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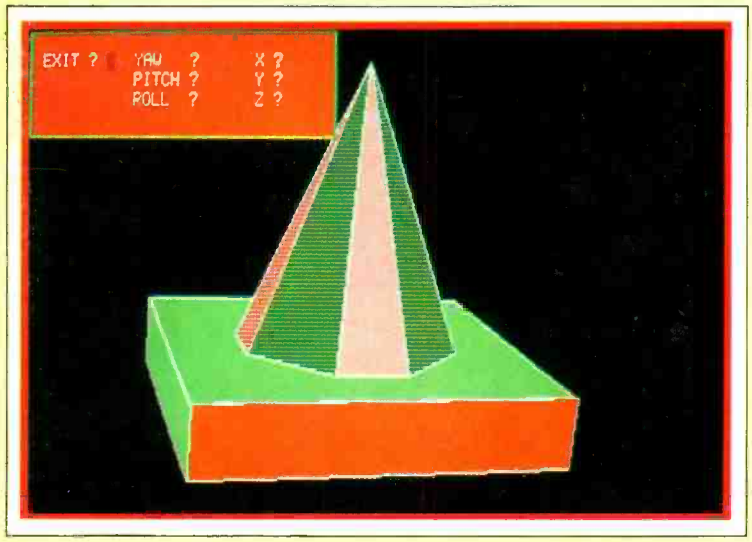

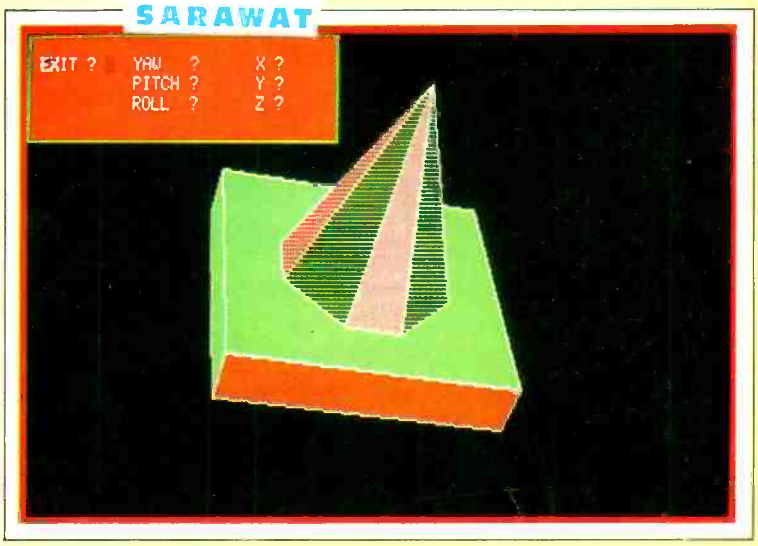

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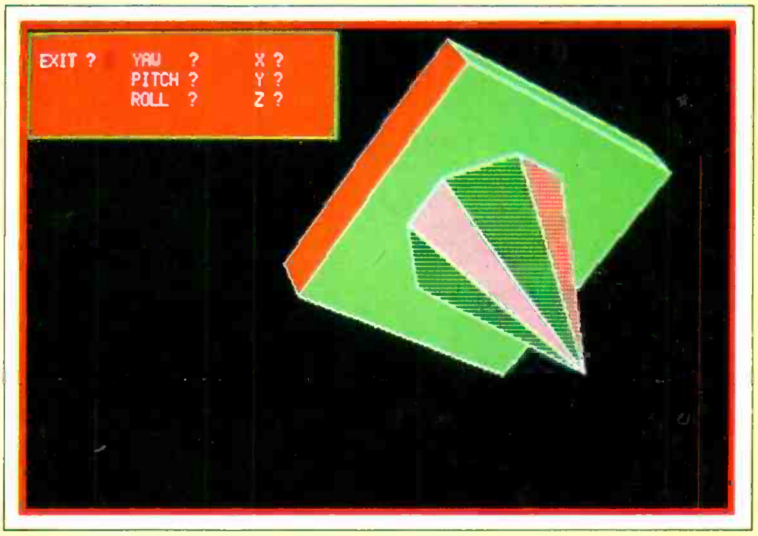

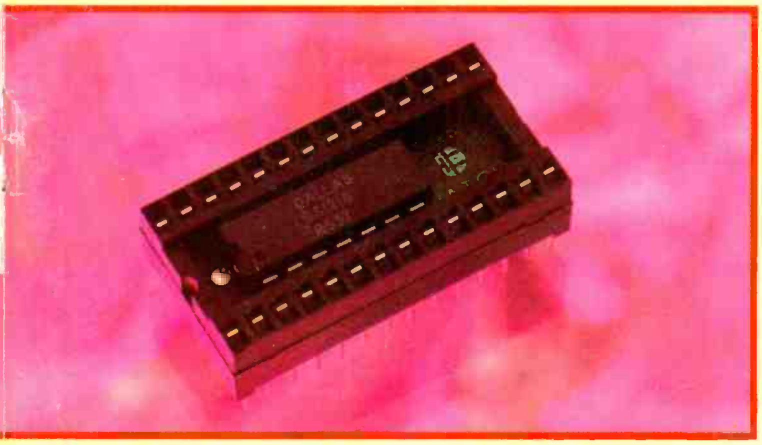

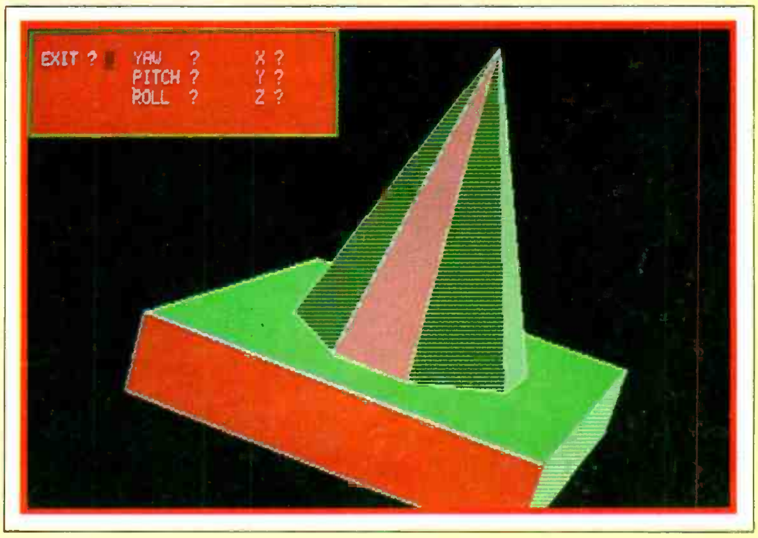

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May 1986
Volume 92
Number 1603

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REGULARS

Front cover shows examples of "3D" graphics provided by H.W. Gleaves and described in his article starting on p.36.

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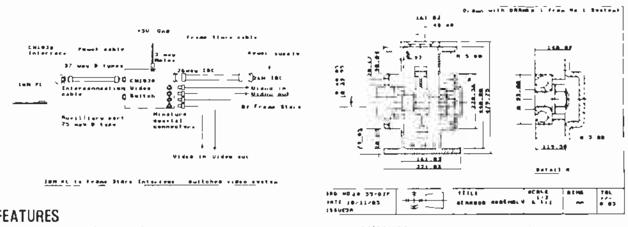

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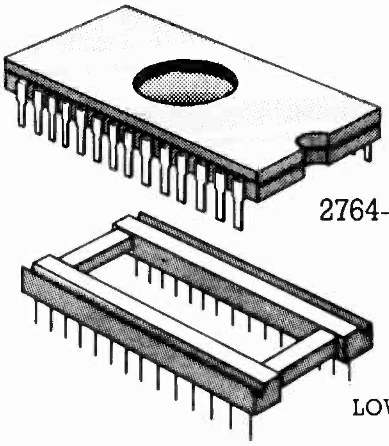

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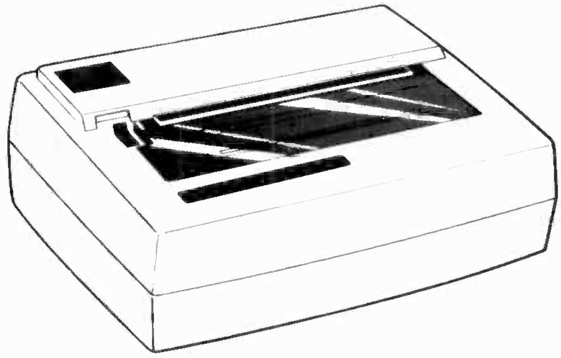

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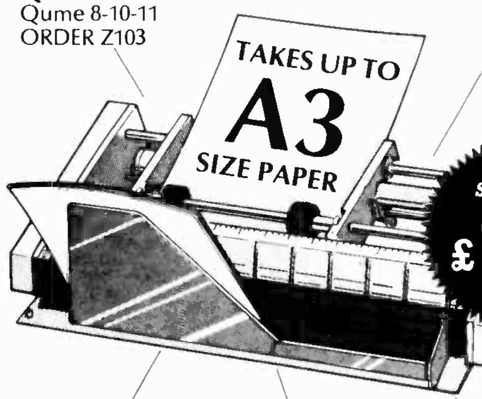

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NEWS COMMENTARY

Radiodata to begin next year

From the autumn of next year, programme-labelling data will be carried by all BBC f.m. radio stations in England. The extra signals will make possible the development of push button radio sets with fully automatic tuning. This, the BBC hopes, will put an end to the increasing difficulty many listeners have in finding the stations they want.

In the initial phase, to begin in September 1987, the new Radio Data Signalling (RDS) transmissions will carry five items of information:

• a programme identification code, very frequently repeated, which uniquely identifies the transmitting station: this helps the receiver to find the service chosen by the user and to select the strongest signal.

• a programme service code, a label of up to eight characters which could be displayed on the receiver (e.g. "BBC YORK") or passed to a voice synthesizer.

• a list of alternative frequencies for the same service: with car radios, for example, this could speed up the retuning process on passing from one transmission area to another. Where networks are split between wavebands, the list could include l.f. and m.f. stations.

