROS (OLDHAM) LTD
LEE STREET, OLDHAM - TEL. 061-652 3221 - TELEX 669911

CIRCLE 120 FOR FURTHER DETAILS.

HOME CONTROL CENTRE

This kit enables you to control up to 16 different appliances by means of coded pulses in the mains wiring which may be decoded by special receivers anywhere in the house. The transmitter may be controlled manually or by the computer interface enabling your favourite micro to make your coffee in the morning, switch lights anywhere in the house, or your electric blanket in your bedroom. Just think of the possibilities — and no wiring! This kit comprises a transmitter with pre-drilled box and two receivers.

XK112 £42.00
Additional Receivers
XK111 £10.00



ELECTRONIC LOCK KIT

With hundreds of uses indoors, garages, car anti-theft devices, electronic equipment, etc. Only the correct easily changed four-digit code will open it! Requires a 5-15V DC supply. Output 750mA. Fits into standard electrical wall box.

Complete kit (except front panel)
XK101 £11.50
Electric Lock Mechanism for use with existing door locks and the above kit. (Requires relay.) 12V AC/DC coil.
(701 150) £14.95

BT STYLE PHONE CONNECTORS

Line Jack Units — Master Unit (first line unit) has bell capacitor and surge arrester.

Flush or surface mounting. Screw connectors.

Master (flush)	(960 110)	£3.00
Master (surface)	(960 112)	£3.00
Master (mini surface)	(960 113)	£3.50
Secondary (flush)	(960 114)	£2.65
Secondary (surface)	(960 116)	£2.65
Secondary (mini surf)	(960 117)	£3.00
Dual outlet adaptor	(960 118)	£4.20
4-way line cord — with plug to spade terminals	(960 120)	£2.00
4-way line cord	(960 130)	£0.20 per m

MICROPROCESSOR TIMER KIT

Designed to control 4 outputs independently switching on and off at preset times over a 7-day cycle. LED display of time and day, easily programmed via 20-way keyboard. Ideal for central heating control (including different switching times for weekends). Battery back-up circuit. Includes box.
18 time settings

CT6000K £39.00

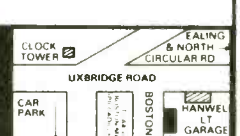
XK114. Relay Kit for CT6000 includes PCB, connectors and one relay. Will accept up to 4 relays. 3A/240V c/o contacts £3.90

701 115 Additional Relays £1.65

TOP QUALITY . . . TOP SERVICE
BOTTOM PRICES!

For FREE CATALOGUE send 9 × 6 SAE — contains full list of stock range all at very competitive prices. Cash with order (except account customers). Access or Barclaycard telephone orders welcome. Add 75p p&p + 15% VAT to all UK orders. Overseas customers add £2.75 p&p Europe, £6.50 elsewhere. Giro No 529314002. Goods by return subject to availability. Shop open 9am – 5pm (Mon-Fri), 10am – 4pm Sat). ALL PRICES EXCLUDE VAT.

TK ELECTRONICS
11-13 Boston Road
London W7 3SJ
ORDERS 01-567 8910
ENQUIRIES 01-579 9794
01-579 2842 TECHNICAL AFTER 3pm



CIRCLE 24 FOR FURTHER DETAILS.

CIRCUIT ANALYSIS
on CBM/PET or COMMODORE 64

An all machine code program for the rapid analysis of linear electronic circuits.
This package evaluates voltage gain, current gain, input impedance and output impedance in magnitude phase angle form.

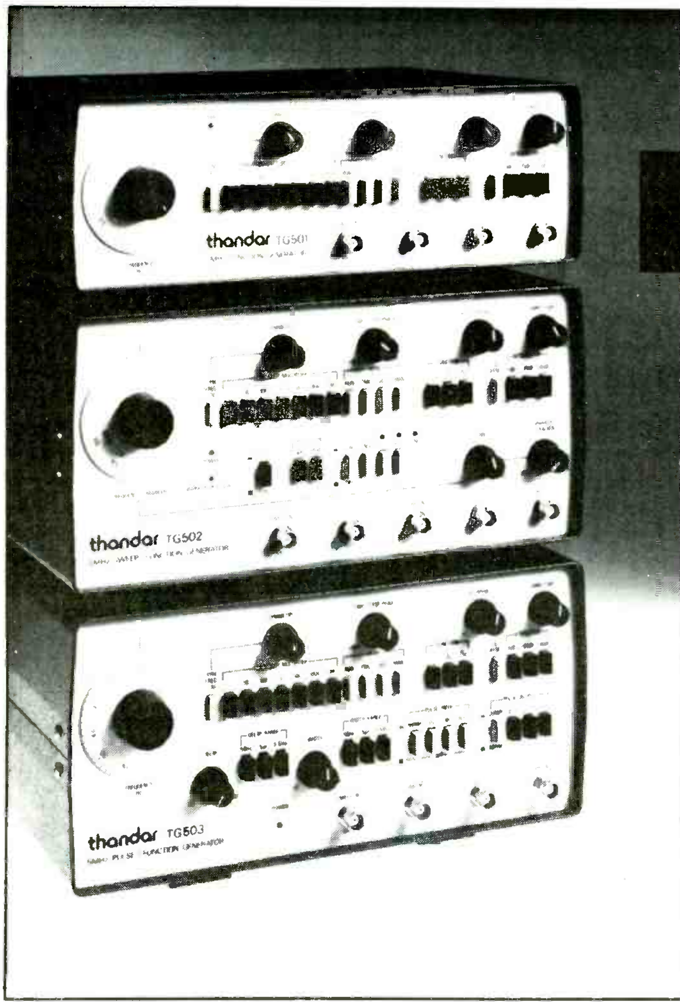
Program features:
Capacity 30 nodes, 100 passive components, 20 active sources.
Uses 32k RAM
Handles transistors, F.E.T., Op-amp., transformer and transmission line. Cct model may be simple or complex.
Simple, rapid, component value or parameter changes.
Hardcopy of all results, including graphs.
Graph axes may be LIN/LOG/db as appropriate with automatic scaling.
Maximum or minimum value of all circuit functions.
Unity gain bandwidth and slope of voltage gain characteristic at this frequency.
Bandwidth at 'x'db down on the response at any freq.
Hardcopy of component list and performance summary.
Filing of circuit details and last used parameter values for the rapid loading of the circuit.
Comprehensive instructions with many examples.
State model and disc drive number. Cassette to order.

Written by a design engineer for other engineers.
Many satisfied users. In use for two years.

S.J. BRANSON
111 Park Road
Peterborough PE1 2TR
Tel: (0733) 67604

PRICE £140 INCLUSIVE NO V.A.T.

CIRCLE 76 FOR FURTHER DETAILS.



NEW GENERATORS

NEW TG501 FUNCTION GENERATOR
.005Hz to 5MHz; sine, square, triangle, ramp, pulse and haverwave waveforms; free-run, triggered or gated modes; variable start/stop phase. 19:1 symmetry range; variable DC offset; variable 50Ω output; TTL output; external sweep mode.

NEW TG502 SWEEP/FUNCTION GENERATOR
Main generator features as TG501 plus internal sweep generator; 1000:1 linear or 10,000:1 log sweep range; precise dial-and-enter setting of sweep limits; marker with variable duration and out-of-range indicator; variable sweep rate; single sweep mode; sweep reset and hold; sweep and pen-lift outputs.

NEW TG503 PULSE/FUNCTION GENERATOR
Main generator features as TG501 plus normal, double and delayed pulse modes; pulse width variable from 50ns to 50ms; delay variable from 100ns to 50ms; 10MHz capability in double pulse mode; complement mode; symmetrical, positive-going or negative-going outputs with adjustable baseline.

For further information contact:

Thandar Electronics Ltd,
London Road, St. Ives, Huntingdon, Cambridgeshire PE17 4HJ
Telephone: (0480) 64646 Telex: 32250.

thandar
ELECTRONICS LIMITED

CIRCLE 6 FOR FURTHER DETAILS.

Happy Memories

Part type	1 off	25-99	100 up
4116 200ns	1.25	1.15	1.10
4164 150ns Not Texas	3.35	3.10	2.90
2114 200ns Low Power	1.75	1.60	1.55
2016 150ns	3.65	3.35	3.10
6116 200ns Low power	7.75	Call	Call
6264 150ns Low power	19.95	Call	Call
2716 450ns 5 volt	3.85	3.45	3.30
2732 450ns Intel type	4.75	4.25	4.10
2732A 350ns	5.25	4.69	4.50
2532 450ns Texas type	3.85	3.45	3.30
2764 300ns Suit BBC	5.95	5.50	5.25
27128 300ns Suit BBC	14.20	13.65	12.60

Low profile IC sockets:									
	Pins	8	14	16	18	20	24	28	40
	Pence	12	13	14	16	18	24	27	38

Available now — The ROAM BOARD for the BBC Micro. Reads Roms via a Low Insertion Force Socket and saves their contents as files, then reloads a file into its sideways Ram as required. Full details on request.

74LS series TTL, large stocks at low prices with DIY discounts starting at a mix of just 25 pieces. Write or phone for list

Please add 50p post & packing to orders under £15 and VAT to total.
Access welcome, 24hr 'phone service on (054 422) 618
Non-Military Government & Educational orders welcome., £15 minimum.

HAPPY MEMORIES (WW)
Gladestry, Kington
Herefordshire HR5 3NY
Tel: (054 422) 618 or 628

CIRCLE 59 FOR FURTHER DETAILS.

E.M.S. POWER SYSTEMS

Solve all your Power Problems by contacting E.M.S.

E.M.S. specialise in systems to eliminate your power problems.

Products range from 35VA switched square wave Power Packs to 1KVA fully uninterruptible sine wave systems.

E.M.S. also manufacture chargers which range up to 60 amps.

For further details please contact:

E.M.S. Manufacturing Limited
Chairborough Road
High Wycombe
Bucks
Tel: (0494) 448484

CIRCLE 48 FOR FURTHER DETAILS.

CIRCLE 40 FOR FURTHER DETAILS.

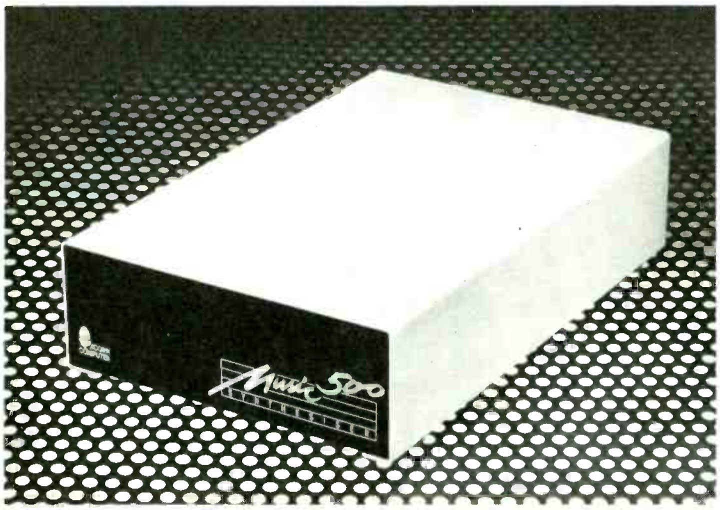
Music on the BBC Micro

Music 500

A virtually unlimited variety of waveforms and envelopes are available for playing on eight voices arranged over seven stereo positions in the Music 500, a synthesizer add-on for the BBC Microcomputer. The hardware comes in a metal-cased box, roughly the same shape and size as a floppy disc drive. It contains its own power supply. It connects to the computer through a ribbon cable which plugs into the 1MHz-bus port and has itself a parallel socket for that bus. The audio output is from a 5-pin DIN socket and a stereo amplifier must be connected to make the output audible.

Supplied with the Music 500 is a cassette which includes AMPLE, a music programming language, some examples of preset waveforms and envelopes and a selection of music produced by the system. There is also a utility to enable the programs to be transferred to disc. Ample works rather like Forth. It enables commands to be defined in terms of existing words and these new words are used in turn within the definitions of other words. Eventually the whole program executes on the command of a single word — 'play'.

There are 16 channels of sound, normally used in pairs to allow a maximum of eight voices. More channels can be assigned to a particular voice at the expense of having fewer voices. Each channel in a pair can have its own waveform and the frequencies may be varied so that one channel will modulate the other. Programming words are available for frequency modulation, ring modulation and synchronized waveforms. Harmonics up to the 16th can be assigned to a channel, each with its own amplitude. The wave is then converted to its geometrical form for storage; the geometrical form can also be defined directly, without harmonic analysis. A noise channel, to produce percussion sounds, is not directly available but can be simulated by introducing a random element into the waveform generation.



Envelopes for the notes can be defined in several ways from a simple attack-decay-sustain-release sequence to complex geometrical and pitch-bending envelopes. Waveforms and envelopes are assigned independantly to sound channels and may be used in any combination.

Musically, notes are entered using their letter names, familiar to musicians. The sequence 'CDEFGABC' would play a C major scale. Sharps and flats are entered with a plus or minus sign before the note and key signatures may be defined at the beginning of a piece, after which only accidentals need to be entered. One convention that takes some getting used to is that upper-case letters are used for the next note above the current one but lower-case is used to descend. 'AG' would play A followed by the G above but Ag would be used to play A followed by the G below it. Hence, if we were to enter 'cdefgabc' instead of getting a scale, each note would be followed by the one a seventh below and that sequence would descend about seven octaves! The synthesizer has a pre-set pitch which may be altered to tune it to a different pitch. Numbers are assigned to relative note lengths and the speed of the music is governed by a 'tempo' instruction.

The language is very comprehensive and it is possible to reproduce almost any sound that can be imagined; but it is also quite difficult to learn and use. This is partly due to the lack of any graphics facilities. Music can only be entered as a computer program through the computer keyboard. Not, for example, as notes on a stave. There are limited facilities to actually hear the waveforms, envelopes or tunes being produced without writing a program and then running it. There is no list of specific waveforms or envelopes so that one could make the output sound like a trombone, a flute or an organ. The pre-programmed examples on the cassette have very computer-sounding noises, not too dissimilar to those available on the BBC's own internal sound generator, even when more than three voices and stereo positioning are used. So the synthesizer is not fully demonstrated except by one's own trial and error methods.

The sound output is of high quality and is best transmitted through a good hi-fi system but it could have been easy to install a low-power audio amplifier to give, for example, headphone output. My computer is in a different room from my stereo equipment and initially I recorded the output on a portable stereo cassette player before being able to hear it. The negative aspects of this review might be of a temporary nature; there has been mention of a keyboard add-on for the Music 500. The present programming language and rather poorly-printed handbook make no reference to this so both must be updated when the keyboard is issued. The keyboard will also allow the synthesizer to be played 'live'. Music 500 was developed for Acorn by Hybrid Technology Ltd., Acorn Computers Ltd., Fulbourn Road, Cherry Hinton, Cambridge CB1 4JN.
EWW100

A system for music

By way of contrast, The Music System (TMS) includes no hardware and relies on the BBC's internal sound generator and computer keyboard. For £25 it offers two discs (also available on cassette) and a handbook. The programs are all inter-linked through a menu page and it is possible to use the Editor for entering music, the Synthesizer module for creating new sounds, the Keyboard programme for playing 'live' music. There is also a printer driver program to enable the printing of music scores and a 'linker' which allows seperately programmed music to be strung together into longer compositions. Each section of the software is menu driven and uses an icon system similar to that of, say the Apple Macintosh, so that there is hardly any need to type at the keyboard at all. Typically a cursor is used to point at an icon, or pictorial representation of the parameter to be altered. Then two keys are used to increase or decrease the value of that parameter.

The Music Editor section of the software works rather like a word-processor for music. Entering music is by positioning one cursor at the note value and then moving a second cursor to the note position on the stave. Key and time signatures are entered at the beginning of a piece and subsequent notes are automatically given the correct sharps and flats. As in Music 500 there is automatic bar checking to ensure that the note values given to each bar agree with the time signature. The music editor works on one voice at a time but may be switched instantly to either of the other voices. Music may be entered one voice at a time or in parallel, working on all voices together by rapidly switching between them. The program will position the cursor at the correct place when switching between voices. One facility which illustrates the thoroughness of the program is the provision for 'first time' and 'second time' bars in a repeated section. Notes may be sounded as they are entered and sections of a piece played at any time during their development.

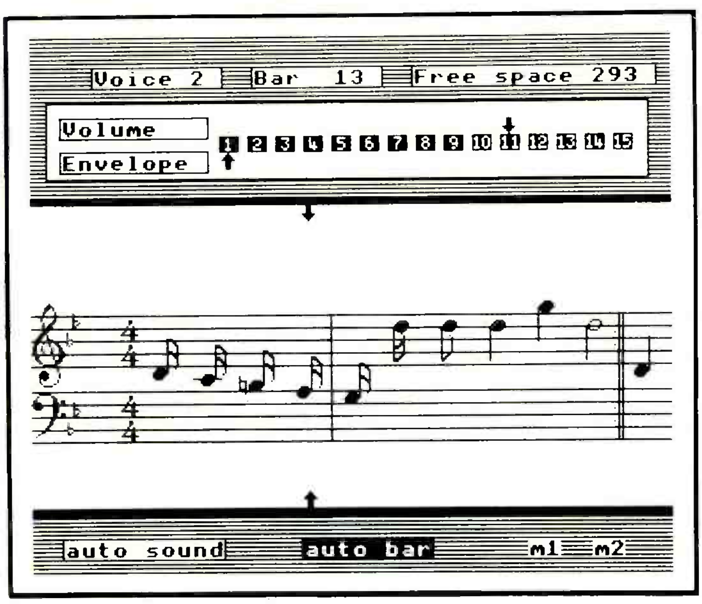
The Synthesizer module is an envelope generator and again is programmed graphically with a representation of the envelope shape on the screen. Pitch and amplitude parameters can be easily changed at will and elements from one envelope can be transferred to another. Up to 30 envelopes can be stored either in a form to be replayed through the rest of TMS or to be incorporated into a Basic program.

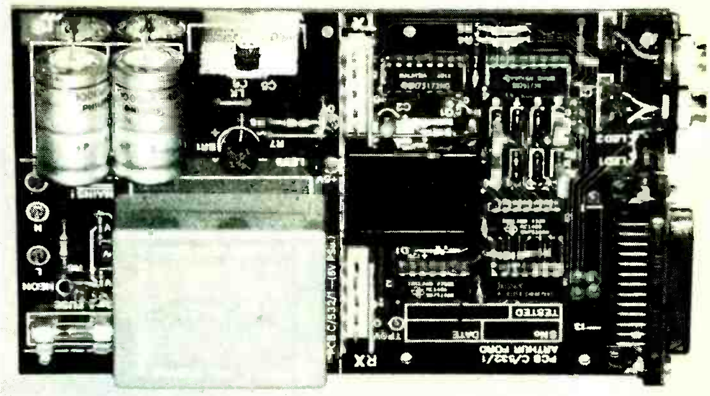
The Keyboard module allows the computer to be used as a 'real time' instrument using the QWERTY keys to play the notes with envelopes previously defined in the Synthesizer module. It is even possible to 'record' one's efforts with a set of keys which will emulate a tape recorder so that it is possible to 'rewind' the memory and play-back or re-record a section. A metronome icon ticks away in the corner of the screen to preserve the tempo. A piece so recorded can be stored on tape or disc as a file. Finally the printout module will enable music programmed into the music editor to be printed out on a Epson or Star Delta dot-matrix printer. It is possible to print one voice at a time or all voices together and there is provision for a very high resolution print-out giving superb printed music or medium resolution which prints much faster. Treble and bass clefs, key and time signatures, accidentals and bar lines appear as they would on conventionally printed music.

All this is documented in the instruction manual which is very well laid out with all functions clearly illustrated.

TMS also has its drawbacks; it only covers a range of four octaves and is restricted to the envelope commands available to the internal sound generator on the BBC computer. The cassette version has fewer facilities than the disc, especially in that it cannot use the fourth (percussion) channel. However the system is under constant revision and there is mention of the extension of the system with a music keyboard and a Midi synthesizer.