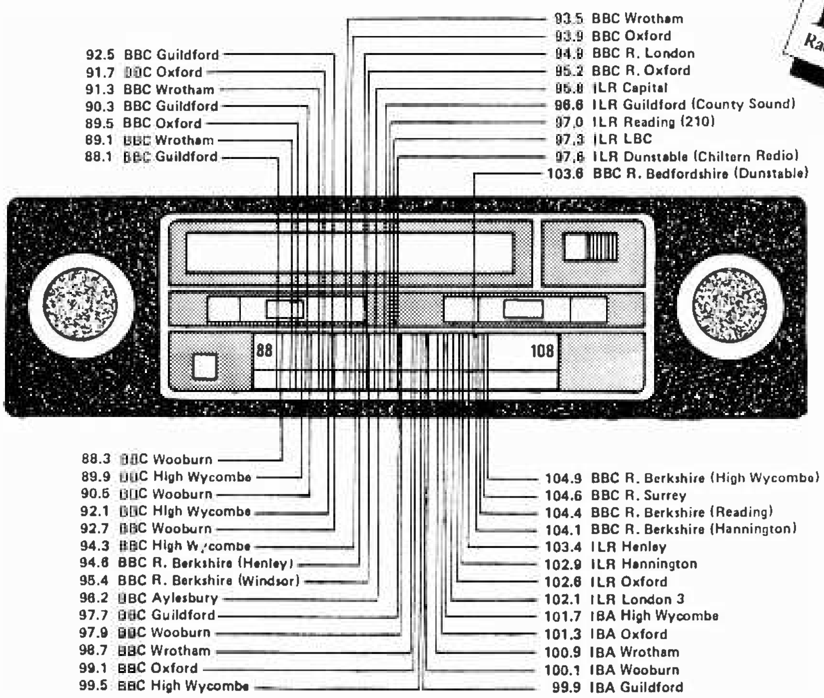
• 'other network' information to allow, say, automatic switching to another station when a traffic announcement is to be broadcast.

• clock time and date.

These features are cheap to implement, says the BBC, because they require no editorial input by the broadcaster.

But if RDS is a success with audiences, a range of other services could be added later. These might include a text block of up to 64 characters to carry programme details, phone-in numbers, newsflashes or even advertisements; identification codes for individual programmes; and a telex-like text channel for downloading programme fact-sheets or computer data.

The BBC's RDS transmissions meet a specification laid down by the European Broadcasting Union after a decade of technical work and international discussion. And this month the system is expected to be adopted as a world standard by the CCIR.



The radio jungle to the west of London: stations shown below the diagram have yet to make their appearance. RDS will bring in the ones you want by tuning and retuning the set automatically.

The data stream, at 1187.5 bit/s, is carried at 57kHz with a deviation of 1-2kHz of the main f.m. carrier. It can coexist with mono or stereo programmes and with most existing subcarriers offered by broadcasters, although some 57kHz systems in the USA would need to move to accommodate it. However, the MBS radio-paging system used in Sweden is now being changed to make it compatible with RDS.

Several European broadcasters are working on plans for RDS, although at present only Sweden is running a service — an experimental operation on one channel only. In Britain, the IBA carried out tests of RDS last year in the London area but has not yet decided to launch a service. No doubt the commercial broadcasters, as a loose federation of separate stations, have rather less to gain from automatic tuning than a national broadcaster who carries the same programme on many frequencies.

The cost of self-tuning RDS sets will depend on whether i.c. makers are prepared to commit themselves to the system. But the BBC says the prospects for its success are good: a recent survey found that over 70% of adult listeners would be prepared to spend an extra £15 on a basic £25 portable set if it could have RDS. And users of car radios are said to have found the idea of RDS especially attractive.

However, although several Japanese firms are said to be working on prototypes, there are no signs yet of a rush to launch RDS sets. And in Britain, Mullard tell us they have no plans at present to produce the necessary i.cs.

Full details of the RDS format are given in an EBU document, "Specification of the radio data system RDS for VHF/FM sound broadcasting", technical publication 3244/E.

In brief

Up to 2×109bytes of information can be stored on both sides of a 12in optical disc and 600MB on a 4.75in compact disc. Such discs are likely to have a similar impact on information technology as the microcomputer, according to a report from the US Technical Information Service. The report includes a detailed assessment of optical disc technology and is available in the UK from Microinfo Ltd, Alton, Hants.

Kef Electronics, makers of loudspeakers, are to have a new head of research in the person of Dr Richard Small, who has left his post as a senior lecturer in the University of Sydney. He is the author of *Direct radiator electrodynamic loudspeaker systems*, which has been reprinted four times and received a Silver Medal award from the AES.

Digital assistance for tv signals

Experiments at BBC's Research Department have produced a system for transmitting analogue picture signals along with high data-rate digital signals carrying control or supplementary information about the picture. One application of this Digitally-assisted tv (DATV) could be to reduce the bandwidth of high-definition tv so that it can be accommodated within a single DBS channel, previously planned for 625-line tv services. DATV is a bandwidth compression technique intended for use with high quality tv signals. The digital control signals assist in the reconstruction of the picture without degradation. One example of the use of the digital component is to carry information about which parts of the picture are static and which are moving. It is possible to repeat the static information and only transmit the changing part of the picture. Such techniques are common in bandwidth-saving exercises, but the DATV experiments have shown that it is possible to apply them to HDTV with a bandwidth reduction by a factor of between two and four.

Another example is the reconstruction of a sequentially-scanned picture where, to save bandwidth in transmission, the signal has been converted from sequential to interlaced scanning.

DATV can also be used to improve the performance of 625-line tv systems which have associated digital capacity, such as the MAC/packet family of transmission standards. However this use restricts the freedom to exploit the full potential of DATV compared with its use to facilitate the transmission of HDTV systems using more than 1000 lines.

Charles Sandbank, deputy director of research said: "DATV is a powerful technique for squeezing HDTV signals through the bottleneck of transmission channels, using the sort of technology that will be available in our homes in the 1990's. I am confident that it will play an important role in establishing a European broadcasting strategy for HDTV."

Light at the end of the tunnel?

The Council of the Electronic Components Industry Federation (ECIF) reported recently that their industry seems to be pulling out of the recession. Most sectors reported encouraging signs. In paticular the semi-conductor manufacturers noticed an increase in demand; enquiries for application-specific i.cs particularly were encouraging. The council thought that lead-times might soon lengthen but warned that another 'boom and bust' cycle was in nobody's interest and if it were to be avoided, equipment manufacturers must recognise that the 'supply tap' cannot be turned on and off rapidly, and that ordering must be planned accordingly. The ECIF were seeking urgent talks on this with customer trade associations.

It was agreed that glimmers of light were appearing at the end of the tunnel, and the council concluded that overall prospects were for a significantly better 1986 than 1985.

After Alvey

The Information Technology (1986) Committee has been formed to look into ways of preserving and maintaining the momentum generated by the Alvey programme. Sir Austin Bide, chairman of British Leyland and former chairman of Glaxo is heading a committee drawn from the IT industry, IT users and academics. The new committee has been organized by Sir Robert Telford, chairman of the Alvey steering committee. A major task for the committee is to establish a proper balance between national and European efforts including the UK relationship with Esprit, Eureka and Race.

The Committee is to report its findings by October 1st.

A good idea? Patent it!

All too often, says the Chartered Institute of Patent Agents, adequate safeguards are not taken to prevent ideas being poached by others, and many entrepreneurs come unstuck in the race to get their idea to the marketplace. The most common mistake is to tell others about the idea before asking for professional advice, only to find that as a result all hope of protection has then been lost.

Manufacturers are well aware of the legal wrangles which can follow discussions of purveyors of unprotected ideas and many will refuse to negotiate with inventors until the proper legal protection has been applied for.

To counter these problems the Institute has launched a campaign to help inventors and entrepreneurs bring their ideas safely into fruition. A working party of patent agents and financiers is looking into the whole area of invention, and the funding of projects in their early stages.

Patent agents believe they must promote a better understanding of the forms of legal protection available for new ideas and of the registration systems involved. They have issued free leaflets as introductory guides to patents, trade marks and registered trade marks, design registration and design copyright, and service marks for service businesses. Available from the Chartered Institute of Patent Agents, Staples Inn Buildings, London WC1V 7PZ.

WALLCHART OF FREQUENCY ALLOCATIONS

It is over ten years since the original frequency allocation wallchart was produced and it is, of course, well out of date. Many changes have taken place during that time and it has been clear for some time that a continuing demand had to be satisfied. In response to repeated requests for a new chart, we have produced a new version, which will be presented as a loose insert with the June issue, on sale on Wednesday, May 21.

Many schools, universities and commercial laboratories still have the original chart, and we expect a large demand for the new one. Readers may find it useful to place an advance order for the journal with their newsagents, or take out a subscription, to ensure that they do not miss this once-only opportunity.

Electron beam writing on GaAs

At its base in Towcester, Plessey 3-5 Group is installing a Cambridge Instruments EBMF 10.5 electron-beam tool. This will enable the consistent production writing of gate lengths down to 0.2μm on gallium arsenide metal semiconductor field-effect transistors (MESFETS). The first product to benefit from this abilty will be a 40GHz MESFET currently under development. Direct writing of features on monolithic microwave i.cs will also be possible.

The equipment allows the fabrication of fine geometries by a highly focussed beam of electrons to expose a specially formulated resist, thus reducing the size of the features compared with that previously possible with photo-lithographic techniques. Computer control provides a high degree of automation.

Such short gate lengths wil not only lead to higher frequency devices but also improve the signal/noise performance of current MESFETS at frequencies down to X-Band.

Microwave power devices will also benefit; large device structures can have total gate widths of several centimeters and gate lengths of 1μm. Such devices are used in phased-array radars and as solid-state replacements of travelling wave guide tubes.

Knowledge base for Esprit

A five-year project, funded by the European Esprit programme, is to be undertaken on research into knowledge-based systems. Such systems are one aspect of 'artificial intelligence' research. They acquire knowledge from experts in a specific field; combine this with codes of practice and/or other rules and regulations, and then programme a computer to analyse and give a prognosis based on the acquired knowledge. One successful example has been used in medical diagnosis.

The software required is intrinsically different from conventional programs. In order to apply it effectively in industry, a better understanding of the methods and techniques for building such systems is needed. Ways of applying the disciplines of software engineering in this new area need to be found. This could also reflect back by providing insights into writing more conventional software.

The work should be of interest to all researchers in providing a better understanding of the way such systems operate. It should also provide modes of operation in applying similar techniques to new areas and for increasingly complex applications.

The work is to be led by STC.

Britain dominates the comms RACE

Yet another European acronym to go alongside Esprit and Eureka is Race; Research in Advanced Communications for Europe. The European Commission has announced details of contracts to be awarded and Geoffrey Pattie, IT minister, is very proud that: "there are more British participants than there are from any other member state. Of the 192 participants, 52 are British. British enterprises are leaders in 14 of the 32 successful consortia and there is a British presence in 26. This shows that Britain is ready, willing and able to take a leading part in colaborative research in Europe, which is important both for Europe and for British companies."