So we have two very contrasted systems; the Music 500 has superb but expensive hardware but the programming language without any graphics is quite difficult to use compounded by the poorly produced but, we hope, temporary manual. The Music System, at about £25, is at the opposite end of the scale with excellent software, and a manual that is very easy to use but the system is restricted by the hardware available on the computer. Both systems are planned to be extended with live-performance keyboards and TMS may get an external synthesizer add-on. The Music System is based on programs orginally developes by System Software but has been extended and enhanced in cooperation with Island Logic. System, 12 Collegiate Crescent, Sheffield S10 2BA. EWW101





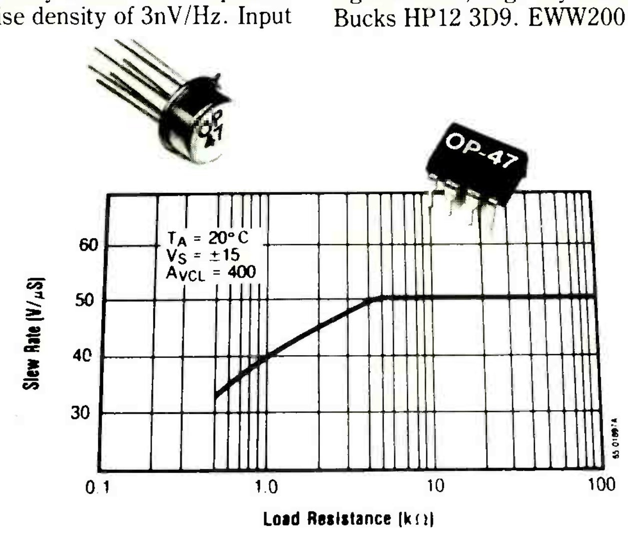
INTERFACE FOR FIBRES

One p.c.b. offers both transmission and reception of serial data along an optical fibre. Although primarily intended for R9232C links, the interface can also be used with t.t.l. levels and R9422/3. Full duplex facilities are available but the board may be used in simplex mode if a separate control signal is needed, such as the 'busy' signal from a printer. Fibres are connected to the board by S.M.A. connectors.

Fibres of the 200 micron glass graded index type give a transmission distance of at least 1km. The company can also provide the optical cables terminated at the required lengths or a termination kit for installation in the field, if required. Applications include installation in areas of high electrical interference, where optical cable can replace RS232C cables. Transmissions are unaffected by r.f.i. and are free from lightning damage and are therefore very suitable for installation in hazardous areas. Arthur Ford Ltd., Park Lane Works, Old Basford, Nottingham NG6 0EU. EWW204

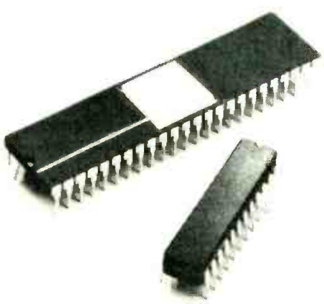
HIGH-SPEED OP-AMP

With the precision necessary for high fidelity audio equipment as well as signal conditioning in instrumentation the Raytheon OP-47 is a low-noise device, available in a TO-99 metal can or an 8-pin plastic dil package and in military or commercial temperature ranges. Power-supply rejection and common-mode rejection are typically 120dB with a spectral noise density of 3nV/Hz. Input bias and offset currents are as low as 10nA and offset voltage is guaranteed to be less than 60µV. The gain bandwidth product is 63MHz and the device is fully output short circuit protected. Typical applications include low impedance microphone amplifiers, professional quality audio amplifiers, spectrum analysers and precision instrumentation amplifiers. Raytheon Semiconductors, Ogilvie Road, High Wycombe, Bucks HP12 3D9. EWW200



ETHERNET NODE ON A CHIPSET

All the logic, protocol and control functions needed to implement the interfacing of a processor to a Ethernet network are incorporated in three chips from AMD. The devices are: 8990 network controller, 7991A serial interface adaptor and 7995 Ethernet transceiver. At the data link level the set supports buffer management, data encapsulation, framing and package control, c.r.c. generation and checking, and serial/deserialization. At the physical level, there is 10Mbit/s data rate. carrier-sense multiple access with collision detection and tranceiver interface compatibility. Dage (GB) Ltd, Eurosem Division, Rabans Lane, Aylesbury, Bucks HP12 3RG. EWW106



16 AMP P.C.B. RELAY

Using Silver Cadmium Oxide contacts for long life, the Zettler A2735 relay is 28mm high and will switch 16A at 250V a.c. Normally supplied with one changeover contact, the relay can handle up to 415V 3500VA. 100 000 operations are claimed at 250V/16A a.c. with pick-up and drop-out times of 7ms and 2ms respectively. High isolation between coils and contact is provided. Direct coil voltages can be selected from a range between 5 and 76V Normally open contacts can be supplied to special order. Sterling Components Ltd, Sterling Road, Slough, Berks. EWW107

MULTI-STANDARD TAPE RECORDER

Based on modular technology, the Stellavox TD9 tape recorder can cope with magnetic formats of 0.25in, 0.5in and 16mm film. All tape transport functions are controlled by a microprocessor with feedback data from opto-electronic tensiometers. The recorder is ergonomically designed to be easy to use and has claimed for it 'the highest sound quality'. It may be quickly adapted to the required format. Amongst its features are: Synchronization, with, or without time-code for film or video, a locator, pre-view facilities, computer control through an interface, line and/ or battery supply, will accept reels up to the 14in. NAB standard, six tape speeds and a variation control, inside or outside oxide winding, a monitor speaker and it may be rack installed. There is a wide variety of accessories. Future Film Developments, 114 Wardour Street, London W1V 3LP. EWW108

FLEXIBLE STORAGE SYSTEM

A multipurpose data storage system is designed for use with the IBM-PC or other compatible computers. The Ram Tape-PC combines a 400Kbyte ram, organised as a 'silicon disc', with 13.5Mbytes of storage on a $\frac{1}{4}$-in tape cartridge. The software configures the first part of the ram as a double-sided disc with direct access from the computer. The remaining ram is available to other disc images. More than 30 double-sided, double-density disc images can be stored on the tape cartridge, which can be loaded from the tape onto the electronic disc to provide access speeds up to 50 times faster than with flexible discs. The electronic disc may also be loaded from any other drive in the system to provide the same rapid access. The Ram Tape-PC has its own power supply, is provided with a host adaptor card and a disc containing the software drivers and utilities to access the various functions. Menu-driven software simplifies the operation for inexperienced users. Euro Electronics Ltd, Lancaster Gate House, 319 Pinner Road, Harrow, Middlesex HA1 4HF. EWW109

PAGED MESSAGES

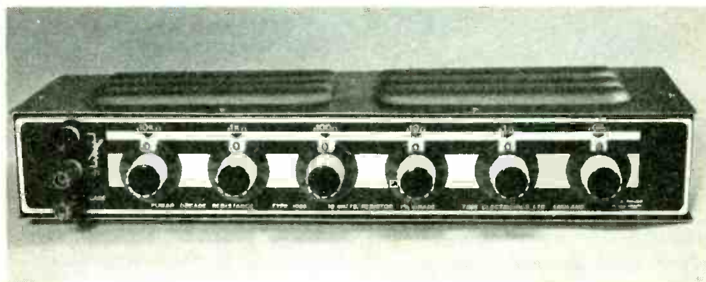
A radiopager with the ability to display and store messages up to 70 characters long has been launched by British Telecom. Message Master can display names and addresses, telephone numbers, share prices or travel information, and up to ten messages with a total of up to 300 characters may be kept in the internal memory for reference. When a message has been received the pager will bleep and flash a light, though it may be muted if the user so requires. Messages are transmitted to the pager directly through Telex or Datel, or by telephone to a central radiopaging bureau, which will forward the message through a computerized system. Various options are available depending on whether the user wishes to use the Message Master in a number of the 40 zones which make up the national system. It costs £75 a quarter and a futher £9 to use the bureau.
British Telecom Radiopaging, 4th Floor, 23 Howland Street, London W1P 6HQ.
EWW208

64K EEPROM

Organized as an 8K byte device the HN58064P is an electrically erasable and programmable rom from Hitachi. It uses a single 5V supply. Latches are provided on-chip for addresses and data. Depending on the status of the chip enable, output enable and write enable lines, six different modes of operation can be selected: chip erase takes about 20ms, individual bytes can be writtin to or read from in 10ms conventional 'Read' mode is available as are a 'deselected' mode and a low powered 'standby'. Different versions of the device offer access times of 250, 300 or 450ns. The device is housed in a conventional 28-pin plastic package. It is specified to operate for over 10000 erase/write cycles.
Hitachi Electronic Components (UK) Ltd., 221 Station Road, Harrow, Middlesex HA1 2XL.
EWW 209

RESISTANCE BOXES

Two boxes offer decades of resistors selected by dial switches which also indicate the value chosen. The 1065 box offers power resistors over the range 0.1 to 120KΩ, while 1066 has precision wire-wound resistors for a range of 1 to 1.2MΩ decade and 0.01% for the others. The power resistors in the other box have an overall accuracy of 1% with the 0.1Ω decade at 5%. These are 10W power rated and the box has a maximum voltage of 500V d.c. whereas the precision box uses 350mW resistors with a maximum total voltage of 150V. Both are designed for laboratory, industrial and academic use.
They are housed in metal cases and are easily transportable. Switch contact resistance has been kept to a minimum by the user of multi-wafer switches each with four parallel, silver-plated, self-wiping contacts.
Time Electronics Ltd., Botany Industrial Estate, Tonbridge, Kent TN9 1RH. EWW203



PLUG-IN CIRCUIT BREAKER

Fitting a standard 13A socket and providing in turn a single 13A socket, the Power Breaker-20 incorporates an residual current circuit breaker (r.c.c.b.) to provide a high degree of protection against damage and electric shock. The device is built in accordance with the relevant British Standards. It has a 'power on' indicator light, a test button and will cut out automatically if plugged in to an incorrectly wired socket, for example if the live and neutral wires are reversed. It works on 220/240V a.c. mains, incorporates a 13A fuse and is slim enough to fit two side-by-side in a double socket. The Power Breaker is available at a number of retail shops and hardware stores and at electrical wholesalers. Suggested retail price is just under £20. B & R Electrical Products Ltd., Temple Fields, Harlow, Essex CM20 2BG.
EWW205

selected for the DESIGN CENTRE LONDON

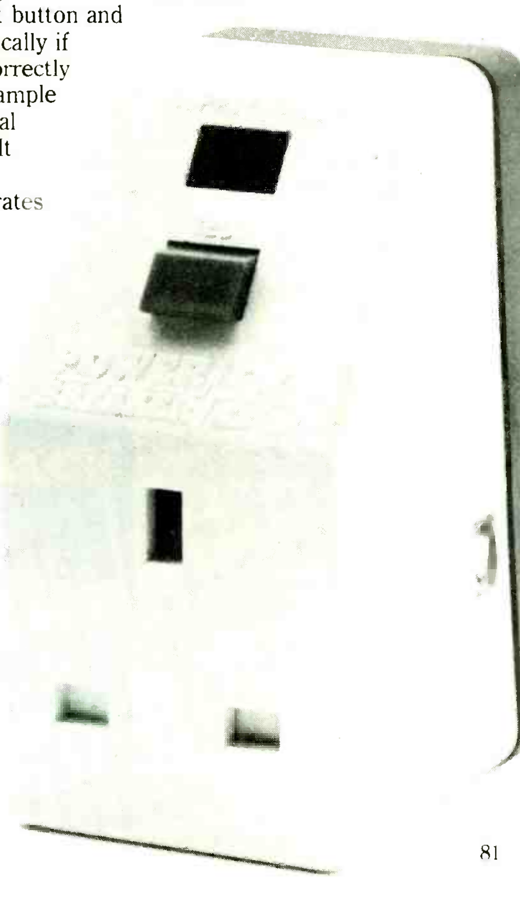


IMAGE FRAME STORE FOR MICRO

A high-resolution video frame store is provided by the Eltime Image III. The single p.c.b. may be used in conjunction with a BBC micro, to capture and display pictures in real time from any 625 or 525-line video source. The highest resolution is 512 by 512 pixels stored in a 64Kbit dynamic ram. Every pixel can be accessed and altered by the assignment of up to 64 grey-scale levels. If a lower resolution is selected, the store can be partitioned to retain multiple pictures, e.g. for 256 by 256 resolution, four pictures can be stored. Pictures from the same or different sources can be compared.

A gated oscillator is used to synchronize incoming frames to the store, this is used in preference to a p.l.l. as the store is only locked to the incoming video for the duration of one field and this enables the device to capture a field from several different sources whose synch timings are not locked to each other and which may have different interlace scans, or none at all.

Software is provided with details of how to configure the system for different resolutions, capture pictures and read or write to individual pixels. An additional board can provide a full frame, the equivalent of two fields. Three boards can be combined in parallel to give an RGB colour store. The board interfaces directly with any of the 6800 series of processors and occupies iK in the host processor's memory map. Additional circuitry is needed for use with other processors.

Applications include robotic vision, medical imaging, factory inspection and security surveillance. Additionally the store can be used to capture pictures which arrive slowly such as weather satellite pictures and ultrasonic scan images. Thus a display can be held steady without the need for a long-persistence c.r.t. As well as the BBC micro, versions are available for use with the Apple and IBM PC. Image III costs just under £2000. It was developed at the BT Research Laboratories and is manufactured under licence from BT by Eltime Ltd., Unit D29, Maldon Industrial Estate, Fullbridge, Maldon, Essex CM9 7LP. EWW EWW202

DIGITAL THERMOMETER

Claimed to be the smallest and cheapest hand-held electronic thermometer on the market, the Vixen is only 103mm long, costs less than £30 and is guaranteed for three years. It operates within a range of -120 to 820° with an accuracy of 0.2% and incoporates automatic cold-junction compensation. The thermometer uses NiCr/NiA1, type K, thermocouples through a standard miniature connector, enabling many standard thermocouples from a variety of sources to be used. The device has a battery life of 6000 hours which is claimed to be the equivalent of over four years normal service life. The display indicates low battery and open-circuit thermocouple. A Fahrenheit version is available. Vixen Hytech Ltd., 17 Amberley Road, Bostal Heath, London 9E2 09G. EWW 201

COMMODORE MODEM

A 300-Baud modem to plug directly into the user port of either a Commodore 64 or Vic 20 home computer has been developed by Intelnet. It uses power drawn from the computer and requires no external supplies or batteries. Model 2074/V21 uses a 10-pole switched capacitor filter i.c. to remove noise from the line and frequencies are very stable as they are derived from crystal oscillators. It operates to CCITT V21 recommended tones for data communication at 300-Baud and may be used for inter-computer communication as well as commercial databases (Distel, Maplin, Estelle, for example) which operate the V21 standard. It is not compatible with the V23 standard of Prestel and Micronet. The modem has a plug to fit a BT telephone socket, though it is not BT approved, and includes a socket for the telephone which is used for dialling. It also has a jack for connection with an amateur radio tranceiver or c.b. set for the radio transmission of data. Switches are provided to select local/on-line, Originate/answer, self test and full/half duplex. Leds indicate when the modem is on-line and whether it is receiving or transmitting. The modem is supplied with cassette software which can be adapted to select the character bit lengths, parity bits etc. as required. £49.50 inclusive from Intelnet Ltd., Unit C2, Faircharm Trading Estate, Creekside, London 9E8 3DX. EWW206

LOW PRICES

DIGITASK BUSINESS SYSTEMS LTD

56, MAPLE DRIVE, EAST GRINSTEAD, WEST SUSSEX, RH19 3UR

SERVICE ADVICE

The PC-16 16-bit computer provides PERFECT COMPATIBILITY with the IBM PC/XT range. The motherboard can be supplied in two versions for stereoscopic conveneince. The 'N' version has no memory on board and the 'B' version with space for 64 to 256K RAM. Addition of the Memory Expansion Card provides a further 64 to 512KB of RAM. BASIC FEATURES INCLUDE:

* 8088 CPU operating at 4.77 MHz
* Provision for 8087 co-processor
* Four DMA channels
* Three TIMER channels on board
* 8 EXPANSION SLOTS
* RUNS MS/PC-DOS & CP/M 86
* READS & WRITES IBM-PC format
* Accepts IBM-PC Peripherals
* Up to 256K RAM ON BOARD

SYSTEM—5 PC16 (B/3) — **PRICE £1599** — Main computer employing 'B' board with 128K on board (upgradeable to 256K on board) PLUS Colour/Graphics adaptor providing signal capable of running monochrome displays on RGB output for full colour. Multi I/O card, providing floppy drive controller for two drives, one parallel port, one serial port, one games port with batter backed clock calander. RAM extension card for 512K. Two DS/DD floppy drives. 83-key keyboard. All complete, built & tested in case with power supply together with Concurrent (multiuser, multitasking)CP/M,CCP/M manual, Basic manual and computer operations manual – ready to run!

MOTHERBOARD 'B', 8-slot, 128K **£449**
MOTHERBOARD 'N', 8-slot **£329**
MULTIFUNCTION card with 128K (expandable to 256K) one PLL-port, one SER-port (2nd option) Clock/Calendar with backup **£259**
MONOCHROME adaptor with printer port **£239**
MULTI I/O CARD — one pll, one serial port, one games port, floppy drive controller, clock calender with battery backup **£299**

14in RGB HI-RES MONITOR (640dots × 300 lines) **£389**
12in HI-RES GREEN MON **£89**
64K RAM EXTEND MODULE **£59**
DS/DD FLOPPY DRIVE (500 KB unformatted **£175**
WINCHESTER DRIVE CONTROLLER **£425**
512K RAM BOARD — comes with 128K RAM installed fully IBM compatible **£299**

WINCHESTER DRIVE 12MB complete with controller **£915**
IBM COMPATIBLE KEYBOARD (83 key) **£89**
KEYTRONIC 5150 K/BOARD **£175**
KEYTRONIC 5151 K/BOARD **£210**
SWITCHING POWER SUPPLY **£105**
ADD SERIAL PORT KIT **£23**
FLOPPY DRIVE CONTROLLER **£109**

DRIVES — MEGABYTES FOR MICROPOUNDS!

5¼" Half height 500 kB 40/80 .... £119
5¼" Half height 1 MB 40/48 .... £125
5¼" Half height 1.6 MB 40/80 .... £159
5¼" Half height 2 MB 40/80 .... £199
3" Half height 500kB £119
3" Half height 1 MB £125
8" Full size 1.6 MB £309
8" Half size 1.6 MB £282
MR521 Half height 12.75 MB Hard Disk unformatted £492

All brand new, boxed, with built in controller — standard power requirments. Full documentation and technical details.

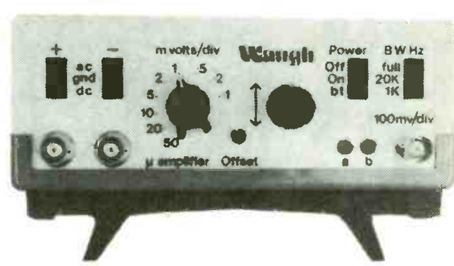
Add 15% VAT to all prices given. Remember, VAT is also applicable on carriage at 15%. Terms CWO. DEALER ENQUIRES WELCOME. FOREIGN enquiries if possible by telex please. However, French & German speaking staff at your disposal. MONEY BACK GUARANTEE. SEND £1.00 for our latest catalogue of over 3000 items, computers, peripherals, consumables, robotics, etc etc.

TEL: (0342) 313427•24631/2 TLX: 957547

CIRCLE 116 FOR FURTHER DETAILS.

There are better ways of measuring hum, ripple and other small signals

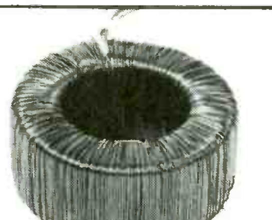
The Waugh Instruments Micro Amplifier extends the measurement capabilities of your oscilloscope to 100μV/div from DC–2MHz differential or single ended input. For details of this and other amplifiers contact:-



Peter Waugh at Waugh Instruments, Otter House Weston Underwood, Olney, Bucks. MK46 5JS (0234) 712445.

CIRCLE 38 FOR FURTHER DETAILS.

Toroidal Transformers



as manufacturers we are able to offer a range of quality Toroidal Transformers at highly competitive prices and fast delivery.

Mail Order Price List

15VA **6.92** 30VA **7.18.** 50VA **8.86.** 80VA **9.92.** 120VA **10.59.** 160VA **12.10.** 225VA **13.69.** 300VA **14.77.** 500VA **19.20.** 625VA **22.09.** 750VA **26.17.** 1KVA **38.82.** 1.2KVA **44.06**
price includes p+p & vat.

Available from stock in the following voltages:—6-0-6,9-0-9,12-0-12,15-0-15, 18-0-18,22-0-22. 25-0-25, 30-0-30,35-0-35,40-0-40,45-0-45,50-0-50,110,220,240(max.10 amp). Primary 240 volt.

Quantity Prices and delivery on request
(we also manufacture conventional E1 type transformers)

AIR LINK

Airlink Transformers.
Unit 6, The Maltings, Station Road, Sawbridgeworth, Herts. Tel: 0279-724425.

CIRCLE 72 FOR FURTHER DETAILS.

VIDEO TERMINAL BOARD

★ 80 characters × 24 lines ★

Requires ASCII encoded keyboard and monitor to make fully configurable intelligent terminal. Uses 6802 micro and 6845 controller. Program and character generator (7 × 9 matrix with descenders) in two 2716 EPROMs. Full scrolling at 9600 baud with 8 switch selectable rates. RS232 interface.

Bare board with 2 EPROMS and program listing — £48 plus VAT. Assembled and tested — £118 Send for details or CWO to:

AM ELECTRONICS

A M Electronics
Wood Farm, Leiston, Suffolk IP16 4HT
Tel: 0728 831131

CIRCLE 53 FOR FURTHER DETAILS.