The aim of the Race programme is to establish a strong Community manufacturing industry in broadband communications and to accelerate the emergence of a viable and competitive Community market for telecommunications equipment into the next century.

IBA plans DBS service

The Independent Broadcasting Authority if proceeding with plans to persuade contractors to provide up to three direct-broadcasting-by-satellite channels. This follows the bringing into action of sections 37 to 41 of the Cable and Broadcasting Act which provide for the contractors to make the financial and other arrangements for the provision of satellite transponders, subject to the specification of the IBA, which as broadcaster will be responsible for ensuring that the services are of high quality.

John Witney, IBA's director general, warmly welcomed the opportunity to provide additional services; "After much discussion as to how DBS could be introduced to the UK, we are enthusiastic at the prospect. We shall be proceeding with all speed while aiming to ensure that the firmest possible basis is laid."

The service, if suitable contractors are found, could be broadcasting by 1990. It is likely to be funded by advertising and/or subscription.

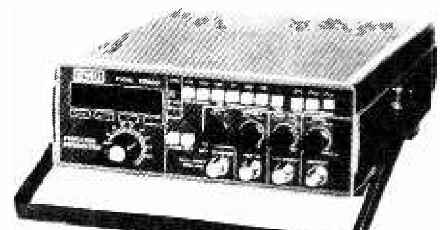
In brief

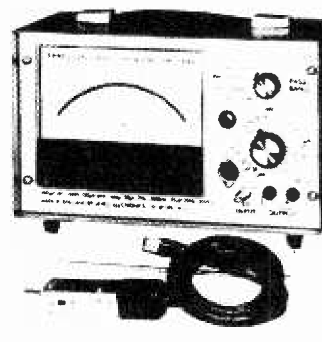
We have received bitter complaints from manufacturers of modems who are frustrated by the red tape and delays in getting BATB approval for their equipment. Nazir Jessa of Watford Electronics points out the Catch-22 situation that he is caught in with Watfords Le Modem: "If I wait for approval before I put Le Modem on sale, I could find that the technology is out of date. Alternatively I could sell (am selling) the modem without approval and risk customer disatisfaction."

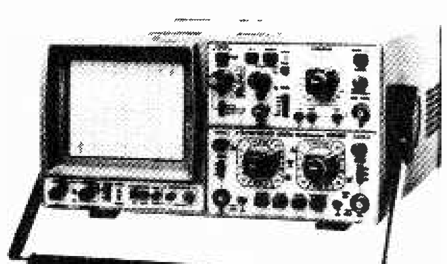
According to Nazir the situation is made more ridiculous because the device is constructed from BT approved components and is actually being offered with a three-month free subscription to Micronet, partly owned by BT.

Similarly vociferous is Barry Krite of DataStar Systems, distributors of the Magic Modem: "BT's marketing policy supposes that modems without BATB approval are potentially dangerous, despite the fact that they themselves sell modems without approval. Until our modem is approved, customers such as government depatments and schools, who are obliged to buy approved products, can't by the Magic Modem." Barry is even more frustrated with the knowledge that the modem has been successfully tested in the BT labs but is still awaiting official approval.

Ceefax, BBC's teletext service is now using six lines in the tv signal compared with the four in previous use. This speeds up the time it takes for the required page to come round. The improvement is the result of the new computer equipment which also increases the efficiency of the system by taking over some of the 'housekeeping' tasks from the contributing journalists. There has also been improvement in the subtitling service: it is now possible to transmit subtitles on both channels simultaneously. The teletext signals are now generated at the point of programme origin, bypassing the Ceefax computers.







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BC558	0.10
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BD204	0.70
BD222	0.46
BD223	0.59
BD225	0.48

BD232	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
BD589	0.45
BD701	1.25
BD702	1.25
BD707	0.90
BDX32	1.50
BF115	0.35
BF119	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
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
BF494	0.45
BF495	0.45
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
BRY39	0.45
BR100	0.26
BR110	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
BU3276	1.20
BU407	1.24
BU500	2.25
BU508A	1.95
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	4.95
MRF450A	13.95
MRF453	17.50
MRF454	26.50
MRF455	17.50
MRF475	2.95
MRF477	10.00
MRF838	13.95
OC16W	2.50
OC23	1.50
OC28	1.50
OC29	2.25
OC32	2.25
OC42	0.75
OC44	0.75
OC45	0.55
OC70	0.45
OC71	0.55
OC72	0.85
OC75	0.95
OC81	0.50
OC171	3.50
R2008B	1.45
R2010B	1.45
R2322	0.58
R2323	0.66
R2540	2.48

HCA16334	0.90
RCA16335	0.80
SKE5F	1.45
TIP29	0.40
TIP29C	0.42
TIP30C	0.43
TIP31C	0.55
TIP32C	0.42
TIP33C	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	0.85
TIP3055	0.55
TIS91	0.20
TV106/2	1.50
2N1308	1.35
2N2219	0.28
2N2222	0.29
2N2905	0.40
2N3053	0.40
2N3054	0.59
2N3055	0.52
2N3702	0.12
2N3703	0.12
2N3704	0.12
2N3705	0.20
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
2N5485	0.45
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	1.40
2SC1307	1.75
2SC1364	0.50
2SC1449	0.80
2SC1678	1.25
2SC1909	1.25
2SC1945	2.65
2SC1954	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	2.95
3SK88	0.95
3SK88	0.95

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VIDEO HEADS

3HSS Suitable for Most JVC and Ferguson models...£29.50
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4HSS(UIN) Suitable for Panasonic Models 370 and 380........£33.95

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DSR-10-R Suitable for Sony SLC5 SLC6 SLC7 £39.50
Sanyo Head for VTC9300/9500..........£41.50
Sanyo Head for VTC 5300/5000..........£41.50

VIDEO BELT KITS

Akai VS9300/9500/9800	£3.75
Ferguson 3V16	4.50
JVCH HR 3330/3600	4.50
JVC HR 3360/3660	4.50
Panasonic NV 300	4.00
Panasonic NV 2000B	3.75
Panasonic 3000B	3.75
Panasonic NV7000	3.50
Panasonic NV 8600B/8610B/VO11	3.75
Sanyo VTC 5500	3.75
Sanuyo VTC 9300	3.75
Sanyo VTC 9300P	3.90
Sharp VC 6300	3.75
Sharp VC 7300	3.75
Sharp VC 8300	3.75
Sharp VC 9300	3.75
Sony SL 3000B	3.75
Sony SL 8000/8080	4.50
Sony SL C7/J7	4.00
Toshiba V5470	4.50

SANYO ORIGINAL VIDEO PARTS

SANYO ORIGINAL PART NUMBER	MODEL	DESCRIPTION	
4-529-10800B	VTC5150	Reel Motor 3.6W	9.95
4-527T-23501	VARIOUS	Motor Assy.	9.75
4-527V-51000	5150	Capston Motor	29.95
143-0-4904-00900	FVHP615	Gear Idler Assy.	5.95
143-2-457T-05900	VTC9455	Stopper Reel Base	0.55
143-0-545T-01701	VARIOUS	Pinch Roller Assy.	8.95
143-0-545T-01700	VARIOUS	Pinch Roller Assy.	1.95
143-0-551T-VTC9300		Idler Assy.	0.95
143-0-661T-03800	VARIOUS	Loading Roller	0.95
143-0-662T-01201	VTC5150	Reel Drive Pulley	8.50
143-0-9974-00100	FVHP615	Mod Kit IC BA6304A	1.95

Video Head Cleaning Tape (VHS automatic wet/dry 6.50
Video Head Aerosol Cleaner........................ 0.85
Video Copying Lead and Connector Kit 'ZV'........ 7.95

VIDEO ALIGNMENT TAPES

S-2P Colour Bars 30 min.	49.50
S-3P Stairsteps 30 min.	49.50

DIODES

AA119	0.80
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
BXY55-600	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	0.06
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	8.26
GEC 2040	8.95
GRUNDIG 1500	15.45
GRUNDIG 510-6010, 2222, 5011-6011	13.46
ITT CVC20	8.20
ITT CVC30	8.25
PHILIPS G&	8.50
PHILIPS G9	8.99
PHILIPS G11	13.99
PYE 725	10.95
RBM T20A	12.40
TANDBERGE 90*	11.15
TELEFUNKEN 711A	11.15
THORN 1590	9.50
THORN 8000	23.50
THORN 9000	9.95
THORN 9800	22.40

E H T 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	8.00
THORN 9000	8.00
UNIVERSAL TRIPLER	5.45

REPLACEMENT ELECTROLYTIC CAPACITORS

DECCA 30 (400-400/350V)	2.85
DECCA 80/100 (400/305V)	2.99
DECCA 1700 (200-200-400-350V)	3.55
GEC 2110 (600/300V)	2.25
ITT CVC20 (200/400V)	1.80
PHIIPS G (600/300V)	2.25
PHILIPS G9 (2200 x 63V)	1.19
PHILIPS G11 (470/250V)	2.35

VARICAP TUNERS

ELC1043/05 MULLARD	8.65
ELC1043/06 MULLARD	8.65
U321	8.25
U322	8.26
U324	11.00

THERMISTORS

VA1040	0.23
VA1056S	0.23
VA1104	0.70
VA8650	0.45
VA1097	0.25

PUSH BUTTON UNITS

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

200MA QUICK BLOW FUSES

100MA	8p each
200MA – 5 AMP	5p each

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

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HEAT SINK COMPOUND	1.00
FREEZE IT	0.95
SOLDA MOP	0.64
SWITCH CLEANER	0.85
WD40	1.75
PUSH PULL MAINS SWITCH (DECCA, GFC, RANK, THORN ETC.)	1.02
PYE IF GAIN MODULE	6.99
ANODE CAP (27kV)	0.69

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HARDWARE	Price £
Qume 1/2 Height D/Drive	65
Graphix Plus Card (Graphics Plus II)	80
Hyperam Card	80
Megaplus Serial Option	10
Paradise Multidisplay Card	85
Quadcolour Card	55
Smorgasbord 64K	73
Visi-On Mouse	33
Grappler + Parallel	26
Luxor 14-inch colour monitor	85
Cluster Adapt. IBM PC	63
Cluster Cable Kit IBM PC	20
Cluster Program—IBM	15
Plan 2000 Network	400
Emudec Box	5
Dacom Buzzbox Modem	40