COMPUTER WAREHOUSE

1000's OF BARGAINS FOR CALLERS

THE 'ALADDIN'S' CAVE OF COMPUTER AND ELECTRONIC EQUIPMENT

RECHARGEABLE BATTERIES

Dry Fit Maintenance FREE by Sonnenschein. **A300 07191315** 12v 3 AH same as **RS 591-770 NEW £13.95** A300 07191202 6-0-6 1.8 AH same as **RS 591-382 EX EQUIP £4.99** Miniature PCB mount 3.6v 100 Mah as **RS 591-477 NEW £1.00 SAFT VR2C** 1.2v "C" size **NICADS** in 18 cell ex equipment pack. Good condition – easily split to single cells £10.50 + pp £1.90

HOT LINE DATA BASE
DISTEL©

THE **ORIGINAL FREE OF CHARGE** dial up data base. 1000's of stock items and one off bargains. **ON LINE NOW** – 300 baud, full duplex CCITT tones, 8 bit word, no parity.

01-679 1888

COMPUTER 'CAB'

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. Also available **LESS PSU**, with FANS etc. Internal dim. 19"w. 16"d. 10.5"h. ***£19.95***. Carriage & insurance £9.50.

EX-STOCK INTEGRATED CIRCUITS

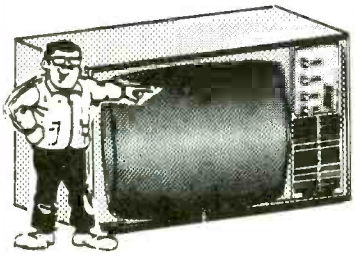
2732 ex equip £3.25, 27128 – 250ns NEW £12.00. 6116-200 £4.50, 6116-250 £3.95, 6264LP-150 £22.00, 4164-200 £3.50, 4864-150 £4.00, 4116-300, £1.20, 2114 £1.75, 6800 £2.50, 6821 £1.00, 68A09 £8.00, 68B09 £10.00, 68B09E £14.50, D8085AH-2 £12.00, D8086 £20.00, Z80A £2.99.

MAINS FILTERS

Cure those unnerving hang ups and data glitches caused by mains interference.
SD5A As recommended by **ZX81** news letter, matchbox size up to 1000 watt load ***£5.95***
L2127 compact completely cased unit with 3 pin fitted socket Up to 750 watts ***£9.99***

COOLING FANS

Keep your hot parts COOL and RELIABLE with our range of **BRAND NEW** professional cooling fans.
ETRI 99XU01 Dim. 92 x 92 x 25 mm. Miniature 240 v equipment fan complete with finger guard. £9.95.
GOULD JB-3AR Dim. 3" x 3" x 2.5" compact very quiet running 240 v operation. **NEW £6.95**
BUHLER 69.11.22. 8-16 v DC micro miniature reversible fan. Uses a brushless servo motor for extremely high air flow, almost silent running and guaranteed 10,000 hr life. Measures only 62 x 62 x 22 mm. Current cost £32.00. **OUR PRICE ONLY £12.95 complete with data.**
MUFFIN-CENTAUR standard 4" x 4" x 1.25" fan supplied tested EX EQUIPMENT 240 v at £6.25 or 110 v at £4.95 or BRAND NEW 240 v at £10.50. 1000's of other fans Ex Stock. Call for Details. Post & Packing on all fans £1.60



PRICE BARRIER SHATTERED ON 16" RGB CASED COLOUR MONITORS

A scoop purchase from a major London Hotel enables us to offer this special converted **DECCA 100 COLOUR** video TV at a super low price of £99.00!! Low enough to suit any budget!! Solid state modular construction, 16" high definition PIL tube, which eliminates convergence problems and our own special modification results in 80 + column text definition and picture quality not seen on monitors costing three times as much!! In fact we guarantee you will be delighted with this product, the quality has to be seen to be believed. Supplied complete and ready to plug direct to a **BBC MICRO COMPUTER** or any other system with a TTL RGB output. Other features include internal audio amp and speaker, compact dimensions only. 52cm W x 34 H x 24 D, auto degaussing circuit, attractive teak finished case, 30 day guarantee.

ONLY £99.00 + *£10.00 CARR.*

Also available unmodified complete with mod data (Mod costs less than £12.00) *£80.00.*

EPROM COPIERS

The amazing **SOFTY 2**. The "Complete Tool-kit" for copying, writing, modifying and listing EPROMS of the 2516, 2716, 2532, 2732 range. Many other functions include integral keyboard, cassette interface, serial and parallel data i/o, UHF modulator, ZIF socket etc. ***ONLY £195.00 + PP £2.50.***

"GANG OF EIGHT" intelligent Z80 controlled gang programmer for ALL single 5v rail EPROMS upto 27128. Will copy 8 27128 in typ. ONLY 3 MINUTES!! Internal LCD display and checking routines for IDIOT PROOF operation. ***ONLY £395.00 + PP £3.00.***

"GANG OF EIGHT PLUS" same spec. as above but with additional RS232 serial interface for down line loading data from computer etc. ***ONLY £445.00 + PP £3.00.***

Data sheets on request.

SPECIAL 300 BAUD MODEM OFFER

Another **GIGANTIC** purchase of these **EX BRITISH TELECOM, BRAND NEW** or little used 2B data modems allows US to make the **FINAL REDUCTION**, and for **YOU** to join the exciting world of data communications at an **UNHEARD OF PRICE OF ONLY £29.95**. Made to the highest **POST OFFICE APPROVED** spec at a cost of hundreds of pounds each, the 2B has all the standard requirements for data base, business or hobby communications. All this and more!!

- 300 baud full duplex
- Full remote control
- CCITT tone standards
- Supplied with full data
- Modular construction
- Direct isolated connection
- CALL, ANSWER and AUTO modes
- Standard RS232 serial interface
- Built in test switching
- 240v Mains operation
- 1 year full guarantee
- Just 2 wires to comms. line

NOW ONLY £29.95

Order now – while stocks last. Carriage and Ins. £10.00

BUDGET RANGE VIDEO MONITORS

At a price YOU can afford, our range of **EX EQUIPMENT** video monitors defy competition!! All are for 240v working with standard composite video input. Units are pre tested and set for up to 80 col use on BBC micro. Even where MINOR screen burns MAY exist – normal data displays are unaffected.

1000's SOLD TO DATE

12" KGM 320-321, high bandwidth input, will display up to 132 columns x 25 lines. Housed in attractive fully enclosed brushed alloy case. **B/W** only ***£32.95*** **GREEN screen *£39.95***

24" KGM large screen black & white monitor fully enclosed in light alloy case. Ideal schools, shops, clubs etc. ***ONLY £55.00*** Carriage £10.00

DATA MODEMS

Join the communications revolution with our super range of **DATA MODEMS** with prices and types to suit all applications and budgets!!
Most modems are **EX BRITISH TELECOM** and are made to the highest standard for continuous use and reliability. RS232 interfaces are standard to all our modems, so will connect to ANY micro etc. with an RS232 serial interface.

DATEL 2B see **SPECIAL OFFER** centre of this ad.
MODEM 13A, 300 baud. Compact unit only 2" high and same size as telephone base. Standard CCITT tones, CALL mode only. Tested with data. ***ONLY £45.00 + PP £4.50.***
MODEM 20-1, 75-1200 baud. Compact unit for use as subscriber end to PRESTEL, MICRONET or TELECOM GOLD. Tested with data. ***£39.95 + PP £6.50.***
MODEM 20-2, same as 20-1 but 1200-75 baud ***£99.00.***
TRANSDATA 307A, 300 baud acoustic coupler. Brand new with RS232 interface. ***£95.00 + PP £4.50.***
DACOM DSL2123 Multi Standard Modem, switchable CCITT or USA BELL 103 standard. V21 300-300, V23 75-1200, V23 1200-75 or 1200-1200 half duplex. Auto answer via MODEM or CPU. CALL or ANSWER modes plus LED status indication. Dim 2.5" x 8.5" x 9". **BRAND NEW** fully guaranteed ***ONLY £268.00 + PP £4.50.***
DATEL 2412 Made by SE LABS for BT this two part unit is for synchronous data links at 1200 or 2400 baud using 2780/3780 protocol. Many features include Auto answer, 2 or 4 wire working etc. etc. **COST OVER** £800. ***OUR PRICE £185.00.***
DATEL 4800, RACAL MPS4800 high speed good condition ***£285.00 CARR £10.00***

SAVE £250 SUPER PRINTER SCOOP
BRAND NEW CENTRONICS 739-2

ONLY £199

The "Do Everything Printer" at a price that will **NEVER** be repeated. Standard **CENTRONICS** parallel interface for direct connection to **BBC, ORIC, DRAGON** etc. Superb print quality with full pin addressable graphics and 4 type fonts plus **HIGH DEFINITION** internal **PROPORTIONAL SPACED MODE** for **WORD PROCESSOR** applications. 80-132 columns, single sheet, sprocket or roll paper handling plus much more. Available **ONLY** from **DISPLAY ELECTRONICS** at the ridiculous price of ***ONLY £199.00*** + VAT Complete with full manual etc. Limited quantity – Hurry while stocks last.
Options. Interface cable (specify) for BBC, ORIC, DRAGON or CENTRONICS 36 way plg £12.50. Spare ribbon £3.50 each BBC graphics screen dump utility program £8.50
Carriage and Ins. £10.00 + VAT

HUNDREDS OF PRINTERS EX STOCK FROM £49.00. Call Sales Office for Details.

1 only large **CALCOMP 1036** AO 3 pen drum plotter and offline 915 magtape controller. Good working order. ***£2500.00.***

DISK DRIVE SPECIALS

SIEMENS FDD-100-5 5¼" 40 track single sided. Ex new equipment tested, guaranteed working. Complete with data ***£75.00***
SHUGART SA400 5¼" 35 track, single sided, Ex equipment, guaranteed working ***£55.00***
SHUGART SA800, SA850 8" drives plus spares EX Stock call for prices.
Hard disk drives.
Large quantities of HARD DISK drives currently EX STOCK including:

DRE series 30 mb Front Load for DEC, NOVA etc	***FROM £295.00***
DIABLO 44/DRE 4000 A, B 5+5 mb cartridge drive	***FROM £995.00***
CDC HAWK 5+5 mb cartridge drive as new condition	***FROM £795.00***
CDC 9762 80 mb **DEC RM03** compatible	***FROM £2900.00***
PERTEC D3422 5+5 cartridge drive	***FROM £495.00***

Large quantities of spares and controllers available for S100, DEC, HONEYWELL, DATA GENERAL. Call sales office for details.
IN HOUSE disk drive refurbishing service – call for competitive quotations!!

ADD VAT TO ALL PRICES

EX STOCK

DEC CORNER

PDP 1140 System comprising of CPU, 124K memory + MMU 16 line RS232 interface, RP02 40 MB hard disk drive, TU10 9 track 800 BPI Mag tape drive, dual rack system, VT52 VDU etc. etc. Tested and running ***£3750.00***

BA11-MB 3.5" Box, PSU, LTC	£385.00
DH11-AD 16 x RS232 DMA interface	£2100.00
DLV11-J 4 x EIA interface	£310.00
DUP11 Sych. Serial data i/o	£650.00
DQ200 Dilog – multi RK controller	***£495.00***
DZ11-B 8 line RS232 mux board	£650.00
LA36 Decwriter EIA or 20 ma loop	£270.00
LAXX-NW LA180 RS232 serial interface and buffer option	£130.00
LAX34-AL LA34 tractor feed	£85.00
MS11-JP Unibus 32 kb Ram	£80.00
MS11-LB Unibus 128 kb Ram	£450.00
MS11-LD Unibus 256 kb Ram	£850.00
MSC4804 Qbus (Equiv MSV11-L) 256 kb	£499.00
PDP11/05 Cpu, Ram, i/o, etc.	£450.00
PDP11/40 Cpu, 124k MMU	£1850.00
RT11 ver. 3B documentation kit	£70.00
RK05-J 2.5 Mb disk drives	£650.00
KL8JA PDP 8 async i/o	£175.00
MI8E PDP 8 Bootstrap option	£75.00
VT50 VDU and Keyboard – current loop	£175.00
VT52 VDU with RS232 interface	***£250.00***

1000's of **EX STOCK** spares for **DEC PDP8, PDP8A, PDP11** systems & peripherals. Call for details. All types of Computer equipment and spares wanted for **PROMPT CASH PAYMENT.**

All prices quoted are for U.K. Mainland, paid cash with order in Pounds Sterling PLUS VAT. Minimum order value ***£2.00***. Minimum Credit Card order ***£10.00***. Minimum BONA FIDE account orders from Government Depts., Schools, Universities and established companies ***£20.00***. Where post and packing not indicated please ADD £1.00 + VAT. Warehouse open Mon-Fri 9.30-5.30. Sat 10.30-5.30. We reserve the right to change prices and specifications without notice. Trade, Bulk and Export

DISPLAY -ELECTRONICS-

32 Biggin Way, Upper Norwood, London SE19 3XF
Telephone 01-679 4414 Telex 27924

CIRCLE 89 FOR FURTHER DETAILS.

ERS — PRINTERS — PRINTERS — PRINTERS
PRINTERS — PRINTERS — PRINTERS — PRI

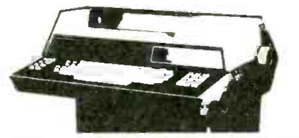
SUPER DEAL? NO — SUPER STEAL!!

The FABULOUS 25CPS TEC Starwriter

BRAND NEW AT ONLY £499 + VAT

Made to the very highest spec the **TEC Starwriter FP1500-25** features a heavy duty die cast chassis and DIABLO type print mechanism giving superb registration and print quality. Micro-processor electronics offer full DIABLO/QUME command compatability and full control via CPM Wordstar etc. Many other features include bi directional printing, switchable 10 or 12 pitch, full width 381 mm paper handling with upto 163 characters per line, friction feed rollers for single sheet or continuous paper, internal buffer, standard RS232 serial interface with handshake. Supplied absolutly **BRAND NEW** with 90 day guarantee and **FREE** daisy wheel and dust cover. Order **NOW** or contact sales office for more information. Optional extras: RS232 data cable **£10.00**. Tech manual £7.50. Tractor feed **£140.00**. Spare daisy wheel £3.00. Carriage & Ins. (UK Mainland) £10.00.

GE MODEL 30



A large purchase of these stand alone terminal units offers an EXTREMELY LOW PRICE for a professional printer for direct connection to your micro. The printer has a standard RS232 serial interface with switchable rates of 110, 200 and 300 baud. Upper and lower case characters are printed by a matrix head with character widths up to 132 columns. Unit accepts standard fan fold sprocket fed paper from 4" to 9.5". Many other features such as numeric keypad, electronic keyboard, auto motor on/off and FREE floor stand. Supplied in good S/H working condition – complete with manual ***ONLY £95.00***

CARRIAGE & INS. £10.00

GE TERMIPRINTER

A massive purchase of these desk top printer-terminals enables us to offer you these quality 30 cps printers at a **SUPER LOW PRICE** against their original cost of over £1000. Unit comprises of full QWERTY, electronic keyboard and printer mech with print face similar to correspondence quality typewriter. Variable forms tractor unit enables full width - up to 13.5" 120 column paper, upper - lower case, standard RS232 serial interface, internal vertical and horizontal tab settings, standard ribbon adjustable baud rates, quiet operation plus many other features. Supplied complete with manual. Guaranteed working ***£130.00*** or untested ***£85.00***, optional floor stand £12.50 Carr & Ins £10.00.

PROFESSIONAL KEYBOARD OFFER

An advantageous purchase of brand new surplus allows a great **QWERTY**, full travel, chassis keyboard offer at fractions of their original costs.
ALPHAMERIC 7204/60 full **ASCII** 60 key, upper, lower + control key, parallel TTL output plus strobe. Dim 12" x 6" +5 & -12 DC. ***£39.50.***
DEC LA34 Uncoded keyboard with 67 quality, **GOLD**, normally open switches on standard X, Y matrix. Complete with 3 LED indicators & i/o cable - ideal micro conversions etc. pcb DIM 15" x 4.5" ***£24.95*** Carriage on keyboards £3.00.

EXTEL PRINTERS

EX NEWS SERVICE compact, quality built 50 column matrix printer, type AE11. Unit operates on 5 BIT BAUDOT code from current loop, RS232 or TTL serial interfaces. May be connected direct to micro, or comms receiver via simple filter network to enable printing of most world wide NEWS, TELEX and RTTY services. Supplied in tested second hand condition with 50 and 75 baud xtals, data sheet and large paper roll. ***ONLY £49.95.***
Dimensions 15" D x 5" H x 10" W
CARR £6.00 Spare paper rolls £4.50 each

TELETYPE ASR33 I/O TERMINALS

FROM £195 + CAR + VAT

Fully fledged industry standard ASR33 data terminal. Many features including ASCII keyboard and printer for data I/O auto data detect circuitry. RS232 serial interface. 110 baud, 8 bit paper tape punch and reader for off line data preparation and ridiculously cheap and reliable data storage. Supplied in good condition and in working order.
Options: Floor stand ***£12.50*** + VAT
KSR33 with 20ma loop interface ***£125.00*** +
Sound proof enclosure ***£25.00*** + VAT

66% DISCOUNT

ELECTRONIC COMPONENTS EQUIPMENT

Due to our massive bulk purchasing programme which enables us to bring you the best possible bargains, we have thousands of I.C.s, Transistors, Relays, Cap's, P.C.B.s, Sub-assemblies, Switches, etc. etc. surplus to our requirements. Because we don't have sufficient stocks of any one item to include in our ads. we are packing all these items into the *'BARGAIN PARCEL OF A LIFETIME'*. Thousands of components at giveaway prices! Guaranteed to be worth at least *3 times* what you pay. Unbeatable value!! Sold by weight.

2.5kls ***£4.25*** + pp £1.25 — 5kls ***£5.90*** + £1.80
10kls ***£10.25*** + pp £2.25 — 20 kls ***£17.50*** + £4.75

20,000 FEET OF ELECTRONIC AND COMPUTER GOODIES
ENGLAND'S LARGEST SURPLUS STORE – SEEING IS BELIEVING!!

D.C. POWER SUPPLY SPECIALS

Experimentors PSU Ex-GPO. All silicon electronics. Outputs give +5v @ 2 amps +12v @ 800 ma -12v @ 800 ma +24v @ 350 ma and 5v floating @ 50 ma. Dim 160 x 120 x 350 mm. All outputs are fully regulated and short circuit proof. Supplied in NEW or little used condition. Complete with circuit.
Only £15.50 +2 £2.50 pp
FARNELL 5 Volt 40 amps. Type number **G6-40A.** This miniature switching PSU measures only 160mm wide 175mm deep and 90mm high, yet delivers a massive 40 amps!! Fully regulated and smoothed with over voltage protection etc. 120 or 240 volts AC input. Supplied **BRAND NEW** and boxed with circuit at a fraction of the current list price. **Only £130.00 + £3.00** carr & ins.
LAMBDA LMCC 5V BRAND NEW 240v AC input with 5 volts DC at 8 to 10 amps fully regulated output. Completely enclosed unit measures only 9" x 4" x 5" **£29.99**
LAMDA LMCC5V 110v AC input with 5 volts DC at 8 to 10 amps fully regulated output. Slightly smoke damaged, hence **ONLY £10.95**
PERIPHERAL SYSTEM SUPPLY. Runs almost any system. Fully cased unit supplied in a brand new or little used condition. Outputs give 5v @ 11 amps "+" 15-17v @ 8 amps "–" 15-17v @ 8 amps and "+" 24v @ 4 amps. All outputs are crowbar protected and the 5 volt output is fully regulated. Fan cooled. Supplied tested with circuit. £55.00 + £8.50 carr.
1000's of other POWER SUPPLIES EX STOCK – CALL SALES OFFICE FOR DETAILS

DUAL DISK DRIVE/ WINCHESTER CASES

Very smart, fully enclosed case unit custom made to accept two full height 5¼" floppy disk drives or two 5¼" winchesters such as the RHODIME RO200 or TANDEM series etc. An internal switched mode PSU supplies all the required voltages to enable you to plug in your drives and go!!
Other features include mains filter, internal cables with standard drive connectors, space for internal PCB, standard fan cut out and mounting, air filter. Overall dimensions 28 cm W x 30 cm D x 19 cm H
ONLY £55.00 + £6.00 CARR.