SOFTWARE APPLE

SOFTWARE APPLE	Price £
Quickfile II	40
Apple Access	11
ASCII Express	24
The Dictionary	12
MailList Manager	25
PFS File	30
PFS Graph	30
PFS Report	20
PFS Apple	20
Multiplan	12
Supercalc II	49
Think Tank II	35
Systematics financial applications	50
Systematics General Ledger	50
Systematics Purchase Ledger	50
Forth	33
Workbench	40
Vlasak Sales Ledger	30
Softcard	60
Apple III System Software	33
Visicalc Manual	3
Viside	30
Pascal	40
Orbit	30
Busifile (Management Info)	33
Quickfile	10

SOFTWARE MAC

SOFTWARE MAC	Price £
EP Start	5
Front Desk Scheduler	25
Main St. Filer	17
Megaform	60
Megafiler	34
Megamemerge	22
PFS Report	32
PFS File	32
Helix	49
Macwrite	45
MacPaint	45
Omnis II	54
Management Edge	46
Sales Edge	46
Negotiation Edge	50
Filevision	33
Mech Eng.	40
Intro to Science	5
TK Solver	38
Music Works	11
Mac Primer	2
Stock Portfolio System	39
Apple Mac Primer (Book)	3

SOFTWARE IBM

SOFTWARE IBM	Price £
SNA 3270 + RJE—IBM	110
VDTE Emulation	10
CP/M 86	40
Cobol Compiler—IBM	100
APL Program	30
Microsoft Cobol Compiler	136
Microsoft Basic Compiler	72
Microsoft Basic Intptr	68
PFS File—IBM	30
PFS Graph—IBM	40
Cardbox—IBM	40
PC Blast	70
D. Graph	43
PC Tutor Intro to DOS	10
PC Tutor	10
System Build Budget	14
System Build Cashflow	14
System Build Fin Rep	14
System Build Multi Regres	14
System Build Mail Shot	14
System Build Project	14
System Build Sales F/Cast	14
Easyfiler	33

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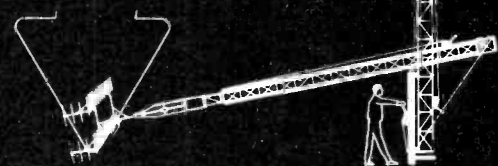
CIRCLE 8 FOR FURTHER DETAILS.

Versatower:

A range of telescopic towers in static and mobile models from 7.5 to 36 metres with tilt-over facility enabling all maintenance to be at ground level.

Designed in accordance with CP3 Chapter V; part 2; 1972 **for a minimum wind speed of 140 kph in conditions of maximum exposure** and specified by professionals world-wide where hostile environments demand the ultimate in design, quality and reliability.
Suitable for mounting equipment in the fields of:
Communications
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The TA3000 is a high performance modular logic analyser which interactively combines up to 16 channels of 100MHz Timing analysis with up to 96 channels of 20MHz State analysis controlled by a powerful multi-level conditional trigger-trace sequencer.

- Flexible, expandable, modular design
- Up to 112 channels
- 100MHz Timing, 20MHz State
- Multi-level conditional triggering
- State/Timing cross-triggering and correlation
- Easy to use softkey control
- CP/M PLUS† operating system
- IEEE-488, RS-232 and parallel printer interfaces

For further information contact:
Thandar Electronics Ltd., London Road, St. Ives, Huntingdon, Cambridgeshire PE17 4HJ.
Telephone: 0480-64646. Telex: 32250.

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CIRCLE 56 FOR FURTHER DETAILS.

ERS — PRINTERS — PRINTERS — PRINTERS

SUPER DEAL? NO – SUPER STEAL
THE FABULOUS 25 CPS "TEC STARWRITER"

Made to the very highest spec the **TEC STARWRITER FP1500-25** features a very 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 381mm paper handling with up to 163 characters per line, friction feed rollers for single sheet or continuous paper, internal buffer, standard **RS232** serial interface with handshake. Supplied absolutely **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 **£3.50**. Carriage & Ins. (UK Mainland) £10.00.

NOW ONLY £499 + VAT

DIY PRINTER MECH

Brand New surplus of this professional printer chassis gives an outstanding opportunity for the **Student**, **Hobbyist** or **Robotics** constructor to build a **printer – plotter – digitiser** etc, entirely to their own specification. The printer mechanism is supplied ready built, aligned and pre tested but **WITHOUT** electronics. Many features include all metal chassis, phosphor bronze bearings, **132** character optical shaft position encoder, **NINE** needle head, 2 x two phase 12V stepper motors for carriage and paper control, 9.5" Paper platten etc. etc. Even a manufacturer's print sample to show the unit's capabilities!! Overall dimensions 40 cm x 12 cm x 21 cm.

Sold **BRAND NEW** at a **FRACTION** of cost **ONLY £49.50** + pp £4.50.

TELETYPE ASR33
DATA I/O TERMINALS

Industry standard, combined ASCII 110 baud printer, keyboard and 8 hole paper tape punch and reader. Standard **RS232** serial interface. Ideal as cheap hard copy unit or tape prep. for CNC and NC machines. **TESTED** and in good condition. Only **£250.00** floor stand **£10.00**. Carr & Ins. £15.00.

EX NEWS SERVICE PRINTERS

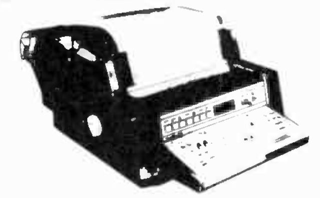
Compact ultra reliable quality built unit made by the **USA EXTEL Corporation**. Often seen in major Hotels printing up to the minute News and Financial information, the unit operates on **5 UNIT BAUDOT CODE** from a Current loop, **RS232** or **TTL** serial interface. May be connected to your micro as a low cost printer or via a simple interface and filter to any communications receiver to enable printing of worldwide **NEWS**, **TELEX** and **RTTY** services.

Supplied **TESTED** in second hand condition complete with **DATA, 50 and 75 baud xtals and large paper roll.**

TYPE AE11 50 Column	**ONLY £49.95**
Spare paper roll for AE11	**£4.50**
TYPE AF11R 72 Col. + Ribbon	**£65.00**
TYPE AH11R 80 Col. ASCII/BAUDOT	**£185.00**

Carriage and Insurance £7.50

GE TERMIPRINTER



A massive purchase of these desk top printer terminals enables us to offer you these quality 30 or 120 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 **GE30 £130.00**, **GE1200 120 cps £175.00**. Untested **GE30 £65.00**. Optional floor stand **£12.50**. Carr & Ins. £10.00.

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Mixed Semis amazing value contents include transistors digital, linear, IC'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 IC's enables us to offer 100+ mixed "**mostly TTL**" grab bags at a price which two or three chips in the bag would normally cost to buy. Fully guaranteed all IC's full spec. **100+ £6.90, 200+ £12.30, 300+ £19.50**

MAINS FILTERS

CURE those unnerving hang ups and data glitches caused by mains interference with professional quality filters. **SD5A** matchbox size up to **1000 watt 240 V** Load **ONLY £5.95**. **L12127** compact completely cased unit with 3 pin fitted socket up to **750** watts **ONLY £9.99**.

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The amazing **SOFTY 2** The "Complete Toolkit" 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 i/o UHF modulator ZIF socket etc.
ONLY £195.00 + pp £2.50.

"GANG OF EIGHT" intelligent Z80 controlled 8 gang programmer for ALL single 5v rail EPROMS up to 27128. Will copy 8 27128 in 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

COOLING FANS

Keep your hot parts COOL and **RELIABLE** with our range of **COLING FANS ETRI 126LF21** 240v 5 blade equipment fan Dim. 80 × 80 × 38mm £9 95. **ETRI 99XUOI** 240v Slimline Dim. 92 × 92 × 25mm. equipment gfan. **NEW** £9.95. **GOULD JB-3AR** Dim. 3' × 3' × 2.5' compact very quiet running 240v operation. **NEW £6.95**. **MUFFIN-CENTAUR-BOXER** standard 120 × 120 × 38mm fans Order 110v OR 240v. 3 or 5 blade, **NEW** at **£10.50** or tested **EX EQUIPMENT** £5.50. Low Voltage DC Fans. **BUHLER 69.11.22**. 8-16v DC micro minaiature reversible. Uses brushless servo motor, almost silent running, guaranteed 10,000 hr life. Measures only 62 × 62 × 22mm. Current cost **£35.00 DUR PRICE ONLY £13.95** complete with data. 120 × 120 × 38mm (4' DC fans). **PANSONIC FB-12C12H** 12v DC 5 blade **£18.00** **PAPST 4124X 24** — 28v DC 5 blade **£18.00**.

100's of other fans Ex Stock.
Call for Details. Post & Packing on all fans £2.00

20,000 FEET OF ELECTRONIC AND COMPUTER GOODIES
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PDP 1140 System comprising of CPU, **124k** memory & MMU 15 line RS232 interface, RP02 40 MB hard disk drive. **TU10** 9 track 800 BPI Mag tape drive, dual track system. VT52 VDU, etc. etc. Tested and running.	£3,750.00
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LA36 Decwriter EIA or 20 mA loop	£270.00
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MS11-LB Unibus 128kb Ram	£450.00
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PDP11/40 Cpu, 124k MMU	£1,850.00
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Brand New **VT100** Keyboards only **£85.00**

1000's OF EX STOCK spares for **PDP8, PDP8A PDP11, PD P1134** etc. **SAE.** for list. or **CALL** sales office for details.
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by J.D. Last, Ph.D., M.I.E.E. (GW3MZY)

New directions for marine d/f

Marine d/f is dying, long live marine d/f.

Dr David Last is a Senior Lecturer in the School of Electornic Engineering Science at the University College of North Wales, Bangor where he teaches Microelectronics. Although he has researched and published papers and patents in the fields of semiconductor and integrated circuit devices and non-linear circuits he now spends most of his time on radio systems. He was joint winner of a Design Council award recently for the rear-heater radio receiving aerial for cars described in February, E & WW. He concentrates largely on radio-navigation systems for ships, aircraft and land vehicles — with a special interest in remote tracking and automatic vehicle location systems and acts as a Consultant on radio navigation and communications to a number of companies and public bodies.

Although radio direction-finding is the oldest and simplest form of radio navigation, it is still the one installed on the greatest number of ships, and aeronautical radio-beacons outnumber all other radio navigation aids for aircraft. The technology of direction-finding, developed before the first World War, has been changing rapidly, the latest receivers employing microcomputers and data-processing techniques. In parallel with these developments in the technology, an inter-governmental radio conference held in Geneva[1,2] agreed radical changes in the transmission formats of maritime radio-beacons. These open the door to the development of a new generation of receivers which promise to revolutionize radio direction-finding.

Alongside the most modern techniques, the earliest method of direction-finding — turning the aerial by hand until the signal received is at a minimum and then noting the direction in which the aerial is pointing — is still in widespread use. Automatic direction-finders employ a similar technique and a pointer shows the bearing of the transmitter relative to the heading of the ship, as in Fig. 1. From this relative bearing and the magnetic heading measured by a compass, the bearing of the radio-beacon is calculated and a line of position drawn through the location of the beacon on a chart. Two or more such lines of position should intersect at the receiver.

Maritime radio-beacons are simple, low-frequency, non-directional transmitters installed at coastal sites and on light-vessels. Figure 2 shows some of the beacons which serve the English Channel. The frequencies, power levels and transmission standards of the more than 500 beacons in Europe and North Africa are organized under an old intergovernmental agreement — the Paris Plan of 1951. The prime object of the Paris Plan was to minimize interference between radio-beacons, but in achieving this laudable aim the Plan has seriously inhibited the development of radio direction-finding. To see how this has happened — and how the new Geneva agreement has freed the logjam — we must look at the way the Paris plan attempted to squeeze a quart of beacons into a pint-pot of spectrum.

The marine radio-beacon frequency band, from 285 to 315kHz, is divided into just 14 channels, spaced 2300Hz apart (top of Fig. 3). However, so many beacons must share each channel that it is only possible to space co-channel groups sufficiently far apart to achieve about 14dB of the 30dB protection ratio on which the Plan is based.

The remaining 16dB of protection is obtained by amplitude modulating the signals of each group of beacons with a different audio tone, one of a set of tones between 354 and 1052Hz. The idea is for operators to measure bearings by turning their receiving aerials until they hear a null in the tone of the wanted beacon, all interfering tones being carefully ignored — the 'audio null' method of direction-finding.

Beacons may be identified by the callsigns which they transmit in Morse code or by the unique combination of carrier frequency, tone and time-slot.

When the systems was designed, some 35 years ago, radio direction-finding was the principal radio navigation aid for ocean-going and coastal ships. Installation was made mandatory under the Safety of Life at Sea Convention for all ships of more than 1600 tons. The receivers on these 'Convention ships' must meet type-approval specifications based on the Paris Plan. But ironically, the great majority of these receivers are operated as

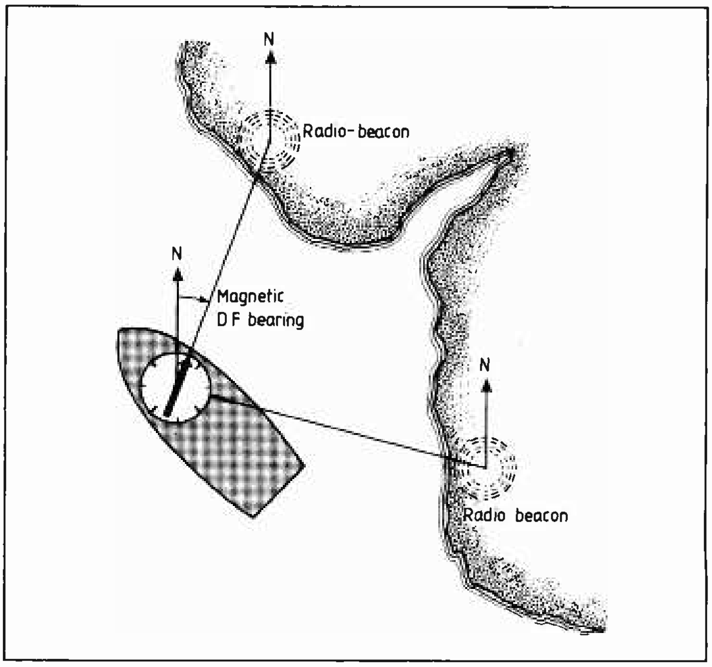

Fig. 1. Fixing the position of a ship by taking bearings on two radio-beacons. The automatic direction-finder shows the bearing of the beacon relative to the ship's heading. The compass measures the heading relative to magnetic north and these two measurements give the magnetic bearing of the beacon.

automatic direction-finders, automatically seeking the null direction of the carrier signal — not the modulation — so the interference protection provided by the audio tones is lost. Moreover, these receivers are used much less frequently nowadays because the ships carry radar, Decca or satellite navigation systems which give more accurate fixes, automatically and continuously. So the people for whom the system was designed don't often use it — and when they do they don't use it as it was designed to be used!

Instead, the main customers of the radio-beacons are the pleasurecraft sailors — relatively rare birds in 1951 but found in large flocks now. They generally carry few other electronic navigation aids, so radio direction-finding — still the cheapest form of radio-navigation — is very important to them. It has been estimated that more than 70,000 d/f receivers were sold by UK manufacturers in the decade up to 1983, principally to pleasure-craft sailors.

Small-craft receivers don't have to be type-approved nor conform to the Paris Plan. This has freed designers to be highly innovative in developing receivers for this large market, which demands ease of operation, low cost and high performance — preferably simultaneously!

For example, one popular receiver has only 10% of the volume, 6% of the weight, 4% of the cost and 0.14% of the power consumption of a Convention ship receiver! Though a few small craft receivers are cheap and nasty, at least one claims to meet the type-approval specification for convention ship receivers.

Many small-craft receivers are hand-held. They include a built-in ferrite-rod aerial, a meter or headhones to show the signal null as the receiver is rotated and a magnetic compass to measure the bearing of the beacon when the null has been found. A hand-held receiver appears deceptively simple; in fact it contains a frequency synthesizer for channel selection and a precise clock to identify the transmission time-slots, since the most users cannot read the Morse code identification.

The most sophisticated small-craft direction-finders are very advanced. Taking bearings under microprocessor control and storing the positions of beacons in memory, they calculate the ship's position and display it as a latitude and longitude or even as a bearing to steer and distance to run to the next viewpoint[3].

But all these receivers, just like the Convention ship ones, measure bearings using the carrier only and ignore the aduio modulation. So they all dispense with the protection provided by the audio tones. This is one of several ways in which the radio-beacon system, which now looks very old-fashioned in concept, is out of step with its users (and their receivers). Other problems include a shortage of channels which is seriously inhibiting the development and improvement of the service, especially in areas of dense shipping movement. But, of course, the channels are few because the transmissions are wide — wide enough to accommodate the modulating tones which the users ignore!

The six-minute transmission sequence is also very unpopular. Navigators want frequently-updated position fixes with no 'skew' errors due to the movement of the ship in the intervals between taking the two or more bearings used to plot the fix; a ship travelling at 20 knots may sail a nautical mile in the interval between measurements on beacons in the same group. A few beacons — generally low-powered ones — operate continuously at present; it would be desirable for all beacons to do so or to be in groups of three at the most.

The Paris Plan actually obstructs the development of the art. For example, although it is now possible to measure and record the bearing errors due to the ship's structure and

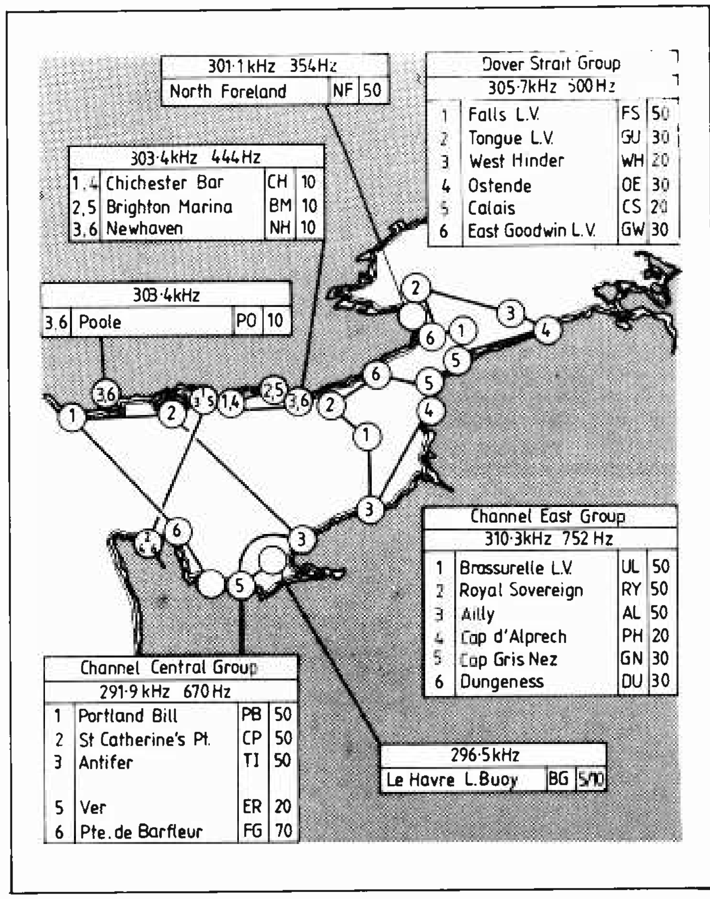

Fig. 2. Radio-beacons covering the English Channel. Most are arranged in groups of six, transmitting in turn on the same frequency. Each table shows the carrier and modulation frequencies of the group and the names, callsings and protected ranges of the individual beacons.

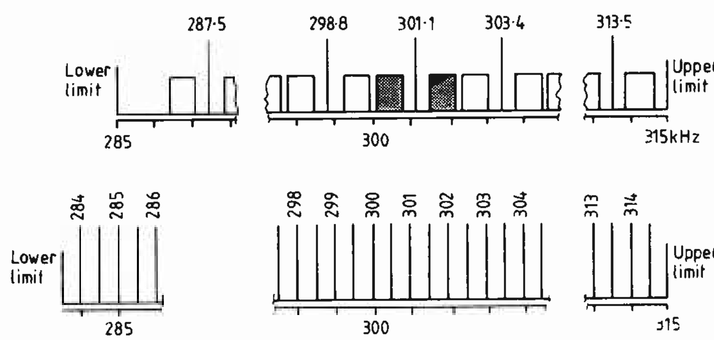

Fig. 3. Channel assignments in the l.f./m.f. marine radio-beacon frequency band: (upper) the present paris Plan arrangement showing the modulating side-tones (lower), the new Geneva Plan narrow channels. In both cases the sidebands of the Morse transmissions are omitted.