SEMICONDUCTOR 'GRAB BAGS'

Mixed Semis amazing value contents include transistors, digital, linear, I.C.'s triacs, diodes, bridge recs., etc etc. All devices guaranteed brand new full spec. with manufacturer's markings, fully guaranteed.
50+ ***£2.95*** 100+ ***£5.15.***
TTL 74 Series A gigantic purchase of an "across the board" range of 74 TTL series I.C.'s enables us to offer 100+ mixed "mostly TTL" grab bags at a price which two or three chips in the bag would nnormally cost to buy. Fully guaranteed all I.C.'s full spec. 100+ ***£6.90*** 200+ ***£12.30*** 300+ ***£19.50***

NORTH STAR HORIZON

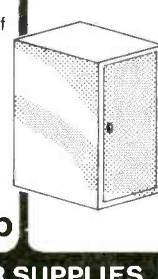
Pro S100 system with dual 5" floppy drives, software, manuals etc.
£850.00 Call sales office for details

ULTRA COMPACT 300 BAUD ACCOUSTIC MODEM — COUPLER

A Major manufacturer's over production and a bulk buy special enables us to offer this **BRAND NEW TRANSDATA 307A** ultra compact, **BT APPROVED**, 300 baud full duplex accoustic modem at a fraction of manufacturer's list price. The unit operates on the standard **CCITT V21** frequencies with **RS232** interface via 25 way 'D' skt.
Combine the adjustable cup system, which fits almost any phone with the benefit of "No jacks or phone cables" and a light weight of only 1.2 Kg and you have a truly portable modem!! Supplied complete with data, 90 day guarantee and ready to use.

ONLY £49.95 + £3.00 pp

PROFESSIONAL 6 FOOT 19" RACK CABINETS



LARGE 19" equipment cabinet. Totally enclosed with locking front and rear doors. An internal sub fram 63" high is pre drilled for standard 19" equipment etc. Other features include internal 12" cooling fan, two-tone blue and grey finish with alloy trims. Mounted on 4 heavy duty castors, mains panel etc. And at a current cost from **IMHOFS** of over £500 A snip at **ONLY £125**. Supplied in **NEW** or little used condition. Carriage £22.00.
Ext. Dim 72.5"h x 23.5"w x 26"d

LOGICAL KEYBOARD

Heavy duty unit in attractive satin alloy case. 55 full travel keys are laid out in a logical format of:

Making a very useful keyboard, ideal for persons unfamiliar with or confused by the standard **QWERTY** layout. All keys generate the equivalent **ASCII** outputs and various control codes shown in data. A 7 bit latched parallel **TTL** output with strobe enables direct connection to any similar micro port etc. Many other features such as internal 240v to 5v PSU, MAINS ON/OFF switch. **Supplied in NEW** or little used condition with data.
ONLY £25.95 Post and packing £4.50

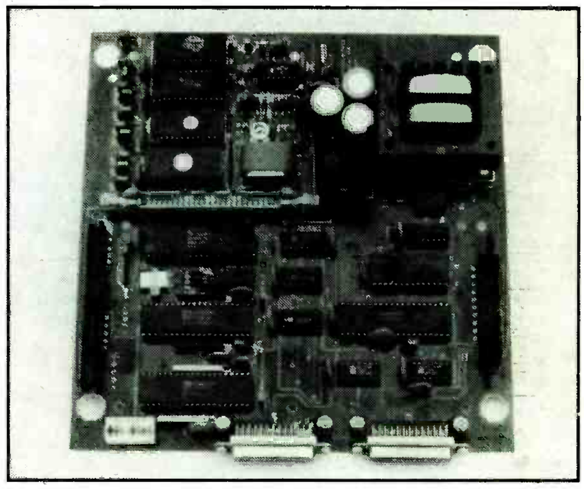
1000's of other EX STOCK items including POWER SUPPLIES, RACKS, RELAYS, TRANSFORMERS, TEST EQUIPMENT, CABLE, CONNECTORS, HARDWARE, MODEMS, TELEPHONES, VARIACS, VDU'S, PRINTERS. POWER SUPPLIES, OPTICS, KEYBOARDS etc. etc. Give us a call for your spare part requirements. Stock changes almost daily.

Don't forget, ALL TYPES and QUANTITIES of electronic surplus purchased for CASH

CIRCLE 90 FOR FURTHER DETAILS.

The Archer-Single Board Computer

The **SDS ARCHER** — The Z80 based single board computer chosen by professionals and OEM users.



FEATURES

* High quality double sided plated through PCB
* 4 Bytewide memory sockets — upto 64k
* Power-fail and watchdog timer circuits
* 4 Parallel ports with handshaking
* Bus expansion connector
* CMOS battery back-up
* Counter-timer chip
* 2 serial ports
* 4 MHz. Z80A

Telephone or write for full technical description and price information.

OPTIONS

* **SDS BASIC** with autostart and "user program in ROM" facility
* **SDS DEBUG MONITOR:** a powerful 8k byte development aid
* On board 120/240 volt mains power supply
* Attractive two tone instrument case

Sherwood Data Systems Ltd

Sherwood House, The Avenue, Farnham Common, Slough SL2 3JX. Tel. 02814-5067

CIRCLE 43 FOR FURTHER DETAILS.

pantechnic

■ **design manufacture and supply**

POWER AMPLIFIERS
HIGH POWER ASSEMBLIES
CONTROL CIRCUITRY

■ **for application in**

INDUSTRY
PUBLIC ADDRESS
HI-FI

■ **available**

OFF THE SHELF
CUSTOMISED
C A D DESIGNED

tel. 01.361.8715 **132 High Road**
telex 266 873 **New Southgate**
PANTEC G **LONDON N11 1PG.**

CIRCLE 47 FOR FURTHER DETAILS.

■ COMPONENT PACKS ■

All Brand New except where marked
Price: £1 per pack
Order 12 you get one extra FREE
Please add £1 post if order under £20

1 – 5 13 amp ring main junction boxes
2 – 5 13 amp ring main spur boxes
3 – 25 13 amp fuses for ring mains
4 – 5 surface mounting switches
5 – 3 flush switches intermediate type
6 – 5 in flex line switches
7 – 4 in flex line swithces with neons
8 – 2 80 watt brass cased elements
9 – 2 mains transformers with 6v 1a secondaries
10 – 2 mains transformers with 12v ½a secondaries
11 – 1 extension speaker cabinet for 6½" speaker
12 – 5 octal bases for relays or valves
13 – 12 glass reed switches
14 – 4 DCP 70 photo transistors
15 – 25 assorted gemanium transistors OC45 etc
16 – 4 tape heads, 2 record, 2 erase
17 – 2 ultra sonic transmitters and 2 ditto receivers
18 – 2 15000 mid computer capacitors
19 – 2 l.d.r. similar ORP 12
20 – 5 diff micro switches
21 – 2 mains interference suppressors
22 – 2 25 watt crossover units
23 – 1 40 watt 3 way crossover unit
24 – 250 screws and self tappers
25 – 1 of each wafer switches — 6p 2 way; 4p 3 way; 2p 6 way; 1p 12 way
26 – 2 tape deck counters
27 – 1 6 digit counter 12v
28 – 1 6 digit counter mains voltage
29 – 1 BOAC in flight stereo unit (s.h.)
30 – 2 NICAD battery chargers
31 – 1 key switch with key
32 – 2 humidity switches
33 – 2 aersol cans of ICI Dry Lubricant
34 – 96 × 1 metre length colour-coded wires
35 – 4 battery operated model motors
36 – 2 air spaced 2 gang tuning condensors
37 – 2 solid diaelectric 2 gang tuning condensors
38 – 10 compression trimmers
39 – 1 Long & medium wave tuner kit
40 – 4 × 465 KC IF transformers
41 – 8 rocker switches 10a mains SPST
42 – 6 rocker switches 10a mains SPDT
43 – 5 rocker switches 10a SPDT
44 – 1 rocker switches 10a SPDT
45 – 1 24 hour time switch mains operated
46 – 1 6 hour clockwork time switch
47 – 2 2 lever switches 4 pole changeover up and ditto down
48 – 2 6v operated reed switch relays
49 – 10 neon valves – make good night lights
50 – 2 × 12v DC or 24v AC 4CO relays
51 – 1 × 12v 2C 0 very sensitive relay
52 – 1 × 12v 4C 0 relay
53 – 2 mains operated relays 3 × 8a changeovers (second hand)
54 – 10 rows of 32 gold plated IC sockets (total 320 sockets)
55 – 1 locking mechanism (with 2 keys)
56 – 1 miniature Uniselector with circuit for electric jigsaw puzzle
57 – 5 dolls house switches
58 – 2 telephone handsets
59 – 2 flat solenoids – to make current transformer etc
60 – 5 ferrite rods 4" × 5" – 16" dia
61 – 5 ferrite slab aerials LW & MW
62 – 4 200Ω ear pieces
63 – 1 Mullard Thyristor trigger module
64 – 10 assorted knobs ¼ spindles
65 – 5 diff thermostats

Most items available in quantity at good discounts. Access & Barclay cards welcome

■ N.B. ELECTRONIC SUPPLIES ■

34 America Lane, Haywards Heath, Sussex RH16 3QU
(24hr phone ordering 0444 454563)

CIRCLE 67 FOR FURTHER DETAILS.

It's OUT – ***NOW!***

it's the ***LATEST,***

it's the ***LARGEST***

and, it is the ***most***

COMPREHENSIVE CATALOGUE

of

ELECTRONIC COMPONENTS

and

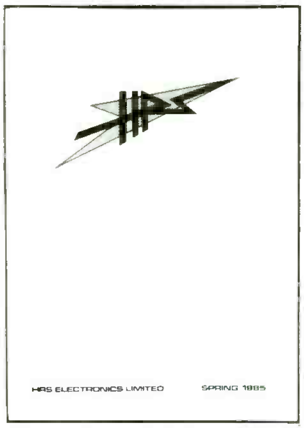
SERVICING EQUIPMENT

ever produced by

HRS

for the

Radio, TV and Video Service Department



for YOUR COPY of the *HRS* Spring 1985 Catalogue
– call us on **021 – 771 2525**

The stock range: **aerial & audio equipment**, batteries, **cables**, capacitors, **cartridges & styli**, cassette recorder spares & tapes (audio & video), **cathode ray tubes**, computer accessories, **connectors**, domestic appliance spares, **eht rectifiers**, fuses, **hardware**, hobby kits, **holders**, indicators, **integrated circuits**, loudspeakers, **multimeters**, oscilloscopes, **power supplies**, production aids, **recorder spares**, remote control units, **resistors**, security equipment, **semiconductors**, service aids, **signal generators**, soldering equipment, **sound equipment**, storage systems, **switches**, tools, **transformers**, tv spares, **valves**, wound components.

***HRS* Electronics Limited**
Great Barr St., BIRMINGHAM B9 4BB
Telephone: **021 – 771 2525** Telex: **339992**

CIRCLE 119 FOR FURTHER DETAILS.

C&A ELECTRONIC

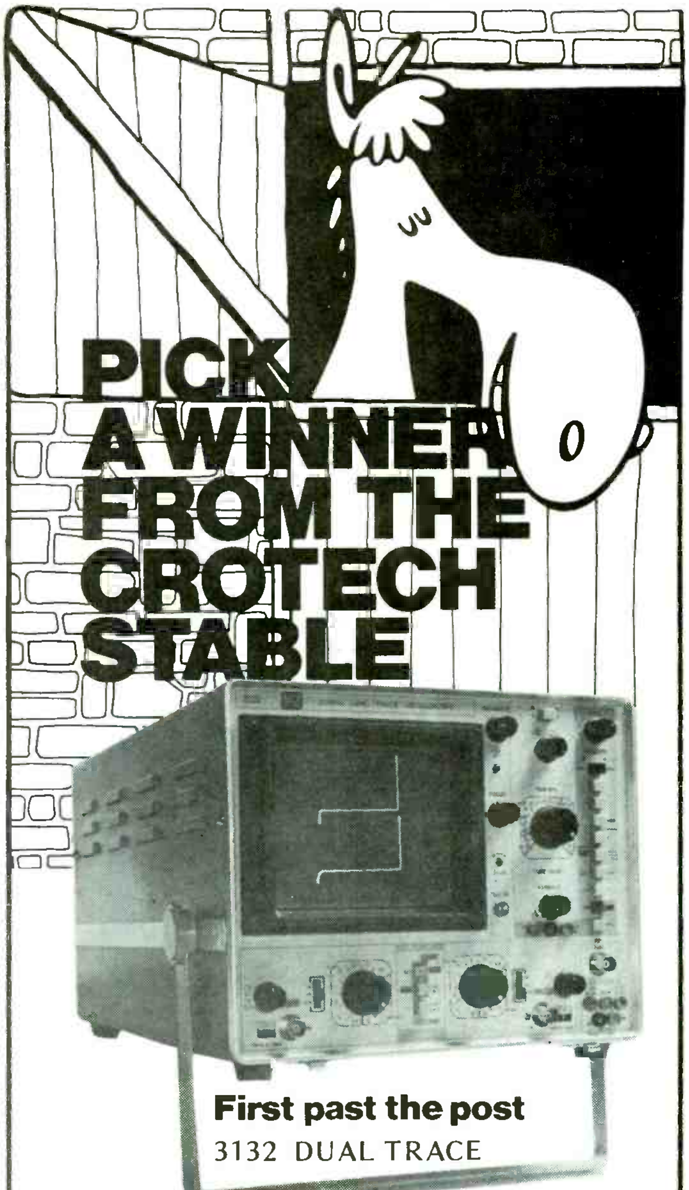
12 CHANNEL GRAPHIC EQUALISER kit No 242

The mother board contains the 2 slide potis (13,5 × 9cm) on which is plugged the circuit board (18 × 7,5cm). So the only cables used are those for pwr supply in/out signals!! Both pcboards are connected with special connector/pins. All potis with pins for pcboard insertion. So, no cables, no confusion...

Technical specification Frequency resp. :10 Hz - 100 khz Equalisation: 14 Hz, 28 Hz, 56 Hz, 100 Hz, 210 Hzz, 500 Hz, 2 knz, 4 khz, 8 khz, 16 khz, 22 khz. Harmonic dist. :0,02% Max. out signal: 7v rms Input res. :47 kout: 100R Powr supply: ±15v DC, 100mA Master volume with isolation. Ics used: (6×2) and one for input vol. output ampl. Signal voltage easily adopted for any combination.

C & A ELECTRONIC O.E.
PO Box 25070 Athens 10026
GREECE Tel:5242867. Tlx:210798 CAGR

CIRCLE 16 FOR FURTHER DETAILS.

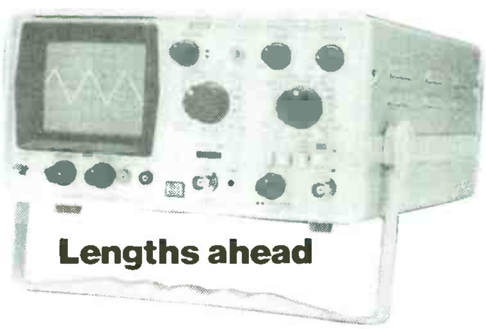


* DC – 20 MHz Bandwidth.
* 2 mV/div Sensitivity.

EXTRA FORM.

* Triple DC Output Source.
* Component Comparator.
* 14 Trigger Functions.
* X – Y Mode.

Starting Price £297*



3030 SINGLE TRACE

* DC – 15 MHz Bandwidth.
* 5 mV/div Sensitivity.
* 200 ns/div. Sweep Speed.
* Component Tester.

Starting Price £179*

For the full form on both models, and our complete range, just give us a call. *(exc. VAT)

Access

Crotech Instruments Limited
2 Stephenson Road, St. Ives, Huntingdon, Cambs. PE17 4WJ
Telephone: (0480) 301818 32/30/10/4/1

CIRCLE 91 FOR FURTHER DETAILS.

AA117 9p, AA19 9p, AAY32 9p, AC107 28p, AC126 17p, AC127 15p, AC128 15p, AC128K 23p, AC141K 30p, AC142K 30p, AC153K 23p, AC176 18p, AC176K 20p, AC187 15p, AC187K 20p, AC188 17p, AC188K 23p, ACY18 48p, ACY19 48p, AD142 60p, AD149 45p, AD161 22p, AD162 22p, AF124 25p, AF125 25p, AF126 25p, AF127 25p, AF139 22p, AF239 22p, AL112 70p, AL113 80p, ASZ15 100p, ASZ17 100p, AU110 110p, AY102 180p, AY106 180p, BA145 10p, BA148 10p, BA154 6p, BA157 12p, BB101 13p, BB103 16p, BB105B 18p, BB205B 24p, BC107 7p, BC108 7p, BC109 7p, BC115 10p, BC118 11p, BC140 19p, BC141 19p, BC142 19p, BC143 19p, BC147 6p, BC148 6p, BC149 6p, BC157 6p, BC159 6p, BC182 6p, BC182L 6p, BC183 6p, BC183L 6p, BC184 6p, BC184L 6p, BC212 6p, BC212L 6p, BC213 6p, BC213L 6p, BC214 6p, BC214L 6p, BC237 7p, BC238 7p, BC300 16p, BC301 18p, BC302 18p, BC303 18p, BC327 6p, BC328 6p, BC337 6p, BC338 6p, BC557 6p, BCY32 150p, BCY33 150p, BCY34 150p, BCY42 20p, BCY56 16p, BCY70 16p, BCY71 16p, BCY72 16p, BD115 26p, BD124P 50p, BD124 110p, BD128 35p, BD131 25p, BD132 25p, BD135 20p, BD136 20p, BD137 20p, BD138 20p, BD139 20p, BD140 20p, BD144 90p, BD150 30p, BD157 38p, BD158 38p, BD166 30p, BD175 30p, BD177 30p, BD179 32p, BD181 45p, BD182 60p, BD183 60p, BD187 30p, BD201 33p, BD202 38p, BD203 42p, BD204 42p, BD222 31p, BD225 31p, BD232 31p, BD234 32p, BD235 28p, BD236 30p, BD237 21p, BD238 24p, BD244 50p, BD245 50p, BD433 28p, BD434 30p, BD435 31p, BD437 28p, BD438 36p, BD439 40p, BD440 40p, BD441 40p, BD442 40p, BD533 50p, BD534 38p, BD535 38p, BD536 38p, BD537 40p, BD538 40p, BD675 40p, BD676 40p, BD677 38p, BD678 40p, BD679 40p

BD680 40p, BD681 45p, BD682 45p, BDX32 100p, BDX65 80p, BDY92 100p, BF180 16p, BF181 18p, BF183 20p, BF184 20p, BF185 20p, BF194 5p, BF195 5p, BF196 6p, BF197 7p, BF198 7p, BF199 6p, BF200 18p, BF240 16p, BF241 10p, BF255 12p, BF256 18p, BF257 18p, BF258 18p, BF259 18p, BF262 25p, BF263 25p, BF270 18p, BF273 15p, BF311 21p, BF324 25p, BF336 20p, BF337 20p, BF338 20p, BF367 13p, BF371 17p, BF414 18p, BF420 16p, BF421 18p, BF422 21p, BF423 15p, BF440 16p, BF451 17p, BF455 14p, BF458 19p, BF459 19p, BF461 60p, BF462 62p, BF469 30p, BF470 28p, BF471 28p, BF479 30p, BF493 18p, BF494 16p, BF595 16p, BF596 16p, BF597 10p, BF615 30p, BF758 41p, BF869 22p, BF870 22p, BF872 23p, BF960 38p, BF963 40p, BF964 38p, BF966 40p, BFR40 25p, BFR51 25p, BFR62 21p, BFR79 25p, BFR90 52p, BFR91 99p, BFX29 20p, BFX84 20p, BFX85 20p, BFX87 15p, BFX88 15p, BFX89 60p, BFY17 30p, BFY18 40p, BFY41 28p, BFY50 14p, BFY51 14p, BFY52 14p, BFY56 25p, BFY57 25p, BFY64 25p, BFY90 45p, BLY48 85p, BLY49 85p, BR100 14p, BR101 43p, BR103 37p, BSX20 15p, BSX26 18p, BSX29 19p, BT106 90p, BT109 90p, BT116 80p, BT119 100p, BT120 100p, BU100A 110p, BU104 100p, BU105 80p, BU108 100p, BU110 110p, BU111 140p, BU124 60p, BU126 70p, BU204 75p, BU205 70p, BU208 75p, BU208A 80p, BU208A 80p, BU208D 100p, BU325 55p, BU326 85p, BU406 85p, BU406D 95p, BU407 75p, BU407D 95p, BU408 85p, BU408D 95p, BU409 95p, BF367 13p, BF371 17p, BF414 18p, BF420 16p, BF421 18p, BF422 21p, BF423 15p, BF440 16p, BF451 17p, BF455 14p, BF458 19p, BF459 19p, BF461 60p, BF462 62p, BF469 30p, BF470 28p, BF471 28p, BF479 30p, BF493 18p, BF494 16p, BF595 16p, BF596 16p, BF597 10p

BF615 30p, BF758 41p, BF869 22p, BF870 22p, BF872 23p, BF960 38p, BF963 40p, BF964 38p, BF966 40p, BFR40 25p, BFR51 21p, BFR62 21p, BFR79 25p, BFR90 52p, BFR91 99p, BFX29 20p, BFX84 20p, BFX85 20p, BFX87 15p, BFX88 15p, BFX89 60p, BFY17 30p, BFY18 40p, BFY41 28p, BFY50 14p, BFY51 14p, BFY52 14p, BFY56 25p, BFY57 25p, BFY64 25p, BFY90 45p, BLY48 85p, BLY49 85p, BR100 14p, BR101 43p, BR103 37p, BSX20 15p, BSX26 15p, BSX29 19p, BT106 90p, BT109 90p, BT116 80p, BT119 100p, BT120 100p, BU100A 110p, BU104 100p, BU105 80p, BU110 110p, BU111 140p, BU124 60p, BU126 70p, BU204 75p, BU205 70p, BU208 75p, BU208A 80p, BU208D 100p, BU325 55p, BU326 85p, BU406 85p, BU406D 95p, BU407 75p, BU407D 95p, BU408 85p, BU408D 95p, BU409 95p, BU426 120p, BU500 110p, BU526 80p, BU801 95p, BU806 120p, BU807 95p, C106D 23p, MJ2500 100p, MJ2501 110p, MJ2955 65p, MJ3000 115p, MJ3001 115p, MJE29A 30p, MJE30A 30p, MJE340 25p, MJE350 80p, MJE520 30p, MJE2955K 90p, OC28 100p, OC29 80p, OC35 100p, OC36 120p, OC45 50p, OC71 30p, OC72 50p, OC200 180p, R2008B 100p, R2010B 100p, TAG4443 76p, TAG4444 76p, TIP29 15p, TIP29A 22p, TIP29C 25p, TIP30 25p, TIP30C 30p, TIP31A 24p, TIP31C 30p, TIP32 24p, TIP32A 24p, TIP32C 28p, TIP33 50p, TIP34 60p, TIP41A 22p, TIP41C 25p, TIP42A 22p, TIP42C 25p, TIP47 40p, TIP48 40p, TIP50 60p, TIP51 120p, TIP52 120p, TIP53 120p, TIP54 140p, TIP105 65p, TIP106 65p, TIP107 65p, TIP110 47p, TIP111 50p, TIP112 40p, TIP115 45p, TIP116 45p, TIP117 50p, TIP120 43p, TIP121 46p, TIP122 47p, TIP125 47p, TIP126 56p, TIP127 56p, TIP141 90p, TIP142 90p, TIP145 65p, TIP146 90p, TIP147 100p, TIP2955 42p, TIP3054 45p, TIP3055 42p, TIS43 45p

TIS44 40p, TIS61 15p, TIS88A 45p, TIS90 15p, TIS91 18p, TIS93 20p, VK1010 88p, VN 10KM 60p, VN.46AF 88p, VN.66AF 100p, VN.88AF 115p, VN.89AF 110p, BU426 120p, BU500 110p, BU526 80p, BU801 95p, BU806 120p, BU807 95p, C106D 23p, MJ2500 100p, MJ2501 110p, MJ2955 55p, MJ3000 115p, MJ3001 115p, MJE29A 30p, MJ30A 30p, MJ340 25p, MJ350 80p, MJ520 30p, MJE2955K 90p, OC28 100p, OC29 80p, OC35 100p, OC36 120p, OC45 50p, OC71 30p, OC72 50p, OC200 180p, R2008B 100p, R2010B 100p, TAG4443 76p, TAG4444 76p, TIP29 15p, TIP29A 22p, TIP29C 25p, TIP30 25p, TIP30C 30p, TIP31A 24p, TIP31C 30p, TIP32 24p, TIP32A 24p, TIP32C 28p, TIP33 50p, TIP34 50p, TIP41A 22p, TIP41C 25p, TIP42A 22p, TIP42C 25p, TIP47 40p, TIP48 40p, TIP50 60p, TIP51 120p, TIP52 120p, TIP53 120p, TIP54 140p, TIP105 65p, TIP106 65p, TIP107 65p, TIP110 47p, TIP111 50p, TIP112 40p, TIP115 45p, TIP116 45p, TIP117 50p, TIP120 43p, TIP121 46p, TIP122 47p, TIP125 47p, TIP126 56p, TIP127 56p, TIP141 90p, TIP142 90p, TIP145 65p, TIP146 90p, TIP147 100p, TIP2955 42p, TIP3054 45p, TIP3055 42p, TIS43 45p, TIS44 40p, TIS61 15p, TIS88A 45p, TIS90 15p, TIS91 18p, TIS93 20p, VK1010 88p, VN 10KM 60p, VN 46AF 88p, VN 66AF 100p, VN 88AF 115p, VN.89AF 110p, ZTX107 11p, ZTX108 11p, ZTX109 12p, ZTX212 27p, ZTX300 13p, ZTX301 16p, ZTX302 16p, ZTX303 24p, ZTX304 17p, ZTX320 29p, ZTX326 29p, ZTX500 13p, ZTX501 13p, ZTX502 18p, ZTX503 18p, ZTX504 25p, ZTX550 24p, 2N 696 26p, 2N.697 22p, 2N.698 40p, 2N 699 45p, 2N.706A 22p, 2N.708 22p, 2N 914 28p, 2N.918 36p, 2N.930 18p, 2N.1131 28p, 2N.1132 28p, 2N 1613 24p, 2N.1711 24p, 2N.2102 50p, 2N.2160 300p, 2N.2218A 24p, 2N.2219 24p, 2N.2221 23p, 2N 2222 23p

2N 2369 15p, 2N.2484 20p, 2N 2646 40p, 2N.2904 20p, 2N.2905 20p, 2N.2906 18p, 2N 2907 18p, 2N 2926 18p, 2N.3019 28p, 2N.3053 18p, 2N.3054 35p, 2N.3055 35p, 2N 3055H 50p, 2N 3440 58p, 2N 3442 85p, 2N.3702 9p, 2N.3703 9p, 2N.3704 9p, 2N.3705 9p, 2N 3706 9p, 2N 3707 9p, 2N 3708 9p, 2N.3771 85p, 2N.3772 90p, 2N.3773 100p, 2N.3819 29p, 2N.3866 68p, 2N.3903 11p, 2N.3904 11p, 2N.3905 11p, 2N.3906 11p, 2N.4031 25p, 2N.4036 25p, 2N.4037 25p, 2N.4058 13p, 2N 4443 76p, 2N.4444 76p, 2N.5061 20p, 2N.5294 30p, 2N.5296 30p, 2N.6106 40p, 2N.6107 40p, 2N.6109 40p, 3N.128 55p, 3N.143 65p

DIODES
AA119 9p, BY100 40p, BY103 32p, BY126 6p, BY127 8p, BY133 8p, BY164 40p, BY176 85p, BY179 35p, BY182 32p, BY184 32p, BY187 32p, BY196 20p, BY206 11p, BY207 11p, BY208 18p, BY210 22p, BY223 72p, BY225 120p, BY226 18p, BY228 32p, BY296 20p, BY299 28p, BY476 90p, BYX10 15p, BYX55/350 30p, BYX55/600 30p, BYX55/800 32p, BYX70/300 29p, BYX70/500 32p, BYX70/800 36p, BYX71/600 80p, OA47 6p, OA90 4p, OA91 4p, OA200 7p, OA202 7p, IN.914 2p, IN.4001 4p, IN.4002 4p, IN.4003 4p, IN.4004 4p, IN.4005 4p, IN.4006 4p, IN.4007 4p, IN.4148 2p, IN 5400 9p, IN 5401 10p, IN.5402 10p, IN 5403 11p, IN.5404 11p, IN 5405 12p, IN 5406 13p, IN 5407 13p, IN 5408 13p

ZENERS
400MV BZY88 Range 2V7 to 39V 6p
1.3 ZENERS BZX61 Range 2V7 to 39V 12p

LOW PROFILE SOCKETS
8 pin 8p, 14 pin 8p, 16 pin 9p, 18 pin 12p, 20 pin 14p, 22 pin 15p, 24 pin 18p, 28 pin 20p, 40 pin 25p

VOLTAGE REGULATORS
7805 35p, 7812 35p, 7815 35p, 7818 35p, 7824 35p, 7905 35p, 7912 40p, 7915 40p, 7918 40p, 7924 40p, 78L05 28p, 78L12 28p, 78L15 28p, 78L18 28p, 78L24 28p, 79L05 40p, 79L 12p, 79L15 48p, LM309K 100p, LM317K 220p, LM317T 180p, LM323K 420p, LM723 32p, 78HGKC 570p, 78HO5KC 520p, 78GU1C 190p, 79GU1C 215p, 79HGKC 670p

VALVES
DAF96 60p, DF96 50p, DL92 47p, DY86 50p, DY87 50p, DY802 45p, EABC80 50p, EB91 44p, EBF80 45p, EBF89 50p, ECC82 40p, ECC83 43p, ECC84 40p, ECC85 40p, ECH81 49p, ECH84 52p, ECL80 57p, ECL82 59p, ECL84 57p, ECL85 57p, ECL86 49p, EF80 31p, EF85 34p, EF89 43p, EF183 45p, EF184 53EL34 190p, EL36 60p, EL84 50p, EL95 50p, EL500 80p, EL504 100p, EY86 31p, EY87 31p, EY88 42p, EZ35 45p, EZ80 50p, EZ81 55p, GZ34 180p, PC97 100p, PCC85 42p, PCF80 58p, PCF200 135p, PCF801 110p, PCF802 57p, PCF806 115p, PCH200 110p, PCL81 54p, PCL82 63p, PCL84 50p, PCL85 55p, PCL86 55p, PCL805 55p, PFL200 85p, PL36 80p, PL82 45p, PL83 32p, PL84 50p, PL95 140p, PL500 110p, PL504 95p, PL508 170p, PL519 450p, PY81 70p, PY88 48p, PY500A 160p

COMPUTER ICS
2114 200p, 2516 200p, 2532 370p, 2716 300p, 2732 400p, 2764 325p, 27128 1100p, 4116 75p, 4164 350p, 5116 400p, 6264-15 2000p, 6502 320p, 6802 220p, 6809 600p, 6821 150p, 6840 320p, 6850 130p, 8080A 400p, 8085 530p, 8155 470p, 8156 380p, 8250 880p, 8251 470p, 8253 580p, 8255 600p, 8288 1000p, AY3-1015 290p, AY5-3600 570p, SPO256AL2 550p, Z80ACPU 250p, Z80BCPU 500p

Z80ADMA 850p, Z80AP10 280p, Z80BP10 600p, Z80ACTC 280p, Z80BCTC 600p, Z80AS10 680p, Z80AS10/1 700p, Z80AS10/2 700p, Z80ADART 680p

LED
LED 3mm RED 5p, LED 3mm YEL 10p, LED 3mm GRN 10p, LED 5mm RED 5p, LED 5mm YEL 10p, LED 5mm GRN 10p

OPTO ELECTRONICS
2N.5777 40p, OCP71 100p, ORP12 85p, ORP60 100p, ORP61 100p

VERY CHEAP
74 series
74LS series
CMOS

LINEAR IC'S
AN-214P 200p, AN-240 150p, AN-360 120p, AN-7110 140p, AN-7114 160p, AN-7115 160p, AN-7120 140p, AY3-1270 680p, AY3-1350 300p, AY3-8910 360p, AY3-8912 400p, AY5-3600 570p, CA270 40p, CA3046 60p, CA3048 190p, CA3060 280p, CA3080E 70p, CA3086 55p, CA3089E 150p, CA3090AQ 300p, CA3130E 80p, CA3130S 100p, CA3140E 38p, CA3189E 250p, CA3240E 90p, HA-1156W 110p, HA-1197 150p, HA-1306W 170p, HA-1319 250p, HA-1339 170p, H-A1342 170p, H-A1366WR 160p, HA-1368 150p, HA-1377 220p, HA-1389 140p, HA-1397 230p, HA-1397 250p, HA-1398 240p, LA-1201 85p, LA-1352 120p, LA-1365 140p, LA-3301 120p, LA-3350 120p, LA-3361 115p, LA-4030 200p, LA-4031 140p, LA-4032 140p, LA-4050 130p, LA-4051 150p, LA-4100 120p, LA-4101 100p, LA-4102SK 140p, LA-4112 250p, LA-4125 210p, LA-4140 70p, LA-4201 120p, LA-4220 120p, LA-4400 190p, LA-4422 130p, LA-4430 130p, LA-4460 170p, LA-4461 180p, LA-5112 120p, LM301 26p, LM311 35p, LM324 35p, LM325 45p, LM339 40p, LM348 60p, LM380 100p, LM381 150p, LM382 130p, LM387 180p, LM709 DIL 30p, LM723 40p, LM741 DIL 18p, LM741 MET 45p

LM747 58p, LM748 35p, LM1458 33p, LM3900 30p, M-51513L 180p, M-51515BL 270p, M-51516 280p, M-51517L 280p, MB3712 150p, MB3730 260p, MB3756 260p, MC1327 70p, NE55 20p, NE556 40p, SAS560 110p, SAS570 110p, SN76003N 140p, SN76013N 140p, SN76023N 140p, SN76033N 150p, SN6110N 70p, SN76115 70p, T8000 52p, TA-7120 55p, TA-7137P 83p, TA-7146P 400p, TA-193P 400p, TA-7200 200p, TA-7201 200p, TA-7203 180p, TA-7204 110p, TA-7205 80p, TA-7210 200p, TA-7222AP 120p, TA-7310P 100p, TA-7609 270p, TAA550 16p, TBA120S 45p, TBA395 80p, TBA396 60p, TBA520 100p, TBA530 100p, TBA540 100p, TBA560 100p, TBA750 100p, TBA800 35p, TBA810S 60p, TBA820 75p, TBA920 100p, TBA950 100p, TBA990 100p, TCA270 40p, TCA300 200p, TCA940 100p, TDA1170 100p, TDA1412 60p, TDA2002 80p, TDA2003 150p, TDA2020 140p, TDA2030 140p, TDA2522 90p, TDA2530 100p, TDA2532 100p, TDA2540 100p, TDA2560 100p, TDA2593 100p, TDA2690 100p, UPC-555H 60p, UPC-556H 80p, UPC-575C2 100p, UPC-577H 64p, UPC-592H2 95p, UPC-1001H 220p, UPC-1025H 230p, UPC-1026C 105p, UPC-1028H 90p, UPC-1031H2 180p, UPC-1032H 70p, UPC-1155 200p, UPC-1156H 140p, UPC-1181H 115p, UPC-1182H 150p, UPC-1185H2 250p, UPC-1350C 150p

JAPANESE TRANSISTORS
2SB324 55p, 2SB507 68p, 2SB754 80p, 2SC495 60p, 2SC1060 99p, 2SC1061 200p, 2SC1096 78p, 2SC1161 110p, 2SC1172 150p, 2SC1306 90p, 2SC1307 100p, 2SC1678 120p, 2SC1969 130p, 2SC2028 75p, 2SC2029 120p, 2SC2078 120p

PLEASE PHONE US FOR TYPES NOT LISTED HERE AS WE ARE HOLDING 3000 ITEMS AND QUOTATIONS ARE GIVEN FOR LARGE QUANTITIES.
Please add 50p P&P and VAT at 15%. Govt, Colleges, etc. Orders accepted.
Please allow 7 days for delivery. All brand-new Components. All values are new and boxed.

GRANDATA LTD

9 & 12 THE BROADWAY, PRESTON ROAD, WEMBLEY, MIDDLESEX, ENGLAND
Telephone: 01-904 2093 & 904-1115/6
Telex No: 932 885 (Sunmit)

CIRCLE 21 FOR FURTHER DETAILS.

TRANSFORMERS EX-STOCK

MAINS ISOLATORS Pri/Sec 120V×2 (60–1000VA Tap Secs)
VA Price P&P: *20 5.82 1.60; 60 9.49 1.80; 100 11.08 2.00; 200 15.69 2.25; 250 18.97 2.64; 350 23.47 2.70; 500 29.23 2.95; 750 41.28 3.70; 1000 53.00 4.00; 1500 68.37 4.70; 2000 82.27 5.10; 3000 115.35 OA; 6000 203.65 OA
*115 or 240V sec only.

400/440 to 200/240V CT
VA Price P&P: 60 9.50 1.80; 100 11.08 2.00; 200 15.68 2.25; 250 18.97 2.40; 350 23.47 2.70; 500 29.23 2.95; 1000 52.98 4.00; 2000 82.27 5.00; 3000 115.37 OA; 6000 228.75 OA

24/12V or 12-0-12V 2×12V Secs. Pri. 240V
12V 24V Price P&P: 0.3A .15 2.41 .90; 1 .5 3.19 1.20; 2 1 4.25 1.20; 4 2 4.91 1.60; 6 3 7.69 1.60; 8 4 8.98 1.60; 10 5 9.82 1.80; 12 6 10.89 1.90; 16 8 12.97 2.12; 20 10 17.46 2.44; 30 15 21.69 2.64; 60 30 44.45 OA; 83 41 51.20 4.50

96/48V. Pri 2×120V Secs 2×36/48V 60,72,84,96,36-0-36 or 48-0-48V
72/96 36/48V Price p&p: 0.5A 1 5.37 1.20; 2 4 14.69 2.20; 3 6 17.79 2.40; 5 10 32.23 3.20; 6 12 40.36 3.50; 8 16 44.03 3.75

50/25V or 25-0-25V 2×25V Tap Secs Volts available 5, 7, 8, 10, 13, 15, 17, 20, 25, 30, 33, 40, 20-0-20 or 25-0-25V
50V 25V Price P&P: 0.5 1 4.13 1.40; 1 2 5.03 1.50; 2 4 8.69 1.84; 3 6 10.36 1.90; 4 8 14.10 2.12; 6 12 18.01 2.20; 8 16 24.52 2.70; 10 20 30.23 3.00; 12 24 36.18 3.20

60/30V or 30-0-30V Pri 2×120V. 2×30V Tap Secs. Volts available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60, 24-0-24 or 30-0-30V.
60V 30V Price P&P: 0.5 1 4.70 1.50; 1 2 7.15 1.50; 2 4 9.20 1.90; 3 6 13.31 2.00; 4 8 15.15 2.20; 5 10 19.16 2.20; 6 12 21.86 2.65; 8 16 30.72 3.00; 10 20 35.76 3.30; 12 24 41.22 3.50

MINIATURES
Sec V Amp Pri P&P: 3-0-3 .2A 3.11 .90; 6×2 1A×2 3.45 1.20; 9-0-9 .1 2.59 .90; 9×2 .33×2 2.41 .90; 8,9×2 .5×2 3.36 1.20; 8,9×2 1A×2 4.27 1.40; 15×2 .2A×2 2.41 .90; 12-0-12 .05 3.11 .90; 20×2 .3×2 3.39 1.20; 20×2 .15×2 1.50 .50; 20,12,0; 12,20 .9 4.13 1.30; 15,20-2 1A×2 5.60 1.60; 15,27×2 .5×2 4.83 1.40; 15,27×2 1A×2 7.30 1.60; 0-7.5-15V 0-5A 2.53 .90; 0-7.5-15V 4A 6.90 1.40; 0-27V 1A 1.50 .50; 9-0-9V 1A 2.20 .60; 100V/4Ω 10W 3.20; 10W .90
14 DAY WIND SERVICE

30/15V or 15-0-15V 2×15V Tap Secs. Volts available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 25, 27, 30 or 15-0-15V
30V 15V Price P&P: 0.5A 1 3.19 1.20; 1 2 4.32 1.40; 2 4 6.99 1.60; 3 6 8.10 1.85; 4 8 9.67 1.90; 5 10 11.95 2.00; 6 12 13.52 2.00; 8 16 18.10 2.26; 10 20 20.88 2.26; 12 24 23.20 2.50; 15 30 26.60 3.00; 20 40 35.64 4.83

AUTOS 105, 115, 220, 230, 240V For step-up or down
VA Price P&P: 80 4.84 1.40; 150 7.01 1.60; 350 11.84 2.00; 500 13.30 2.24; 1000 24.14 2.80; 1500 28.17 3.20; 2000 42.14 4.00; 3000 71.64 4.80; 5000 108.30 OA

CASED AUTOS 240V cable I/P 115V USA skt outlets
VA Price P&P: 20 7.21 1.50; 80 9.35 1.60; 150 12.10 1.90; 250 14.73 2.00; 500 24.14 2.20; 1000 33.74 2.80; 2000 60.47 4.50; 3000 86.80 5.70

EDUCATIONAL METERS Front finger screw terminals 78×98mm
0-10A DC – £3.98; 0-30V DC – £3.98; .50 p&p

PLEASE ADD 15% VAT TO ALL ITEMS AFTER P&P

INVERTERS 12/24V DC-240V AC
100W £65.15; 250W £172.70; 500W £196.19; 1000W £396.72; 2000W £779.90; 4000W £1160.00

CONSTANT VOLTAGE TRANSFORMERS 1% Spike-free stable mains
250VA £172.40; 500VA £196.69; 1KVA £338.40; 2KVA £594.50; 3KVA £840.00; 4KVA £1266.00; 5KVA £1531.00; 6KVA £1743.00; 7.5KVA £2073.00; 10KVA £3347.00

AVOs & MEGGERs
8Mk6(latest) £138.70; DA211 LCD £68.40; DA2000 LCD £72.80; DA117 AUTO £157.00; Megger Gen £116.40; Batt Megger £85.50; TT169 Transistor Tester £61.30
P&P £2 VAT 15%

WW MODEM PROJECT Transformers T1, T2 £6.90 pair inc VAT, P&P

METAL OXIDE ¼W 5% RESISTORS £1/100 12, 20, 33, 47, 75, 390, 430, 510Ω, 560, 1k, 1k1, 1k3, 1k6, 1k8, 2k, 3k, 3k9, 15k, 16k, 24k, 27k, 39k, 56k, 82k, 100k, 110k, 120k, 130k, 150k, 200k, 220k, 270k, 300k. P&P 20p.