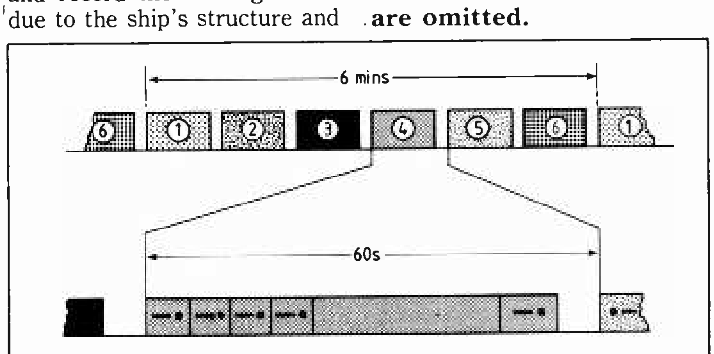

Fig. 4. Transmission sequence of a group of six radio-beacons. Transmissions start on each minute of the clock and are identified by callsigns transmitted in Morse code.

Acknowledgements
The author acknowledges the advice of Mr F.E.J. Holden of Trinity House Lighthouse Service and Mr W. Paterson of the Northern Lighthouse Board in the preparation of this article.

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4. Bozic, S.M., 'Digital and Kalman filtering', Edward Arnold, London 1979.
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to apply corrections automatically, the Paris Plan requires the errors to be plotted and corrections applied by the operator!

These criticisms of the present system — together with a call for much greater automation of receivers — have led to new radio-beacon transmission standards being agreed: in April 1992 the Geneva Plan of 1985 will replace the Paris Plan of 1951.

The new Geneva plan totally abandons the use of modulating tones. The resulting narrow-band transmissions can be spaced by only 500Hz, so creating 62 channels, in place of the previous 14, in a slightly-expanded band (bottom of Fig. 3). Although these are sufficient channels to do away with the grouping of beacons and allow every beacon to operate continuusly without mutual interference, some national administrations will continue to group many of their beacons. They argue that navigators find it more convenient to receive beacons in the same area on a common frequency. In no case, however, will there be more than three beacons to a group.

At first glance, the transmission sequence in Fig. 5 looks remarkably little altered: the long transmissions have been retained — though slightly shortened — for the use of hand-held receivers. The Morse code identification is still there too, but the carrier is keyed instead of the modulation. This means that receivers must have beat-frequency oscillators (b.f.os) but most already have them to receive certain (A1A) aeronautical radio-beacons.

In fact, the new transmissions are compatible with the old receivers, even though the channels have been packed so much more tightly together. Most small-craft receivers already have very narrow bandwidths, since they require only the carrier for direction-finding. The Geneva Plan protects the older Convention ship receivers which have wider passbands by not allocating adjacent channels to beacons in adjacent areas. So the existing receivers should take the changes in their stride and no-one is forced to buy a new receiver.

The 'revolution' is in the short transmissions, shown in Fig. 5, which are radiated at one-minute intervals and allow a new generation of 'high-tech', automatic, processor-controlled receivers to be developed. Beacons which are grouped in threes will each transmit rapidly in turn so that these high-tech receivers can take and store sets of bearings with negligible skew errors at one-minute intervals.

But the short transmissions contain provision for something more: the identity, latitude and longitude of the beacon transmitted in digital form. Using this information, together with the measured bearings, the receivers will compute the ship's position and show it in digital form or even on a moving map display. The data transmissions will use narrow-band frequency-shift keying — either conventional f.s.k. at 100 baud, +/− 85Hz shift (similar to the marine telex system) or minimum shift keying (m.s.k.) at 40 baud. The choice between f.s.k. and m.s.k. will be made by a World Administrative Radio Conference in 1987.

Although these data transmissions are not essential to high-tech. receivers, their great value is in providing rapid and immediate access to up-to-date information. Navigators are supposed to note and record all changes of radio-beacon parameters — a tedious task. Because the data transmissions will make this process more certain — and safer — several administrations, including the UK, are planning to introduce them as soon as the Geneva Plan comes into force.

The short transmissions with their data signals will lead to a major advance in radio direction finding, but the possibilities start to get really interesting when one thinks of putting a processor in control of the tuning of the receiver — so creating a scanning receiver which can step through the beacon frequencies. When first switched on, the receiver would have no idea of its position. It would locate itself by scanning through the radio-beacon channels for a period of three minutes, building up a record of the strengths and signal-to-noise ratios of all the signals received. The strongest transmissions would then be identified either by receiving their data transmissions or by comparing the frequencies and time-slots of the transmissions with radio-beacon data stored in the receiver. The bearings of these beacons and the ship's heading would also be measured. Then, using all this data, the processor would calculate the ship's position, taking into account not just the bearings of two beacons but weighting the contributions of all nearby beacons in accordance with their signal-to-noise ratios.

The information about each beacon which is transmitted or stored will also contain its 'protected range' — the area within which the Geneva Plan ensures that its signal is at least 15dB stronger than that of any other beacon which shares its channel. This information will allow the processor to check that the ship is within the protected ranges of the beacons it uses to calculate its position.

Once the receiver has obtained an initial fix, it continues to track the vessel, displaying its position continuously. The simplest receivers would recalculate position coordinates

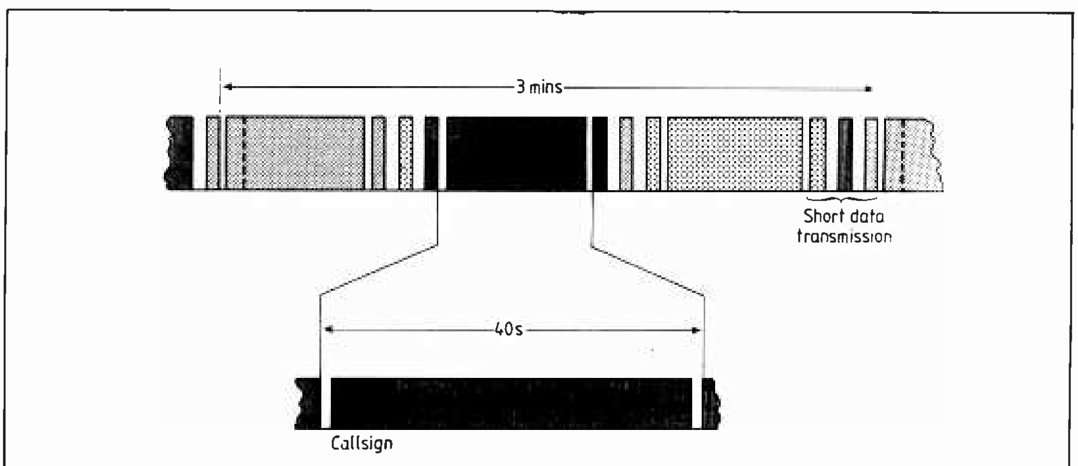

Fig. 5. Under the new Plan, some radio-beacons will be in groups of three, although many will transmit continuously on individual frequencies. The Morse transmissions are retained and short data transmissions are introduced at one-minute intervals. New 'high-tech' direction-finders will use these to measure bearings and read the beacons' identities, locations and ranges.

each time a bearing was measured. Cleverer receivers would use a Kalman filter[1] to model the dynamics of the ship, modifying and displaying the position estimates continuously on a moving map display. Position inputs from other navigation receivers could be combined to give an integrated navigation system.

So the new transmission standards make possible the development of revolutionary direction-finding receivers which operate wholly automatically, providing the navigator with a continuous view of his position. No such receivers exist, of course, and it is sensible to question when — or even whether — they will be appear. To create such receivers requires no technique is not already known and understood nor any which is especially expensive — as ever in electronics, the greater the role of the processor, the lower the production cost. The most advanced direction-finders already compute positions automatically, using beacon data typed in by the operator who must also specify the beacons to be used. The new transmissions simply remove the restrictions on the further development of such receivers, providing automatic input of beacon data, automatic selection of beacons and easier identification.

If there is no technical obstacle to the development of these high-tech receivers, will their development be plain sailing? Pessimists would say not — pointing to the falling costs and ready availability of small-boat receivers for the hyperbolic navigation systems (several for Decca Navigator alone), the rapidly growing use of satellite receivers and the promise of NAVSTAR. "D/f", they say, "is dead"!

But d/f has been a-dying for years and, while doing so, maddeningly continues to grow! There are now more radio-beacons and more receivers than ever before. It has been estimated by the International Association of Lighthouse Authorities (IALA) that throughout Europe, a quarter of a million people depend on direction-finding as their primary means of radio navigation, whilst some 57% of Convention ships report that they still use d/f.

Part of the reason is that, while Decca and LORAN-C are only available in parts of the world (not by any means in all of Europe), while present satellites give quite infrequent position fixes with significant errors due to the vessel's movement and NAVSTAR is subject to delays and fiscal cut-backs, radio-beacons are available in both advanced and developing countries. They are operated in each state by local administrations, not by overseas government agencies or companies; their technology is simple and operating costs low.

One or two possible glimpses of the future have been given by the French, who have suggested that radio-beacons will not so much die as be metamorphosed into something new. For some years certain French radio-beacons have transmitted 'differential Omega' data. Omega is a world-wide, v.l.f. hyperbolic navigation aid. Because of periodical changes in the ionosphere, Omega receivers experience position errors which are substantially constant over large areas. So the errors measured at fixed stations on land are broadcast as 'differential Omega corrections' and used to correct the fixes of marine receivers in the same area. The US Coast Guard are likewise proposing to use radio-beacons to broadcast differential data to improve the accuracy of fixes made using the proposed NAVSTAR (GPS).

In addition, the French have developed and installed a hyperbolic radio navigation system — RANA — operating in the radio-beacon frequency band[5] and IALA are studying the possibility of precisely synchronising the carriers of groups of beacons to form hyperbolic systems. These beacons could be used not only for good old-fashioned direction-finding but simultaneously for precise hyperbolic navigation to accuracies of a few metres!

Whether that will happen or not I do not know. But I suggest that the next few years will prove interesting and that, in its 'death throes', radio direction-finding will make far more waves than many suspect. ■

FEEDBACK

BLACK BOXES

The magic of amateur radio still exists and, in some ways, with greater power, despite the proliferation of black boxes. High equipment costs do present problems to newcomers to the hobby and to the image amateur radio presents to the public.

Outsiders look upon amateur radio as 'more expensive CB' and turn away. People generally are unimpressed with communications technology: crystal-clear colour tv coverage of cricket in Australia or the latest pictures from Uranus are taken for granted.

There is nothing wrong with radio amateurs using black boxes, however expensive. Japanese equipment manufacturers release new models every year and people buy them. It must be fun being wealthy! As far back as I can remember, big powerful stations have existed in places such as Kilowatt Alley, but the casual listener is not to know how those operators are qualified to run expensive equipment. I know that many of them have started on the factory floor, worked their way up through all aspects of electronics design and manufacture, to retire as multi-national company directors. They are entitled to enjoy the amateur radio they can afford.

We have to accept that black boxes are and ever will be an established part of amateur radio. Thanks to new technology and manufacturing techniques, equipment now represents far greater value per pound earned than in the 1950s. But there is a very great deal that experienced amateurs can do to portray the existence of the low cost approach to our hobby.

These days, beginners come into amateur radio 'backwards', starting with v. or u.h.f. f.m. with zero interference and no 'need' for internationally recognised operating procedures, then progress into h.f. and wonder what hit them! The B licence causes problems in forcing one to start at v.h.f., where it is difficult to home brew gear, so one is compelled to buy. It might be better to have beginners introduced directly into h.f. where a valve oscillator/p.a. transmitter is within everyone's reach.

The formative years of pre-licence short-wave listening are missing, so there is a great need for magazine articles, club lectures and shack visits, to fill the gaps in the amateur radio education process. Dealers need to advertise their black boxes in order to make a living: consequently magazines, including the RSGB Radcom, unavoidably present the expensive image that turns a lot of potential enthusiasts away from the hobby. So there is a need for as much exposure of el cheapo amateur radio as possible, such as construction information, QRP and SWLing.

Public interest can be roused. Try featuring Morse code communication at your club's next appearance at the local hobbies exhibition or rally. You'll be amazed how the public associates old up-down key technology with 'real radio'. A microprocessor c.w. decoder and v.d.u. make the interest even greater.

The future of amateur radio depends upon us making the most of new technology and keeping alive vital interest in the basics of radio, communication and electronics.

Denzil S. Roden, G3KXF
Sompting
Lancing
West Sussex

YES MINISTER

The letter from David Rudd of the Department of Transport (March 1986) well illustrates the capabilities of innovation and originality that our public servants have. The abdication of planned and responsible spectrum allocation in favour of the discredited monetarism of his current masters is a perfect though late demonstration of the supine theorising to which our country is subject.

If, as he alleges, the spectrum is abused by vandals, selfish, large, and obdurate, using outdated techniques and unsuitable frequencies, is it not the fault of our public servants? Are the established bully-boy users to be confirmed in their place by the size of their purse? Do the "small latecomers" have bigger purses? If there are bad practices, stop them. In this regulation-ridden society I am sure that suitable regulations exist. If they too are out of date, I would be happy to offer my services, but to pretend that spectrum renting will solve abuses generated by managerial deficiencies is an arrogance.

Another arrogance is the pretence that the present secret practices of allocation would somehow be ended by the transfer of money. Is it not possible for administrators to display their competence in public? The dissemination of claptrap through the media of papers, lectures, letters etc. still leaves it as claptrap; it cannot be mistaken for a display that would bring any credit to the propagator.

I will always be indebted to the Department of Transport for defining "arcane" for me, but now they have no buses to run could they leave the spectrum alone? It may well need attention but surely not from them.

D. E. Kershaw
Marton
Blackpool
Lancashire

ELECTROLYTICS AND DISTORTION

I have read with interest, in February 1986*E&WW*, letters from White and Self, on the subject of electronic components affecting the subjective sound quality of audio amplifiers.

White seems to sit on the fence and invoke a whole host of variables along the record/replay chain to explain perceived differences in the final sound quality. Self uses a very strange logic to 'prove', that because his and others' tests on capacitors show only limited deviations from the ideal, then somehow they cannot affect sound quality. Self argues that the proponents of 'better capacitors' have dreamt up "new effects", which Self argues cannot exist without "a theoretical mechanism for the operation of the effect that is logically consistent if not actually plausible".

Does Mr Self genuinely believe that an implausible theoretical mechanism is of any value in furthering the present state of development of audio amplifiers?

In the real world, a great many well liked and widely sold amplifiers, make extensive use of non-aluminium electrolytic capacitors. Aluminium electrolytic capacitors are certainly the cheapest; hopefully manufacturers that use non-aluminium ones have a good reason for doing so. Amplifier manufacturers tend to make more sales and therefore profit, when their amplifiers sound better than their competitors and I think Mr Self should give credence to this fact and examine its implications.

Familiarity with a range of presently available amplifiers reveals that non-aluminium electrolytics are prevalent in very low level circuitry, in direct contradiction to Mr Self's implausible depolarisation theory which predicts quasi-perfect behaviour from aluminium types at these tiny signal levels.

I agree that these subjective observations should be confirmed by suitable tests and statistical analysis but I suggest that manufacturers have little to gain from this. It can be more properly explored in university research departments, if there are any left to do this work after current government cuts. Hopefully we may also see a capacitor model produced from measurements down to microvolt and nanoamp levels, which will predict non-linearities of an audible proportion.

Mr Self knows of no mechanism whereby a sinewave can be left intact and yet music 'mangled'. There exists a phenomenon called phase distortion which can be of such a magnitude as to render speech unintelligible after transmission over, for example, long unloaded telephone lines. This is quite a serious distortion when one considers that speech, when infinitely clipped is still intelligible. Furthermore a linear low-pass filter, at say 100Hz, will not produce any harmonic distortion but can be said to mangle music considerably.

From my present (unconfirmed) observations (a) aluminium electrolytics are the worst sounding capacitors commonly available, and (b) back-to-back aluminium electrolytics (which incidentally will not cyclically depolarise) are little, if any, better.

B. Powell
Crimson Elektrik
Stoke-on-Trent

VON NEUMANN

I was somewhat disappointed by the January article (p.6) "Von Neumann's elephants." There are several statements with which I would take issue. Computable Numbers is certainly a landmark paper in the history of numerical methods. However, modern computers did not start to appear until some years later.

The machine described in Turing's paper does not have a Von Neumann architecture. The program quite clearly resides in the "head" in the form of "configurations", which approximate to the routines being executed at any moment.

Furthermore (though I am open to correction on this) I believe that the machines on which Von Neumann actually worked did not have subroutine capability, being effectively large calculators. There is a case to be made for all modern computers being derived from the Babbage architecture and the machines designed and worked on by Turing and others after 1945. Turing's major claim to fame, I submit, is the profoundly practical nature of his genius, and the fact that (unlike other mathematicians) he was prepared to teach himself the electronic engineering he needed to make his prosposals concrete.

RISC computers are one thing, and the data-driven architectures alluded to in the article are quite another. The basis of the RISC principle is the building of fast machines by limiting the instruction set to instructions and addressing modes that can be executed without appreciable microcode, while providing a partly exposed microarchitecture that provides good hooks for complex operations. RISC machines typically employ numerous registers to speed context switching but this is not essential. The Pyramid superminicomputer and the new Acorn ARM processor are members of the species; the TMS32010 DSP uses RISC techniques to such effect that its execution speed is comparable with bit-slice designs. RISC machines do not avoid the Von Neumann bottleneck, however; in fact they may actually worsen it in one respect. Microcoded processors typically do not use the buses with great efficiency (in fact the old 6502/6800 designs leave the bus dead for half the memory cycle time.) It is thus possible to have multiple processors sharing one set of utilities. A RISC machine with highly efficient bus utilisation cannot share the bus without having to wait for program and data.

If I may suggest a slightly different analogy, the new generation of 32 bit c.p.us resemble Rolls-Royces and the RISC processors resemble racing motorcycles. (The Intel 386, with an enormous array of bells and whistles, perhaps more closely resembles one of those Cadillacs modified for desert oil sheiks, but this is getting rather silly.) I suspect choice is largely a matter of market forces or personal preference. The Transputer is apparently a way out of the bottleneck — it has serial links between processors to relieve the bus overhead problem — but consideration shows that some time must be consumed in interprocessor communication. No doubt Inmos have looked very hard at the trade off between parallel processing costs and sophisticated memory architectures for processor-to-processor messaging, but my own feeling is that the Transputer architecture has as its major virtue the ease of connecting multiple processors rather than the avoidance of bus limitations.

One of the worst bottlenecks in computing is the backing store. The problem is that where numerous users share a large data base, any modification made by one must reach all. Reductions in the cost of semiconductor memory do not necessarily help this problem since the ability to store very large amounts of data in ram transfers the bottlenecks from disc to ram without changing its nature. My own pessimistic conclusion is that it is the field of mass storage peripherals that we need a revolution — not in c.p.us. Historically, peripherals have always been the performance limiters, especially when one considers total program run-time rather than c.p.u. execution time. Anybody who doubts this should reply honestly to one simple question; last time your driving licence was updated, how long did it take?

Martin Bacon
Taunton
Somerset

CLASS B OUTPUT

There would seem to be very few new circuits under the sun. A circuit similar is that described by Mr Nalty in 'Circuit Ideas' (February 1986) was previously published by Mr Edwins in *Hi Fi News and Record Review*, October 1971. This circuit differed only in detail from that submitted by Mr Nalty; in the Edwins circuit three diodes were used to generate the bias voltage.

Having built one of these circuits some ten or twelve years ago, and used it ever since, I would state that the quality of sound it helps produce is significantly superior to the traditional class B circuit. When first built the circuit was extensively tested for distortion both at high and low signal levels. The only conclusion reached was that better measurement equipment was required, as it was discovered that what was being measured was the 'distortion' output of the oscillator. The equipment used was manufactured by Radford and was of a very high standard — type numbers have been forgotten.

R. T. Wrigley
Ware
Hertfordshire

MATHS PUSHERS

I feel that Ivor Catt is aiming at the wrong target with his polemic, in recent issues, against mathematics and mathematicians. I would like to take one example, a topic which he has touched on several times over the years in *WW*: the use of Fourier series.

Mr Catt has held up to scorn the assertion of a certain FRS that "reality is made up of sine waves", and has pointed out that Fourier expansions are no more than a computational tool, sometimes useful and sometimes not. It is mere fantasy to suppose that the description of a single square pulse as a continuous spectrum of sine waves has a better claim to reality than the pulse itself. Fantasy becomes absurdity when one contemplates the action on such a pulse of a perfect low-pass filter (which is defined by what it does to sine waves): its output must begin before the leading edge of the pulse arrives.

All this is true. But is it the fault of mathematicians? Around ten years ago I was studying pure mathematics at Edinburgh University. I recall that in the course on partial differential equations, the lecturer pointed out (as Mr Catt has done in your columns) that the most general solution of the wave equation:

$$\frac{\partial^2 u}{\partial x^2} = \frac{\partial^2 u}{\partial t^2}$$

is $u = f(x+t) + g(x-t)$, for arbitrary (sufficiently differentiable) functions f and g, and not, as is sometimes supposed, some complicated Fourier series. Who, then, are these people who believe that "reality is made of sine waves"? I went to the library of the university where I currently work, and looked at a random selection of books on p.d.es on the mathematics shelves. All of them gave the general solution, and those books which treated Fourier expansions at all did so only at a much later point. Then I looked on the shelves for physics and engineering. Out of ten books, only two gave the correct general solution. The remainder all dove straight into separation of variables, superposition and Fourier transforms, and never mentioned the general solution at all. It seems that physicists and engineers do not suffer from too much mathematics, but too little, and too little understood.