BRIDGE RECTIFIERS
1A 400V .32; 2A 200V .45; 35A 100V £2.60; 50A 100V £3.20; 12.5A 500V £3.40

BARRIE ELECTRONICS LTD
Unit 211, Stratford Workshops Burford Road, London E15 2SP
Tel: 01-555 0228 (3 lines)
WW-6

CIRCLE 75 FOR FURTHER DETAILS.

SALE BY AUCTION

DAY 1 — 12 March, 85

Electronic Test Equipment including: Tektronix 491 Spectrum Analysers, 7704A, 7313 Oscilloscopes, HP.Logic and Network Analysers, 8640 and other Signal Generators, Oscilloscopes. Telequipment Osciloscopes. Marconi Equipment. Plotters, Power Meters, etc, etc.

Computer Equipment including: Qty. new 14" Colour Video Monitors, Texas and Motorola Computer Systems, 40MB Disk Drives, Altos Computer systems, Emulators, 5 Portable Andromeda Computer Systems, Printers and I.C's etc.
Components and General Surplus. In all some 500 lots.

DAY 2 — 13 March, 85

Fork Lift Trucks, Bearings, Hardware. Cable and Wire, Motors, Howden Universal Tension Tester. Fry's Flow Soldering Line, believed unused, Optical Test Stations, Gilt PCBs and General surplus, in all some 450 lots.

Suitable entries still accepted for both days.
Closing date for entries 28 February, 85.
Catalogues available from the Auctioneers. Price £1.50 at:

INDUSTRIAL AUCTIONS LIMITED
Bromyard Road Industrial Estate, Ledbury, Herefordshire.
Telephone Ledbury 5456

Appointments

Advertisements accepted up to 12 noon Tuesday 5 March for April Issue

DISPLAYED APPOINTMENTS VACANT: £19 per single col. centimetre (min. 3cm).
LINE advertisements (run on): £4.00 per line, minimum £25 (prepayable).
BOX NUMBERS: £5 extra. (Replies should be addressed to the Box Number in the advertisement, c/o Quadrant House, The Quadrant, Sutton, Surrey SM2 4AS).
PHONE: IAN FAUX, 01 661 3033 (DIRECT LINE)

Cheques and Postal Orders payable to BUSINESS PRESS INTERNATIONAL LTD. and crossed.

ecm

THE BEST APPROACH

£7,000-£30,000 + CAR

★ **Where does your interest lie:** Graphics; CAD; Robotics; Simulation; Image and Signal Processing; Medical; Automation; Avionics; Acoustics; Weapons; Comms; Radar; Opto and Laser?

★ **Experienced in:** VLSI; Microprocessor Hardware or Software; Digital and Analogue circuitry; RF and Microwave techniques?

★ **There are hundreds of opportunities in:** Design; Test; Sales and Service for Engineers and Managers

★ **For free professional guidance:** Call: 0638 742244 (till 8pm most evenings) or write (no stamp needed) to

ELECTRONIC COMPUTER AND MANAGEMENT APPOINTMENTS LIMITED
FREEPOST, The Maltings, Burwell, Cambridge. CB5 8BR.

(1926)

Electronics Engineers £10,039

Communications Design in High Tech Country

At H.M. Government Communications Centre we're using the very latest ideas in electronics technology to design and develop sophisticated communications systems and installations for special Government needs at home and overseas.

With full technical support facilities on hand, it's an environment where you can see your ideas progress from initial concepts through prototype construction, tests and evaluation, to the pre-production phase, with a chance to influence every stage. Working conditions are pleasant, the surroundings are attractive, and the career prospects are excellent.

Ideally we're looking for men and women who have studied electronics to degree level or equivalent and have had some experience of design, whether obtained at work or through hobby activities. Appointments will be made as Higher Scientific Officer (£7435-£10,039) or Scientific Officer (£5909-£8153) according to qualifications and experience.

For further details please write to the address given below. As our careful selection process takes some time, it would be particularly helpful if you could detail your qualifications, your personal fields of interest and practical experience, and describe the type of working environment most suited to your career plans.

The Recruitment Officer, HMGCC, Hanslope Park, Buckinghamshire MK19 7BH.

(2448)

UNIVERSITY OF LIVERPOOL

INSTITUTE OF MEDICAL AND DENTAL BIO-ENGINEERING

TECHNICIAN

GRADE 3 (ELECTRONICS)

To assist with circuit design, construction and maintenance of electronic control equipment in a medical research laboratory. Candidates must possess O.N.C., Intermediate T.E.C., or appropriate equivalent as minimum qualification plus three years experience which should include general workshop skills.

This post is available for two years.

Salary within range £5399 - £6325 per annum.

Application forms may be obtained from the **Registrar, the University, P.O. Box 147, Liverpool, L69 3BX.**

Quote Ref: RV/938/EWW (2487)

Senior Development Engineer

Granada houses and manages one of a number of small Technical Development Laboratories whose work is funded and directed jointly by all the Independent Television Companies. The function of these laboratories is to investigate new techniques, theories, and equipment in relation to broadcasting in its widest sense.

A vacancy exists for a Senior Development Engineer in the above laboratory. Suitable applicants require basic knowledge of colour television principles and some knowledge of any of the basic technologies encompassed within the general framework of broadcasting. These include colorimetry, optics, magnetic recording and digital and analogue circuit design. Work is undertaken in a purpose-built laboratory and applicants will be responsible for complete projects from specification to final documentation.

This is a specialised appointment providing freedom of expression for men or women of ability. Commencing salary is £12330, with the usual large company benefits including re-location assistance, contributory pension scheme and free Life Assurance.

Written applications including a full cv together with all other relevant information should be sent by 1st March to

Bob Connell,
Ref: A26,
Granada Television Ltd., Quay Street,
Manchester M60 9EA.

GRANADA TELEVISION

An equal opportunity employer

(2479)

SALES ENGINEER

A small division of a large electronics Group involved in the manufacture and marketing of R.F. Test Equipment requires an enthusiastic self-motivated Sales Engineer. Existing knowledge/experience of R.F. Test Equipment and advantage. Potential involvement in U.K. and overseas markets.

Write to: Radio Telephony Test Systems
Enterprise House
Central Way
North Feltham Trading Estate
Feltham Middlesex TW14 0RT

or telephone Mr G Varrall
Mr R Belcher 01-844 1811

(2500)

Analogue Engineers

Required for challenging work in State of the Art Technology

AN OPPORTUNITY TO DEVELOP YOUR SKILLS

If you have high frequency circuit design experience relevant to one of the areas listed below, we would be most interested to hear from you.

- ★ WIDEBAND AMPLIFIERS
- ★ FAST ADC/DAC
- ★ SEMI/CUSTOM ANALOGUE
- ★ FAST PULSE CIRCUITS

GOULD

We are located at Hainault which is on the edge of the Green Belt close to all the facilities of London. Gould designs and builds Europe's leading digital storage oscilloscopes. We offer good working conditions, competitive salary, flexible working hours and assistance with relocation.

Telephone: Mrs. Pat Lawson on
01-500 1000
GOULD INSTRUMENTS LTD.

Electronics (2485)

TELECO

A SONAT COMPANY SONAT

Teleco is a proven innovative company providing Measurement-While-Drilling (M.W.D.) services to major oil companies worldwide. As a result of highly successful technical advances coupled with increased international growth, we are experiencing a period of expansion. Presently we have vacancies for:—

ELECTRONICS TECHNICIANS

The successful candidates will possess practical experience of digital and analogue systems as well as having formal qualifications such as ONC or equivalent C & G qualifications in Electronic Engineering.

Included in the total package of company benefits are competitive salary, contributory pension scheme and good working conditions. Applicants should realise that relocation to the Aberdeen area is essential, and that all positions are shore based.

Removal assistance will be provided.

Interested candidates should write enclosing a C.V. stating salary requirements for the attention of:—

Miss F. Skinner, Assistant Personnel Manager
TELECO OILFIELD SERVICES LTD.
Barclayhill Place, Portlethen, Aberdeen AB1 4PF.

Agency enquiries are not requested.

(2482)

Appointments

Electronic Engineers – What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around **£6,000 – £20,000.**

If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you.

All applications are treated in strict confidence and there is no danger of your present employer (or other companies you specify) being made aware of your application.

TJB ELECTROTECHNICAL PERSONNEL SERVICES,
12 Mount Ephraim,
Tunbridge Wells,
Kent. TN4 8AS.

TJB

Tel: 0892 39388
(24 Hour Answering Service)

Please send me a TJB Appointments Registration form:

Name . . . .

Address . . . .

. . . .

(861)

THE UNIVERSITY OF SUSSEX
SCHOOL OF BIOLOGICAL SCIENCES
Electronics Technician Grade 5

An electronics technician is required to work in the Experimental Psychology Group on an SERC research project on AI and speech recognition. The post is for two years in the first instance. The successful applicant will work with the Laboratory technical staff interfacing audio and digital devices to BBC micros and to a VAX-11/780. Experience with these machines would be an advantage, but some training will be given.

Salary within the scale for **Technicians Grade 5 £6,581 - £7,684 per annum,** depending on age and experience.

Closing date for applications: **February 28th 1985.**

Applications in writing to the **Laboratory Superintendant, School of Biological Sciences, University of Sussex, Falmer, Brighton BN1 9QG.**

(2496)

EXPERIENCED AUDIO/ELECTRONIC ENGINEER

Experienced Audio Electronic Engineer required for progressive company specialising in P.A. Studio Installations. Design & Servicing of Professional Audio Equipment. Digital experience an asset.

Phone 01-609 8282 (2475)

Imperial Chemical Industries PLC
Agricultural Division : Billingham : Cleveland
Catalysts Group

Micromeritics Technologist

The Catalysts Group of Imperial Chemical Industries PLC, Agricultural Division, requires an Experimental Officer working on the provision and development of micromeritic services for the Division.

The job consists of operating and maintaining manual and automatic equipment for the measurement of surface areas, pore size distributions, mercury and helium densities of pellets and powders. Significant skills are required in the interpretation of the data obtained and in communicating these to the experimental and scientific staff of the Division.

The work will be in a laboratory environment and also involves the use of computers for control, calculation and data presentation.

The successful applicant must be self-motivated and capable of independent work. He/she should have a first degree in physics, physical chemistry or materials science and be interested in the utilisation of computers for improving the efficiency of the service provided. Interpretation of the results with respect to the particular material properties will be needed. Their relevance to the particular system being considered will need to be discussed with the customers of the micromeritics service. Previous experience with computers and electronics would be an advantage.

ICI

Remuneration will be commensurate with qualifications and experience. The Company operates house purchase, profit sharing and contributory pension schemes and offers financial assistance towards removal expenses.

Applications giving details of age, qualifications and experience should be sent as soon as possible to:

Mr M A J W Pegg, Personnel Department, Imperial Chemical Industries PLC, Agricultural Division, PO Box No. 1, Billingham, Cleveland TS23 1LB.

(2495)

Dolby Laboratories

Dolby Laboratories manufacture a range of professional audio noise reduction equipment which is used by major recording companies, the cinema industry and broadcasting authorities throughout the world.

TEST DEPARTMENT SUPERVISOR

Reporting to the Production Manager the person appointed will be responsible for planning the flow of products through the department, providing technical support and ensuring high quality. The 17 staff test and trouble-shoot analogue circuits to component level, using ATE where appropriate. The position, which is both demanding and rewarding, would suit a graduate engineer aged 25—40 with supervisory experience in a similar environment.

PRODUCTION ENGINEER (ELECTRONICS)

The person appointed will join a small team which is responsible for technical support to the production department as well as interfacing with sales and design engineers on product improvement and new developments.

The successful applicant — aged between 25 and 35 — will be an electronics engineer with an enthusiastic, practical approach backed up a degree or HNC and several years experience in electronic equipment manufacturing. A keen interest in audio electronics and experience with ATE and CAM would be an advantage.

Salaries will be commensurate with qualifications and experience and assistance towards relocation is given in suitable cases.

The company operates a free life insurance and pension scheme.

For application form write or phone:

Sarah Kennedy, Dolby Laboratories Inc., 346 Clapham Road, London SW9 9AP. Tel: 01-720 1111

2474

Electronic Engineers and Technicians

They're asking for you in Alexandria.

Voluntary Service Overseas is looking for experienced and qualified Electronic Engineers and Technicians to work with and help train members of third world communities in Egypt (University of Alexandria Research Centre) and in Sri Lanka (Chilaw Diocesan Industrial Centre).

Applicants should be aged between 20 and 65, without dependants and willing to accept no more than the 'local' rate of pay.

If you have the right qualities and experience and you're free to go, please believe you're needed urgently!

(For more information, complete and return the coupon now.)

VSO

VOLUNTARY SERVICE OVERSEAS

Why not?

I'm interested in volunteering, my qualifications or experience are ____________

Name ____________

Address ____________

EWW/3/85

Post to Enquiries Unit, Voluntary Service Overseas, 9 Belgrave Square, London SW1X 8PW (S.A.E. appreciated.) Charity No 313757 (2480)

UNIVERSITY OF SUSSEX

Electronics Technician

In the Arts and Social Studies Area. Duties will include maintenance and repaiir of computer terminals and printers, installation and checking of wiring, installation of computers, ordering and keeping stock of spare parts. An interest in computing is desirable.

Salary within **Grade 4 £6,106 – £7,024 per annum,** according to age and experience. Application form from **Susan Cory-Wright, Personnel Office, Sussex House, University of Sussex, Falmer, Brighton BN1 9RH.** Applications must be received by 10th April, 1985. (2499)

HARROW HEALTH AUTHORITY
Northwick Park Hospital & Clinical Research Centre, Watford Road, Harrow, Middlesex. Tel: 01-864 5311

ELECTRONICS TECHNICIAN (MPT Grade IV)

Technician required to service and calibrate a wide range of equipment used for medical, surgical and engineering purposes. The successful applicant will work closely with medical, nursing and other professional staff. The major part of the work involves basic maintenance and repair of the equipment.

O.N.C. or equivalent and three years previous experience is the essential qualification for this post.

Salary: £5404 - £7104, plus London Weighting £623.

For further details and application form please contact the Personnel Department, Ext. 2001.

Closing date: 6th March 1985 (2491)

Civil Aviation College (Gulf States) **DOHA, QATAR**
Required Soonest:

AVIATION ELECTRONICS INSTRUCTOR

1. University Degree in Electronics or Electrical Engineering or equivalent.
2. Qualified and Experienced in the Installation and Maintenance of Aeronautical Radio Systems and Electronics Air Navigational Aid Ground Equipments.
3. Minimum ten (10) years teaching experience in an ICAO recognized training centre.
4. Salary and allowance up to U.S. Dollars 3400 per month.

Applications to:

The Principal
Civil Aviation College (Gulf States)
P.O. Box 4050
DOHA
State of Qatar

(2489)

Appointments

THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND COMMUNICATION ENGINEERING

SENIOR TECHNICAL INSTRUCTOR

Applications are invited for the above position which will be available from July 1985. Applicants should have a higher certificate/diploma/degree qualification and relevant industrial experience. Preference will be given to candidates with a teaching qualification and experience in digital communication systems.

Salary: Senior Technical Instructor I – K16,820, Senior Technical Instructor II – K17,870, (K1 = Stg. 0.9182). Level of appointment will depend upon qualifications and experience.
The initial contract period is for three years. Other benefits include gratuity of 24% taxed at 2%, appointment and repatriation fares, leave fares for the staff member and family after 18 months of service, settling-in and settling-out allowance, six weeks leave per year, education fares and assistance towards school fees, free housing. Salary protection plan and medical benefitt schemes are available.

Detailed applications (two copies) with curriculum vitae together with the names and addresses of three references and indicating earliest availability to take up appointment, should be received by: the Registrar, Papua New Guinea, University of Technology, Private Mail Bag, Lae, Papua New Guinea, by **30 March 1985.**

Applicants resident in United Kingdom should also send one copy to the Association of **Commonwealth Universities (Appts), 36 Gordon Square, London WC1H 0PF**, from whom further general information may be obtained. (2520)

PICCADILLY RADIO 261

PICCADILLY RADIO seeks an ENGINEER

Qualified to HNC/HND to perform varied tasks in a friendly and challenging environment. ILR2 salary plus shift allowance.

Apply:— **Chief Engineer,**
Piccadilly Radio, P.O. Box 261,
Manchester M60 1QU.

Piccadilly Radio — An Equal Opportunities Employer

(2498)

Broadcast Television Electronic Maintenance Engineer

A vacancy exists in our videotape post-production department for a suitably qualified person The applicant should have an appropriate academic qualification and be conversant with modern television post production equipment. MPC has a range of state of the art equipment such as ADO, Mirage and FGS 4000. Shift working is required and remuneration will be based upon qualifications and experience.

Please apply in writing only
with full details to John Beedle

The Moving Picture Company
25 Noel Street, London W1. (2484)

Carlton Television

As a result of continual expansion, Carlton Television has a vacancy for a broadcast Vision Control Engineer, to work on operations both within our 2 studios and on Outside Broadcasts.

Previous experience of broadcast colour cameras and associated equipment is essential.
The salary will be negotiated according to experience.

Applications in writing only to:
Neil Wilson
Carlton Television
St John's Wood Studios
St John's Wood Terrace
LONDON NW8

(2478)

F.W.O. Bauch Limited

Major suppliers of professional audio equipment to the recording and broadcasting industries have vacancies for SERVICE ENGINEERS in their well equipped professional audio laboratory in Boreham Wood.

Relevant electronic experience and an interest in sound recording would be an advantage.

Apply in writing with full C.V. to Christine Melhuish
Personnel Department

F.W.O. Bauch Limited
49 Theobald Street, Boreham Wood, Hertfordshire WD6 4RZ
Telephone 01-953 0091, Telex 27502

(2502)

EALING HEALTH AUTHORITY
EALING HOSPITAL — GENERAL WING

ELECTRONICS TECHNICIAN I

A vacancy exists for an Electronics Technician in this Acute/Maternity Unit. Accountable to the Unit Works Officer the successful applicant will be able to demonstrate technical, supervisory and professional abilities and will be responsible for this E.M.E. Department which serves the District. Applicants should possess an H.N.C. or equivalent in Electronic Engineering and will be paid on the following scale: Applicants must possess a current driving licence.
£9925 — £11489 including London Weighting.
For an informal discussion contact
Mr C H Jones, Unit Works Officer, Tel: 01-574 2444 Ext. 304/5.
Job description and application forms available from **Personnel Department, Ealing Hospital — Genereral Wing, Uxbridge Road, Southall, Middx.**
Tel: 01-5742444 Ext. 344.
Closing date for receipt of application forms 13th March 1985.

(2497)

Appointments

UNIVERSITY OF LIVERPOOL
COMPUTER LABORATORY
TECHNICIAN GRADE 5

to undertake installation and repair work. Ability to fault diagnose and repair electronic equipment (both digital and analogue based) to component level expected. Opportunities also exist for participating in work of small team, developing advanced micro-electronic interfaces includin Ethemet Products. Experience in micro-electronic construction desirable. Successful candidate will be expected to plan his own work schedules based on objectives defined by the Section Manager. Progress reporting, indentification of potential delays and record keeping are important aspects of the work.

Applicants should possess a current driving licence. O.N.C. or appropriate equivalent is minimum qualification plus seven years relevant experience.

Salary within range £6581 - £7684 per annum.

Application forms may be obtained from the Registrar, the University, P.O. Box 147, Liverpool, L69 3BX.

Quote Ref: RV/956 (2511)

MORE JOBS FOUND IN EXTRA

ELECTRONICS & Wireless World

Remember to look at our "Appointments extra" supplement for four more pages of vacancies.

Telecommunications Engineering Technicians

Openings in Servicing and Maintenance Up to £8,873

Our business is to install and maintain the communications equipment used by the Police and Fire Brigades in England and Wales – some of the latest you will find in operation anywhere.

We have a number of vacancies at our Service Centres in various parts of the country, for Telecommunications Engineering Technicians with practical skills in locating and diagnosing faults in a wide range of equipment from computer-based data transmission to FM and AM radio systems.

The work provides excellent opportunities for extending your technical expertise, with specialised courses and training to keep you up to date on developments and new equipment. There are also opportunities for day release to gain higher qualifications.

Applicants, male or female, must be qualified to at least City & Guilds Intermediate Telecommunications standard and possess a current driving licence. Some travelling will normally be involved. Registered disabled persons can of course apply.

The Home Office is an equal opportunities employer.

Salary will be on a scale £6501 to £8873 a year with generous leave allowance and pension scheme.

Good prospects for promotion.

If you are interested in working with us, please write for further details and application forms quoting reference WW/1 to: Miss M Andrews, Home Office, Directorate of Telecommunications, Horseferry House, Dean Ryle Street, London SW1P 2AW.

(2517)

HONI SOIT QUI MAL Y PENSE

Home Office — **Directorate of Telecommunications**

AMPEX is a company at the forefront of magnetic recording technology, which manufactures Professional Video Equipment, Instrumentation Recorders, Disk Drives, Terminals and Magnetic Media.

AMPEX INTERNATIONAL TRAINING, based in Reading, England, is currently expanding and there are several vacancies for Instructors to conduct quality maintenance courses on AMPEX products.

Applicants should be men or women who have experience in one or more of the following areas:

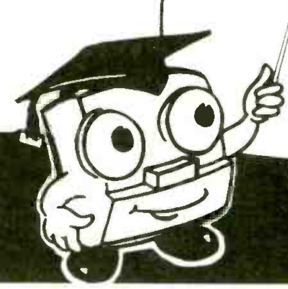
Digital Processing, Professional Video Recording, Digital Magnetic Recording, Microprocessor Based Equipment.

Teaching experience is not essential, as appropriate training will be given.

An attractive salary is offered, together with the usual large company benefits.

For application forms, please contact:
Maureen Brake, Personnel Department,
or John Watkinson, Training Manager.

AMPEX INTERNATIONAL TRAINING



Reading (0734) 875200

AMPEX, ACRE ROAD,
READING RG2 0QR.

(2483)

Appointments

Manager, Production Engineering Services

We have established a new management position in the Technical Operations Department at our Nottingham Production Centre – one of the most modern studios in the UK.

The person appointed will be responsible for the CAR, VT and Vision Control sections and for monitoring their technical performance.

We want someone who combines engineering competence with managerial ability – qualified to at least HND or equivalent with a minimum of five years engineering experience with a studio centre or an equipment manufacturer: experience at or above supervisory level is essential, with the skill to organise and control technical resources in a cost-effective manner. An understanding of TV production operations would be an asset. Candidates' likely age range will be 30-40.

The salary and benefits are attractive and reflect the ability and experience required for the position. If you have the necessary qualities, why not send us your CV?

Personnel Department,
Central Independent Television plc,
East Midlands Television Centre,
Nottingham NG7 2NA.

An equal opportunities employer.

CENTRAL (2510)

£20.00—P/HR.

1) **Microwave Amplifier Design** Canada. 6 months +. £20 P/HR.
2) **High Frequency Trigger Amplifier Design.** 100 MHZ. Essex. 6 months +.
3) **RF Designers.** M.O.D. Herts/Essex. 6-12 months. (2516)

Phone or write:
Roger Howard, C.Eng., M.I.E.E., M.I.E.R.E.
CLIVEDEN CONSULTANTS
92 The Broadway, Bracknell, Berkshire
Tel: 0344 489489

CLIVEDEN

THE UNIVERSITY OF LEEDS

ELECTRONICS TECHNICIAN

Dept. of Physiology

Required to assist in the construction of maintenance of electronic equipment associated with research and teaching of biological studies (under the supervision of the electronics engineer). Must be capable of working from circuit diagrams and sketches. Applicants should hold O.N.C. or equivalent qualifications and have 3-5 years relevant experience (including training period).
Salary will be grade 3 £5,399 - £6,325 p.a.

Applications stating age, qualifications and full experience, together with the name and address of 2 referees, should be addressed to.
Mr. S. Stainthorp.
Dept. of Physiology.
Medical and Dental Building,
University of Leeds,
Leeds LS2 9JT. (2515)

BCS LABORATORY DEPUTY HEAD

Due to expansion we have a vacany for on experienced standatds engineer to carry out calibration on DC and LF instrumentation in our laboratory, which is approved by the British Calibration Service.
This position would ideally suit someone in the calibration gield wishing to futher their career prospects. Experience in this type of environment is a necessity.

An attractive salary, pension and BUPA benefits will be offered, also relocation expenses where applicable.

Apply in writing giving details of employment to date:
Mr. J. Macalister
GMR Ltd.,
Unitig,
Salisbury Square, Radford,
Nottingham. (2518)

SATELLITE RECEPTION RESEARCH ASSISTANTS

Monitoring Service

With the advent of satellite communications, broadcasting and news agency organisations are switching from conventional means to satellites for their transmissions. Satellite Reception Research Assistants will be involved in the Monitoring Service's work in this field.

Duties include frequency scanning and the compilation of transmission schedules. Extensive experience in communications with C and G Intermediate Telecommunications Technicians Certificate or equivalent qualification and a thorough grasp of satellite communications are essential. Knowledge of major broadcasting systems, familiarity with news agency transmissions and the ability to recognise a range of languages an advantage.

Applicants will be required to take written tests and appointment will be subject to satisfactory hearing tests. Shift work involved.

Salary £7,867—£9,761. Plus 10% shift allowance. Based Caversham Park, Reading. Relocation expenses considered.

Write or telephone immediately for application form (enclosing addressed, foolscap envelope and quote ref. 2037/WW), to **Senior Personnel Officer, BBC Monitoring Service, Caversham Park, Reading, Berkshire RG4 8TZ. Tel: (0734) 472742. Ext. 212.**

We are an equal opportunities employer

BBC

(2507)

BORED ?

Then change your job!

1) **Test Engineer**
To work on inter active video systems and data acquisition equipment. Berks. To £10,500.
2) **Field Service Engineers**
To work on mobile radio communications. Berks. To £7,500.
3) **Test Engineers**
Working an analogue digital control systems for radio and microprocessor equipment. Surrey. To
4) **Service Engineer**
To work on computer peripheral equipment. Berks. To £2500
5) **Technical Author**
Naval hardware systems. Surrey. To £11,000
6) **Junior Electronics Development**
Involved in the design of colour and monochrome TV monitors. HNC/HTC+. Bucks. To £10,000.

Hundreds of other Electronic and Computer vacancies to £12,500
Phone or write:
Roger Howard, C.Eng., M.I.E.E., M.I.E.R.E.
CLIVEDEN CONSULTANTS
92 The Broadway, Bracknell, Berkshire
Tel: 0344 489489 (1640)

CLIVEDEN

Classified

THE SERVICES SOUND AND VISION CORPORATION
BROADCAST AND ELECTRONIC ENGINEERS

Required for Broadcast operations and engineering in the Services Sound and Vision Corporation which provides radio and television services to the British Forces and their dependants abroad. Candidates (preferably aged 22 - 35) should be educated to HND standard in electrical and electronic engineering and have work experience in the broadcasting or related industry.

The work, often overseas, includes the operation, maintenance and installation of the full range of professional radio studio equipment and Medium Wave and VHF broadcast transmitters.

Good salary and allowances paid together with fringe benefits. There are also prospects of promotion to higher grades and opportunities for training and transfer to Television and other departments of the SSVC.

Please apply in writing to:
Mrs Anna Sive, Personnel Officer
The Services Sound and Vision Corporation,
Chalfont Grove Narcot Lane, Gerrards Cross, Bucks SL9 8TN (2504)

DESIGN AND DEVELOPMENT ENGINEER

Experienced engineer required to join small electronics company involved in design and manufacture of telecomms products for BT and other PeT authorities.

Applicants should have experience in line equalisation equipment, filters, SMPS and automatic testing using microprocessor techniques.

Qualifications to degree or HNC with suitable experience. Attractive salary + usual benefits to right person.

Application to include current c.v. to:
Kenton Research Ltd. Europe Trading Estate, Erith, Kent DA8 1QL.
Telephone: (032 24) 419 33
(2519)

Dont Forget!

for your classified adverts ring

Ian Faux

01 661 3033

When replying to classified advertisements, readers are recommended to take steps to protect their interests before sending money
(2519)

BIO-ENGINEERING OPPORTUNITIES IN SAUDI ARABIA

General Arabian Medical and Allied Services Ltd. are management consultants and agents for the recruitment of staff to the Riyadh Al Kharj Hospital Programme in Saudi Arabia. The programme comprises three hospitals including the 600 bed Riyadh Armed Forces Hospital and provides a very high standard of health care to members of the Armed Forces of Saudi Arabia and their families.

The Department of Medical Physics and Bio-Engineering has programme-wide responsibilities and with a mainly British staff of more than 40, is the largest department of its kind in the Middle East. A very wide range of clinical support and development work is undertaken by our well qualified professionals. Successful candidates will have the opportunity to widen their experience in a busy modern department with excellent facilities allowing them to achieve the high standard of work expected of them.

Further expansion of the department's activities, including a commitment to provide technical support for medical equipment on the Kingdom's fleet of Lockheed C-130 Hercules "flying hospitals" and air ambulances has created the need for additional qualified bio-engineering technicians

MEDICAL ELECTRONICS TECHNICIANS
ANAESTHETIC EQUIPMENT MAINTENANCE TECHNICIANS
SALARY c £16,230 -- £18,234 pa tax free incl. bonus

The above posts are offered on the Medical Physics Technical Officer (Bio-Engineering) grade, equivalent to the NHS grade III MPT. Qualifications to OTEC or equivalent level is essential; HTEC and/or some years of relevant experience is highly desirable.

There are also Locum positions available for medical physics technical officers for a period of not less than three weeks.

Benefits

Contracts are normally offered for a two-year initial term and include free fully furnished accommodation; four weeks leave after every six months' service; free air fares (including leave flights); free health care and extensive recreational facilities. The bonus will be paid on completion of the contract.

Salaries for these single status positions are paid in Saudi Riyals and the sterling salaries quoted are calculated at the current rate of 4.1 Saudi Riyals = £1.

For further information apply with a detailed C.V. or telephone for an application form.

Susan Grice, Recruitment Officer,
GAMA INTERNATIONAL LTD.,
6 Duke of York Street, London SW1Y 6LA.
Telephone: 01-839 6843.
(2508)

BUSINESS OPPORTUNITY

SOUTH SHROPSHIRE DISTRICT COUNCIL
SWITCHBOARD AND TELEPHONE INSTALLATION

The Council need to replace their present switchboard arrangements and telephone installation for the Council Offices, Stone House, Corve Street, Ludlow.

A specification giving details of the Council's requirements and a form of tender is available from the undersigned.

Completed forms of tender must be received by not later than 12 noon on Monday 18th March 1985.

G. Kellet, Chief Executive,
Stone House, Corve Street, Ludlow, Shropshire.
Tel: Ludlow 2381 Ext. 22.
(2516)

ARTICLES FOR SALE

DRIOTWICH STANDARD FREQUENCY RECEIVER

Outputs, 1MHz, 10MHz
Phase locked crystal oscillator. Complete with ferrite rod aerial, usable throughout U.K. Now available in updated version.
£185.00
R.C.S. Electronics, Wolsey Road, Ashford, Middx. Phone 53661. (2656)

Classified

ARTICLES FOR SALE

BRIDGES waveform/transistor analysers. Calibrators, Standards. Millivoltmeters. Dynamometers. KW meters. Oscilloscopes. Recorders. Signal generators — sweep, low distortion, true RMS, audio, FM, deviation. Tel. 040 376236. (1627)

QUARTZ CRYSTALS OSCILLATORS AND FILTERS of all types. Large stocks of standard items. Specials supplied to order. Personal and export orders welcomed — SAE for lists please. OEM support thru:- design advice, prototype quantities, production schedules. Golledge Electronics. Merriott. Somerset TA16 5NS. Tel: 0460 73718 (2472)

ENCAPSULATING EQUIPMENT FOR coils, transformers, components, degassing silicone rubber, resin, epoxy. Lost wax casting for brass, bronze, silver, etc. Impregnating coils, transformers, components. Vacuum equipment, low cost, used and new. Also for CRT regunning metallising. Research & Development. Barratts, Mayo Road, Croydon CR0 2QP. 01-684 9917. (9678)

MORSE READING PROGS. Work on clean signals without hardware interface. ZX81 1K UNEXPANDED MEMORY. Translated code with word and line spaces for easy reading Automatic scroll action. £7 incl. (2532)

OPTOELECTRONICS DATA BOOK 1984

Price by Texas £6.00

DIGITAL ELECTRONIC CIRCUITS & SYSTEMS by N.M. Morris PRICE: £5.45

MICROELECTRONICS: A PRACTICAL INTRODUCTION by R.A. Sparkes PRICE: £8.50

SOLDERING IN ELECTRONICS by R.J. Klein Wassin Wassink PRICE: £51.00

OPTICAL FIBER COMMUNICATIONS BY G. Keiser PRICE: £9.50

DIGITAL IMAGE ANALYSIS by S. Levialdi PRICE: £26.00

SEMI-CUSTOM IC DESIGN & VLSI by P.J. Hicks PRICE: £13.50

INTRODUCTION TO MOS LSI DESIGN by J. Mavor PRICE: £18.50

HANDBOOK OF BATTERIES & FUEL CELLS by D. Linden PRICE: £63.00

THE DESIGN & DRAFTING OF PRINTED CIRCUITS by D. Lindsey PRICE: £41.50

★ *ALL PRICES INCLUDE POSTAGE* ★

THE MODERN BOOK CO.

BRITAIN'S LARGEST STOCKIST of British and American Technical Books

19-21 PRAED STREET LONDON W2 1NP

Telephone: **01-402 9176**

Closed Saturday 1 p.m.
Please allow 14 days for reply or delivery

(2245)

VINTAGE VALVE SPARES — Valves, Radios, Amplifiers, Service Data. Antique Wireless Newsheet sample upon request. Mail Order Only. Vintage Wireless Co., Cossham Street, Mangotsfield, BRISTOL BS17 3EN. Tel: 0272-565472 (2471)

CALCOMP FLAT bed plotter 8" × 6" ex ministry hever beem used since with controller and all cables and plugs day 01-878 2090 eve/w.e. 948 1049 (2513)

WAVEGUIDE, Flanges and dishes. All standard sizes and alloys (new material only) from stock. Special sizes to order. Earth Stations, 01-228 7876, 22 Howie Street, London SW11 4AR. (2099)

WANTED

WANTED

Test equipment, receivers, valves, transmitters, components, cable and electronic scrap and quantity. Prompt service and cash. Member of A.R.R.A.

M & B RADIO
86 Bishopsgate Street
Leeds LS1 4BB
0532 435649

(9956)

WANTED

SURPLUS ELECTRONIC COMPONENTS AND EQUIPMENT

We also welcome the opportunity to quote for complete factory clearance

B. BAMBER ELECTRONICS
5 STATION ROAD, LITTLEPORT, CAMBS.
Phone: Ely (0353) 860185

(2483)

★ MICROCOMPUTERS
★ PERIPHERALS
★ INSTRUMENTATION

For fastest, best CASH offer, phone,

COMPUTER APPRECIATION
Oxford (0865) 55163
Telex 838750

(2492)

ARTICLES FOR SALE

Eurocard Power Supplies

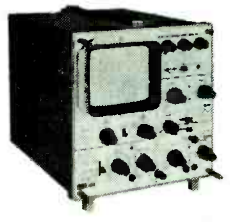
5v @ 1A, 1.5A, 3A, and 5A
Options: ±12v @ 100mA for RS232, Crowbar, 12 or 15v main output, Front Panel with IEC mains SKT.
Prices from £15 for IA kit (£23 built) + VAT for details contact:
Sleevemain Ltd., dept WW, P.O. Box 512, Windsor, Berks SL4 4NU. (2501)

65C02 CMOS MICROCONTROLLER. Uses BBC Computer as host. Boild standalone controllers simply quickly. Bare boards or built & tested. Large s.a.e. for details or technical manual £2.50: Nikam Electronics Ltd 25 Suffolk Drive. Lacey Green. Wilmslow Cheshire SK9 4DE (2512)

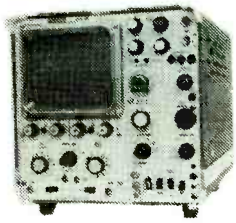
Sullivan Decade capacitor **£49**, FM/AM Generator **£89**. Sweep Generator (TV) **£69**. Thermocouples **£2.50 ea.** Chart Recorders, 2, 6, 20 channel. Data Logger. Anemometer. Small earboxes **£5 ea.** Oexion Guillotine **£18**. Valve testers. Ignition Analyser **£39**. Centrifuge. Wow/Flutter meter. W-K Video Oscillator. Large stage, micrometer operated microscope **£89**. Stereo headsets **£6**. Tektronix Calibrator/Time Mark Generator **£79**. Calibration Digital Voltmeter **£85**. Vibration Analyser **£65**. Film Processor **£75**. Matrix Programmer **£30**. Casselle Micro-manometer **£49**. Bransom Ultrasonic Generator **£29**. Sirett Proportional Temperature Controller **£45**. Colour Distortion Meter **£75**. T&R Simulator Main Alternator Control **£45**. Dynatron Pulse Analyser **£39**. Stabilised PSU's Creed Teleprinter Terminal **£65**. Spot-welding Heads, capacitance, D.C., etc. welding, thermocouples, circuit connections, dissimilar metals etc. etc. **£45**. General Radio UHF Admittance meter **£25**, Multiple Battery Substitution PSU **£35**. Surface Guage (Micro-mches) **£29**. Switched 1,2,3,4,5 KV EHT Supply **£30**. etc. etc.

040 376236 (2016)

SMALL SELECTION ONLY LISTED RING US FOR YOUR REQUIREMENTS WHICH MAY BE IN STOCK



Portable Battery or Mains Oscilloscope. SE Laboratories 111 Oscilloscope — Solid State — General purpose — Bandwidth DC to 18/20MC/S at 20MV/CM — Dual Channel — Rise time 19NS — Calibrated Sweep — Calibrator — Display 10CMS×8CMS — Power AC — 95 Volts to 100-190 Volts to 260 or 24 Volt DC battery — Size. W.25.5.CM — H25.5CCMS — 56CMS Deep — WT11.4KGS — Carrying handle — Tested in fair condition with operating instructions £120.00.



Latest Bulk Government Release — Cossor Oscilloscope CDU150 (CT531/3) £150 only. Solid state general purpose bandwidth DC to 35MHz al 5MV/CM — Oual Channel — High brightness display (8×10cm) Full delayed time base wilh gated mode — Risetime 10NS — Illuminated graticule — Beam finder — Calibrator 1KHz squarewave — Power 100 — 120V.200V — 250 volts AC — Size W 26CM — 41CM deep — WT 12.5 K.G. carrying handle — colour blue — protection cover fronl containing polarized viewer and camera adaplor plale — probe (1) — Mains lead. Tested in Fair condilion with operating instructions — £150.00.

Communication Recievers. Racal **500KC/S to 30MC/S in 30 bands 1MC/SWIDE** — RA17 MK11 **£125**. RA17L **£150**. RA117E **£200**. New Metal Louvred Cases for above **£25. All receivers are air tested and calibrated in our workshop — supplied with dusl cover — operation instructions — circuit — in fair used condition.** Racal Synthesisers **(Decade frequency generalors)** MA350B **Solid State for use with — MA79 — RA217** — RA1218 **Etc £100 to £150**. MA250 — **1.6MC/S to 31.6 MC/S £100**. MA1350 **for use with RA17 receiver £100.** MA259G **Precision frequency standard 5MC/S — 1MC/S — 100KHz £100 to £150**. Panoramic Adaptor **RA66 £150**. RA137 and RA37 **£40 to £75 LF convertors 10 to 980KC/S**. RA218 **Independent SSB unit £50** RA98 **SSB-ISM Covertor £50**. RA121 **SSB-ISB convertor £75.** EC964/7K **Solid state — single channel — SBB — mains or battery — 1.6 to 27.5 MC/S and 400 to 535KHz £100 with manual** Plessey PR155G **Solid State 60KC/S — 30MC/S £400**. Creed 75 Teleprinters — **Fitted tape punch and gearbox for 50 and 75 bauds — 110volts AC supply — in original transport tray sealed in polythene — lik new £15EA. Redifon TT11 Audio Teleprinter convertor receiver solid state — supply 110 or 240AC — Made for use with above teleprinter enabling print-out of messages recieved from audio input of communication receiver £15 with circuit tested.** Redifon TT10 Con**vertor as above but includes transmit facilities £20.** Oscilloscopes — stocks always changing **Tektronix 465** — 100MC/S £750. **FM Recorder** Sanghmd Sabre 111 14 channels £350. **Transtel Matrix printers — AF11R** — 5 level Baudot Code — up to 300 Bauds — for print out on plain teleprinter paper £50 to £100. **Transtel AH11R** — As above but also 8 level ASC11 (CCITT No 2 and CCITT No. 5) Like new £100. **Army lield telephone sets.** Type F — L and J — Large quantity in stock £6 to £15 depending on type and quantity P.D.R. **Don 10 Telephone Cable** — half mile canvas containers £20. **Night viewing infra-red AFV periscopes** — Twin Eyepiece — 24 volt dc supply £100ea. Original cost to government over £11,000ea. **Static invertors** — 12 or 24 volt input — 240 volt AC sinewave output — various wattages P.O.R. **XY Ploters and pen recorders** various — P.O.R. **Ferrograph series 7 Tape recorders** mono £100, stereo £150. **Signal Generators various — TF995/A3** £60. **TF801D/8s** — 10MC/S to 485MC/S £90 **TF144H/A4** £90. **TF1060/2** £60. **HP606A** — £90 £140 **HP608** £50 **HP614A** £100 **HP618B** £100 **HP620A** £100. **Marconi TF1064B/5** £100 **TF791 Deviation meter** £100 **TF893A Power meter** £50 **Aerial mast assembly** 30ft high complete with 16ft whip aerial to mount on top – guyropes – insulators – Base and Spikes etc., in heavy duty carrying bag – new £30. **Racal frequency counter** Type 836 £50 **Tektronix plugs-ins** — 1A1 £50, 1A2 £40, 1A4 £100 M£50. All items are bought direct from H.M. Government being surplus equipment: Price is Ex works. S.A.E. for enquiries. Phone for appointment for demonstration of any items. Also availability or price change. V.A.T. and carriage extra.

EXPORT TRADE AND QUANTITY DISCOUNTS GIVEN

JOHNS RADIO (0274) 684007
WHITEHALL WORKS,
84 WHITEHALL ROAD,
EAST BIRKENSHAW, BRADFORD
BD11 2ER

WANTED: REDUNDANT TEST EQUIPMENT — RECEIVING AND TRANSMITTING EQUIPMENT — VALVES — PLUGS — SOCKETS SYNCHROS ETC.

(2743)

SERVICES

PCB Fault Location and Repair. Jaecrow Systems Services, 29/31 Lower Coombe Street, Croydon, Surrey CR9 1LX, Britain's leading maintenance company, now offers a fast board diagnosis and repair service UK and overseas, using the latest ATE. Ask for full details, without obligation Ring: 01-680 9191. Quote ref: EW385 (2471)

PROFESSIONAL DESIGN SERVICE. Analogue/RF circuit/System design. Specialising in microwave amplifier, oscillator and network design. MOTOROLA 6805/6809 series microprocessor design/development capability. All work carried out to a high standard by competent professional engineers. Trontech Electronic Design Services Ltd., Unit 8B, Rose Industrial Est., Bourne End, Bucks. 06285 28835 (2439)

TURN YOUR SURPLUS i.cs transistors etc. into cash, immediate settlement. We also welcome the opportunity to quote for complete factory clearance. Contact COLES-HARDING & CO, 103 South Brink, Wisbech, Cambs. 0945 584188. (9509)

DESIGN AND DEVELOPMENT SERVICE. RF transmitters and receivers. Telemetery U.H.F. V.H.F. Anologue and digital circuits, control systems. Full manufacturing facilities. RCS Electronics, Wolsey Road, Ashford, Middx. Phone Dr. Eric Falkner on 53661. (2637)

FOR THE BEST PCB SERVICE AVAILABLE

★Circuit Design & Development
Digital and Analogue

★Artwork Layout
PCB artwork layout and mechanical detailing. P.O. approved standard.

★Board Manufacture
Prototype to semi-production, excellent rates.

★Wiring & Assembly
PCB assembly, wiring and cable forming. Flow soldering facilities available.

★Test
Full test facilities available.

One or all services available. Please telephone Chelmsford (0245) 357935, or write to HCR Electronics, The Industrial Unit, Parker Road, Chelmsford. (30mins from Liverpool Street St.) (1169)

DESIGN AND MANUFACTURE. ANALOGUE, DIGITAL, RF AND MICROWAVE CIRCUIT AND SYSTEM DESIGN. Also PCB design, mechanical design and prototype/small batch production. — **Adenmore Limited**, 27 Longshot Estate, Bracknell, Berks. Tel: Bracknell (0344) 52023. (656)

SMALL BATCH PCBs, produced from your artwork. also DIALS, PANELS, LABELS. Camera work undertaken. FAST TURNAROUND. Details: Winston Promotions, 9 Hatton Place, London EC1N 8RU. Tel. 01-405 4127/0960. (9794)

VIDEO DESIGN, development and consultants delay lines, filters, attenuators and amplifiers design, development and manufacture full test facilities. Contact Faraday Technology Ltd., Unit 2, Brampton Industrial Estate, Newcastle, Staffordshire. Tel: Newcastle (0782) 661501. (2454)

IMPROVE YOUR PROSPECTS

with skills that employers want – learn the easy way with modern home study courses from Ideal Schools.

MODERN ELECTRONICS
Train for success in the fastest ever growing industrial sector.

COMPUTER PROGRAMMING
The demand for Programmers is increasing constantly – don't miss out!

For free booklet write today to

(2774)

IDEAL

IDEAL SCHOOLS
(Ref. EW2)
60 St. Enoch Sq
Glasgow G1 UK.
Tel: 041-248 5200

WANTED

CIRCOLEC
THE COMPLETE ELECTRONIC SERVICE
Artwork, Circuit Design, PCB Assembly, Test & Repair Service, Q.A. Consultancy, Prototypes, Final Assembly. Full PCB Flow Soldering Service.
Quality workmanship by professionals at economic prices.
Please telephone **01-646 5686** for advice or further details.
TAMWORTH MANOR
302-310 COMMONSIDE EAST, MITCHAM
(1391)

E C COMPONENTS
We buy large and small parcels of surplus I/C, transistors, capacitors and related electronic stock. Immediate settlement.
Tel: 01-208 0766
Telex: 8814998
(2491)

SURPLUS
We offer good prices for test equipment, components, redundant computers, PCB's connectors. Immediate settlement.
TIMEBASE
94 Alfriston Gardens
Sholling, Southampton SO2 8FU
Telephone: (0703) 431 323
(1832)

TO MANUFACTURERS, WHOLESALERS BULK BUYERS. ETC.
LARGE QUANTITIES OF RADIO. TV AND ELECTRONIC COMPONENTS FOR DISPOSAL
SEMICONDUCTORS, all types, INTEGRATED CIRCUITS, TRANSISTORS, DIODES, RECTIFIERS, THYRISTORS, etc. RESISTORS, C/F, M/F, W/W, etc. CAPACITORS, SILVER MICA, POLYSTYRENE, C280, C296, DISC CERAMICS, PLATE CERAMICS, etc.
ELECTROLYTIC CONDENSERS, SPEAKERS, CONNECTING WIRE, CABLES, SCREENED WIRE, SCREWS, NUTS, CHOKES, TRANSFORMERS, etc.
ALL AT KNOCKOUT PRICES – Come and pay us a visit ALADDIN'S CAVE
TELEPHONE: 445 0749/445 2713
R.HENSON LTD.
21 Lodge Lane, North Finchley, London, N.12
(5 minutes from Tally Ho Corner)
(1613)

WANTED: Ex.-RAF Air — publications, manuals, ect., from 1938 onwards relating to transmitters — receivers, navigation equipment and radar. Excellent price paid. M. Gee 29 Studland House Aston Street London E14 7NL Phone 01-254 9083 evenings. (2514)

WANTED: Recording Equipment of all ages and variety. Microphones, outboard, etc. Dan Alexander 965 Hilldale Berkeley, Ca. 94708 USA (415) 5271411 (2493)

STEWART OF READING
110 WYKEHAM ROAD
READING RG6 1PL
TEL NO: 0734 68041
TOP PRICES PAID FOR ALL TYPES OF SURPLUS TEST EQUIPMENT, COMPUTER EQUIPMENT, COMPONENTS etc. ANY QUANTITY. (2616)

BUSINESS OPPORTUNITY

PROFITABLE DISTRIBUTORS of specialised electrical and electronic service tools and equipment, catering equipment and hardware for sale. Profits c. £10,000 p.a. Reply Smallfield, Cody & Co, 24 Portland Place, London W1N 4AU. (2495)

The Publishers take all reasonable care to ensure that classified advertisements are genuine, but readers must satisfy themselves that they will be obtaining what they require before entering into transactions, particularly if they involve large sums of money. (2519)

CAPACITY AVAILABLE

TW ELECTRONICS LTD
THE PCB ASSEMBLERS
More and more companies are investigating the advantages of using a professional subcontractor. Such an undertaking requires certain assurances.
TW are able to satisfy all of them – quality, competitive pricing, firm delivery and close co-operation with the customer.
Assembled boards at 100% inspected before flow soldering and reinspected after automatic cropping and cleaning.
Every batch of completed boards is issued with a signed certificate of conformity and quality – our final assurance.
For further details, contact us at our new works:
Blenheim Industrial Park
Bury St. Edmunds
Suffolk IP33 3UT
Telephone: 0284 3931 (1466)

FREE P.T.H. PROTOTYPE of the finest quality with EVERY P.C.B. artwork designed by us. Competitive hourly rates, and high standard of work. Halstead Designs Limited, 34, High St., Halstead, Essex. Tel. (0787) 477408/474554. (2126)

VALVES, PROJECTOR Lamps, 6000 types, list 75p. world wide export. Cox radio (Sussex) Ltd., The Parade, East Wittering, Sussex. Phone (0243) 672023 (1991)

• Layout • Fast service
• Artwork • Competitive
pcb design
0386-832152
Williams P.C.B. Artwork, 49 Westbourne, Honeybourne, Evesham, Worcs. WR11 5PT
(2537)

CLASSIFIED ADVERTISEMENTS
Use this Form for your Sales and Wants

PLEASE INSERT THE ADVERTISEMENT INDICATED ON FORM BELOW

To "Wireless World" Classified Advertisement Dept., Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS

- Rate £4.00 PER LINE. Average six words per line. Minimum £25 (prepayable)
- Name and address to be included in charge if used in advertisement
- Box No. Allow two words plus £5
- Cheques, etc., payable to "Business Press International Ltd." and cross "& Co."

NAME ....
ADDRESS ....
....
....

			REMITTANCE VALUE .... ENCLOSED		

PLEASE WRITE IN BLOCK LETTERS. CLASSIFICATION .... NUMBER OF INSERTIONS ....

CIRCLE 92 FOR FURTHER DETAILS.

ELECTRONICS & Wireless world

INDEX TO ADVERTISERS

Appointments Vacant Advertisements appear on pages 92 — 103

PAGE

AEL Crystals 4
Airlink Transformers 84
AM Electronics 84
Amplicon Electronics 55
Andelos Systems 42
Antex Ltd .... Inside back cover
Armon Products Ltd 48
Aspen Electronics 14
Automation & Control Tech 27

Barrie Electronics 90
Beckenham Peripherals 24
Black Star Ltd 64
Branson, S.J. 74
Bull, J. (Electrical) Ltd 88

C&A Electronics 89
Cambridge Kits 64
Cambridge Micro Processor 58
Carston Electronics 14
CIL Electronics 56/57
Clark Masts Ltd 30
Computer Appreciation 104
Conguin Software .... back cover
Cricklewood Electronics 83
Crotech Instruments 89
Cymbernetic Applications 9

Dataman Design 5
Dedicated Micro Processors 48
Digitask Business Systems 84
Display Electronics 86/87

EDA Software 53
Electronic Brokers 10/11, 13
Electronic Equipment Company 9
Ellmax Electronics 27
Electrovalue 40
Eltime Ltd 51
EMS Manufactures 75
Essex Electronics 64

PAGE

Farnell Instruments .... Inside front cover
Field Electric Ltd 1
Fylde Electronics 36

Gemini Microcomputers 40/41
Gould Instruments 48
GNC Electronics 14
Grandata Ltd 90
Greenwood Electronics 27

Hameg Oscilloscopes 4
Happy Memories 75
Harris Electronics 24
Harrison Bros 48, 64
Hart Electronics 91
Henrys/Audio Electronics 39
Hi-tech 15
HRS Electronics 89
HW International 76
Henson, R. Ltd 30

ILP Electronics 9, 35
IMS Electronics 53
Industrial Auctions Ltd 90
Interface Quartz Devices Ltd 36
Irvine Business Systems 51

Keithley Instruments 21
Kemo Ltd 53
Kimberry Ltd 30

Langrex Supplies 85

Martin Associates 42
Midwich Computer Co 47
Monolith Electronics 14

Newrad Instruments Case's 1
Northern Amateur Radio Society Association 14
Number One Systems 12

PAGE

Omnitest Ltd 24

Pantechnic 88
Philips Personal Computers 4
P.M. Components 22/23
Pye Unicam 65

R. Henson Ltd 30
Radford Electronics 4
Radiocode Clocks 1
Raedek Electronics 77
Research Communications 24

Service Trading Co 12
S.J. Branson 74
Sherwood Data Systems 88
Special Products (Distributors) 40
Stewart of Reading 76
Strumech Engineering 64
Surrey Electronics 42
Sowter, E.A. Ltd 76

Taylor Bros 74
Technomatic Ltd 28/29
Television 30
Thandar Electronics 35, 75
Thanet Electronics 51
Thorn EMI Datatech 58
TK Electronics 74
Triangle Digital Service 12
Time Electronics 91
Thurlby Electronics 16

Vigilant Communications Ltd 42

Waugh Instruments 84
Withers Communication(R) 36

OVERSEAS ADVERTISEMENT AGENTS

France and Belgium: Pierre Mussard, 18 — 20 Place de la Madelaine, Paris 75008.

Hungary: Ms Edit, Bajusz, Hungexpo Advertising Agency, Budapest XIV, Varosliget.
Telephone: 225 008 — Telex: Budapest 22-4525 INTFOIRE

Italy: Sig C. Epis, Etas-Kompass, S.p.a. — Servizio Estero, Via Mantegna 6, 20154 Milan.
Telephone: 347051 — Telex: 37342 Kompass.

Japan: Mr Inatsuki, Trade Media — IBPA (Japan), B.212. Azabu Heights, 1.5.10 Roppongi, Minato-ku 106.
Telephone: (03) 585 0581.

United States of America: Jay Feinnan, Business Press International Ltd, 205 East 42nd Street, *New York*, NY 10017 — Telephone (212) 867-2080 — Telex: 23827.
Jack Farley Jnr., The Farley Coi. Suite 1584, 35 East Walker Drive, *Chicago*, Illonois 60601 — Telephone (312) 63074.
Victor A. Jauch, Elmatex International, P.O. Box 34607, *Los Angeles*, Calif. 90034, USA — Telephone (213) 821-8581 — Telex: 18-1059.
Jack Mantel, The Farley Co., Suite 650, Ranna Building, *Cleveland*, Ohio 4415 — Telephone (216) 621 1919.
Ray Rickles, Ray Rickles & Co., P.O. Box 2028, *Miami Beach*, Florida 33140 — Telephone (305) 532 7301.
Tim Parks, Ray Rickles & Co., 3116 Maple Drive N.E., *Atlanta*, Georgia 30305. Telephone (404) 237 7432.
Mike Loughlin Business Press International, 15055, memorial Ste 119, *Houston*, Texas — Telephone (713) 783 8673.

Canada: Colin H. MacCulloch, International Advertising Consultants Ltd., 915 Carlton Tower, 2 Carlton Street, Toronto 2 — Telephone (416) 364 2269.
*Also subscription agents.

Printed in Great Britain by Index Printers Ltd., Oldhill, Dunstable, and typeset by Legendary Characters, South Street, Lancing, for the proprietors, Business Press International, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. © Business Press International 1984. *Wireless World* can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd., Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency Ltd: Willian Dawson & Sons (S.A.) Ltd. UNITED STATES: Eastern News Distribution Inc., 14th Floor, 111 Eighth Avenue, New York, N.Y. 10011.

ANTEX
a world of soldering

Tomorrows Soldering Technology Today.

ANTEX has a worldwide reputation for quality & service & for many years has been one of the best known & most popular names in soldering. Always at the forefront of technology, ANTEX is continually researching new and better ways of achieving more accurate, reliable, and cost effective soldering. On ANTEX Soldering Irons, the advanced design of the interface between the element & the bit allows more efficient heat transfer to the bit and improved stability of the temperature at the point of contact with the work. Indeed, experiments have shown that an XS25 watt iron can be used for tasks where a 40 watt iron would normally have been required.

ANTEX Soldering Irons exhibit exceptionally low leakage currents & hence are suitable for use on Static Sensitive Devices. Sophisticated temperature controlled soldering units have recently been added to the ANTEX range.

Model C – 15 Watts. Available for 240, 220, 115, 100, 50 or 24 volts.

Model XS – 25 Watts. Available for 240, 220, 115, 100, 50, 24 or 12 volts.

Model XS-BP – 25 Watts. 240 volts, fitted with British Plug.

ST4 Stand – To suit all irons

SK5 Soldering Kit. Contains model CS 240v Iron, an ST4 Stand and solder.

SK6 Soldering Kit. Contains model XS240v Iron, an ST4 Stand and solder.

SK5-BP and **SK6-BP** Soldering Kits as above with British Plug.

Model CS – 17 Watts. Available for 240, 220, 115, 100, 50, 24 or 12 volts.

Model CS-BP – 17 Watts 240 volts, fitted with British Plug.

TCSU1 – Very robust temperature controlled Soldering Unit, with a choice of 30 Watt (CSTC) or 40 Watt (XSTC) miniature irons. Range 65°C to 420°C. Accuracy 2%.

TCSU-D Elegant Temperature Controlled Soldering Unit with 50 W Iron (XSD) and built around FERRANTI custom-made ULA. Range Ambient to 450°C. Accuracy ± 5°C. Zero crossing switching. Detachable sponge tray.

ANTEX Made in England

ANTEX (Electronics) Ltd., Mayflower House, Plymouth, Devon. Tel: 0752 667377 Telex: 45296

Please send literature, price list and my nearest stockist to:

Name

Address

Telephone

EWW/03/85

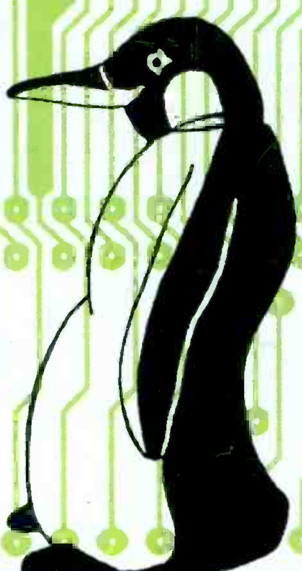
CIRCLE 2 FOR FURTHER INFORMATION

CIRCUIT BOARD DESIGN WITHOUT THE TEDIUM

smARTWORK lets the design engineer create and revise printed-circuit-board artwork on the IBM PC or compatibles.

Forget tape. Forget ruling. Forget waiting for a technician, draftsman, or the CAD department to get to your project. smARTWORK software turns your IBM PC or compatible into a professional, high quality drafting tool. It gives you complete control over your circuit-board-design — from start to finish.

What makes smARTWORK so smart is that it understands electrical connections. Conductor spacing is always correct, lines do not become too narrow, and connecting lines do not intersect other conductors. smARTWORK can automatically find and draw the shortest route between two conductors. Or you can specify the route.



smARTWORK is the only lowcost printed-circuit-board artwork editor with all these important advantages:

- Complete interactive control over placement and routing
- Quick correction and revision
- Production-quality 2× artwork from pen-and-ink plotter
- Prototype-quality 2× artwork from dot-matrix printer
- Easy to learn and operate, yet capable of sophisticated layouts
- Single-sided and double-sided printed-circuit boards up to 10×16 inches
- Multicolour or black and white display
- 32 user selectable colour combinations; coincident points may be displayed in contrasting colours
- Can use optional Microsoft Mouse as pointing device

System Requirements

- IBM PC, XT or compatible with 192K RAM, 2 disk drives and DOS 2.0
- IBM Colour/Graphics Adapter with RGB monitor or B& W monitor
- Epson MX-80/MX-100 or FX-80/FX-100 dot-matrix printer
- Houston Instruments DMP-41 pen-and-ink plotter (optional)
- Microsoft Mouse (optional)

The Smart Buy

At £895 (+VAT) smARTWORK is exceptional value, particularly when compared to conventional engineering workstation costs.

Write to the address below or use the enquiry card for more information on smARTWORK. Or call Richard Lambert on 0524 381423 to arrange a FREE demonstration or to discuss your requirements.

Starter kit comprising of: SAM 2001 PC, monochrome monitor, FX-100 dot matrix printer, DOS-2.0, smARTWORK, 1 Year on-site maintenance and much more £3995.00

Starter kit plus 10M hard disk drive £4995.00

Colour monitor £395.00

Microsoft Mouse £149.00

Pen and ink plotters from £1795.00

smARTWORK £895.00

smARTWORK Demo disk £10.00

10% Discount on all Orders processed and paid for before 28th February 1985.

Note: All prices exclude VAT and are subject to change without notice.

Terms: Strictly CASH WITH ORDER.

Conguin Software, 20 Morecambe Road, Lancaster LA1 5JA
Phone: 0524 381423

CIRCLE 3 FOR FURTHER DETAILS.