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ENERGY TRANSFER

There is no problem with electric current theory as questioned by Mr Fant (Letters, March 1986).

The resistance of a wire is inversely proportional to cross-sectional area at zero frequency (d.c.). Without getting bogged down in EM theory (Theory M. Theory H and Ivor Catt's Theory C!) it is broadly true to say that a time-varying EM field cannot exist inside a perfect conductor and that when it penetrates a good, but not perfect conductor, its magnitude drops off as the depth increases. A good analogy is that it is 'seeping' into the conductor, and the rate of seepage depends on the conductivity and the frequency. The skin depth is a convenient measure of this rate of seepage. Since the drop off is exponential, it is useful to define the skin depth as the depth at which the magnitude of the field has dropped to 1/2 or $\exp(-1)$ of its surface value. The current is not confined to a surface region as Mr Fant perhaps thinks, and the skin depth is not a magic depth below which current cannot penetrate.

At high frequencies, the skin depth is indeed small — a few micrometres at v.h.f., but even at 50Hz the skin depth is only about a centimetre. There is no point, then, in making power cables more than a few centimetres in diameter, as the central portion would not carry much current. I am led to believe that this is why the cables on overhead transmission lines are often bunched as a group of four small cables rather than one larger one.

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MAXWELL'S EQUATIONS

Maxwell's equations are merely more precise formulations of the following phenomena, verifiable by experiment:
1. Changes in the spatial distribution of an electric field are attributable to a magnetic field which changes as a function of time.
2. Changes in the spatial distribution of a magnetic field are attributable to an electric field which changes as a function of time.

Maxwell's equations merely state the empirically observed phenomena described above in the "shorthand" notation of vector analysis, a particular branch of mathematics which lends itself very nicely to the expression of spatial and temporal changes in a symbolic form and thereby avoid the cumbersome and imprecise sentences written above.

In my opinion, Maxwell's great contribution lies not in any inherent truth or mystical quality (not to mention "obvious truism") attributable to the equations themselves but in the manner in which it made possible the derivation of a unified theory that explained diverse phenomena manifested in Faraday's experiments covering a broad field known today as electrostatics, electric circuit and network theory (both lumped constant and distributed parameter versions), skin effect, antennae, wave propagation, etc. from just two basic equations stating "obvious truisms". As a matter of fact, Maxwell's equations actually predicted the existence and behaviour of radio and microwaves since, at the time of their publication, these had not yet been discovered.

It seems that Maxwell's equations are beautiful examples of the so-called scientific method, whereby a large and diverse group of natural phenomena observed experimentally can be explained within the framework of a unified theory, which is even capable of predicting future discoveries.

Maxwell's equations make statements of obvious truisms much like Euclid's postulates from which a lot less obvious truisms were later derived, much to the surprise of everyone. However, Euclid's postulates were not the last word in geometry, much as Maxwell's equations were not the last word in electromagnetic theory.

Catt's rather extertaining equations presented by him as a parody of those of Maxwell, might still turn out to be great milestones in science, should they somehow become recognized as a theoretical framework for a large group of phenomena observed empirically.

I would like to present a modest contribution of my own, most humbly called Shaw's theorem. To conserve space, illustrations will be dispensed with. In a recent scientific experiment. I placed an apple on the table, and a few minutes later, another apple was also placed thereon. This experimental fact may be expressed in the following mindboggling mathematical jargon:

$a + a = 2a$

This, of course, represents only an obvious truism, since it is only a symbolic expression of the facts observable in my experiment. (The astute reader might even predict, as an inevitable outcome of my revolutionary discovery, that if the symbol a means a banana, the equation would still be valid! But let us leave such discoveries to posterity . . . before Mr Catt would hastily remind us that the above equation does not teach us anything about fruit . . .)

It seems to be fashionable today to say that scientific theories are nothing but tautologies and obvious truisms, purposely obscured by mathematical jargon. In defence of the mathematical jargon, I wish to say that motion and change in time and space will, if expressed in mathematical "shorthand" notation, necessarily involve "a mixture of integrals, divs, curls" called "headspinning brew" by those who never understood their function as merely shorthand symbols, easily manipulated and visualized by means of simple rules even by first-year university students. As to tautologies and obvious truisms, logical thinking is a process which needs to start from a set of first principles or axioms, accepted by everyone as being obvious truisms, unprovable and fundamental. Thus any sort of "truth" derived from a set of axioms can only be relative and confined with respect to the framework of the axioms from which it was derived. Change one of the axioms and you end up with an entirely different set of "truths". (This actually happened to one of Euclid's postulates which gave rise to a new kind of geometry.) In fact, you can invent any set of axioms you wish and derive any "truths" from them you wish. These, however, become scientific truths only whenever verified by experiments, providing that somehow they relate to our real world (another bad choice of words). In fact, Mr Catt's funny equations teach us just that.

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XY PLOTTER

In the excellent 'X.Y. plotter update' article in December 1984, author P.N.C. Hill, the formulae printed for the calculation of the best next step to take in the plotting of a 'straight line' (at the bottom of page 77) requires, on most computers the use of 'floating point' routines, which of course tend to be relatively slow and not directly amenable to translating into a machine code program.

A rework of the formulae is shown below: it now requires for its solution only the use of simple integer additions, and can be coded up with no great difficulty (my own Z80-based home-built plotter uses this method).

It is written in program form as the computer's own screen can demonstrate the line draw.

```
10 INPUT "LINE FINISH
POINT (X)"; XF
20 INPUT "LINE FINISH
POINT (Y)"; YF
30 B=XF
40 C=YF
50 F=0
60 IF F=1 THEN A=A+YF:
C=C+YF
70 IF F=2 THEN D=D+XF:
B=B+XF
80 IF ABS(A-B) <ABS(C-D)
THEN 90: ELSE 100
90 Y=Y+1: PLOT X,
Y:F=2:GOTO 60
100 X=X+1:PLOT
X,Y:F=1:GOTO 60
```

The program is shown only working in the first quadrant, lines 90 and 100 being altered to suit the machine in use.

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by R.F. Coates

68000 board – 6

Bob Coates ends his description of the monitor software with details of some applications

```
LOC     OBJECT   M  STAT E LINE SOURCE LINE

                             1 *
                             2 * example 1
                             3 * Demonstrates using breakpoints and the trace function
                             4 *
                             5 lab     asect   rom
000000                       6       org     h'400400'
                             7 *
400400 7000             1    8       moveq   #0,d0          * clear 'd0'
400402 7200             2    9       moveq   #0,d1
400404 207C0000         3   10       movea.l #h'100',a0     * set 'a0' to $100
       0100
                            11 *
40040A 5280             4   12 loop  addq.l  #1,d0          * increment 'd0'
40040C 0601000A         5   13       addi.b  #10,d1         * add 10 to 'd1' (byte operation only)
400410 5588             6   14       subq.l  #2,a0          * subtract 2 from a0
                            15 *
400412 60F6             7   16       bra     loop           * and loop for ever
                            17 *
400414                      18       end
```

```
LOC     OBJECT   M  STAT E LINE SOURCE LINE

                             1 *
                             2 * example 2
                             3 * Demonstrates how system calls are used and how 'pdatam' call
                             4 * selects display format according to column mode set.
                             5 *
                             6 renter  equ   0              * call number of 'renter'
                             7 pdatam  equ   6              * call number of 'pdatam'
                             8 *
                             9 lab     asect rom
000000                      10         org   h'400430'
                            11 *
400430 4DFA000A         1   12         lea   string,a6      * load 'a6' with address of 'string'
                            13 *
400434 4E4B             2   14         trap  #11
400436 0006                 15         data  0,pdatam       * call 'pdatam'
                            16 *
400438 4E4B             3   17         trap  #11
40043A 0000                 18         data  0,renter       * return to monitor
                            19 *
                            20 string  equ   $
40043C 48656C6C             21         data  'Hello from "KAYCOMP". This example is '
       6F206672
       6F6D2022
       4B415943
       4F4D5022
       2E205468
       69732065
       78616D70
       6C652069
       7320
400462 8D8A                 22         data  h'8d',h'8a'
400464 746F2064             23         data  'to demonstrate "PDATAM".'
       656D6F6E
       73747261
       74652022
       50444154
       414D222E
40047C 0D0A                 24         data  h'0d',h'0a'
40047E 42796520             25         data  'Bye-Bye'
       427965
400485 00                   26         data  0
                            27 *
                            28 *
400486                      29         end
```

To illustrate some of the techniques we have discussed, we will now look at some simple programming examples.

We shall touch briefly on accessing the duart and p.i.t. but these devices are very complex and it is beyond the scope of this series to deal with them in any depth. Interested users should therefore obtain the Motorola data manuals. These are fairly voluminous documents! The data manuals will be obtainable from Magenta Electronics, who are producing a package consisting of manuals for the processor and for the duart and p.i.t.

When using Kaycomp with only a terminal and with no access to a 68000 assembler, it is feasible to assemble by hand but it is a somewhat laborious task. This problem will be solved by the introduction of the eprom-based assembler for the board.

Other recommended reading is '68000 Assembly Language Programming' by Kane, Hawkins and Leventhal, published by Osborne/McGraw-Hill. The necessary information to hand-assemble is available from this, the MC68000 User's Manual and the MC68000 Programming Card from Motorola.

In the examples which follow, the listings were produced by an assembler which uses a different convention for denoting hex constants from Motorola's, h '1F' being equivalent to $1F etc. The assembler directives are also different, but should be self-explanatory.

The examples start at address 400400_{16} which is the lowest ram address that the user may use; 400000_{16} to $4003FF_{16}$ are reserved for use by the monitor.

Example 1

A very simple example is sufficient to demonstrate the trace function and the use of breakpoints when running a program. Using the *MO* command, enter the object code, which is the second column of the listing, into memory at the address shown in column 1.

The first three lines of the program preset three of the processor's registers, d_0, d_1 and a_0 with 0, 0 and 100_{16} respectively. The loop section of the program then adds 1 to d_0, 10 to d_1 and subtracts 2 from a_0.

First try putting a breakpoint at address 40040A. Now run the program using *GO* 400400.

The registers should now be displayed with their preset values as the breakpoint has been hit.

Next set another breakpoint at 400412. This must be a different breakpoint number from the previous one, as we shall continue from the previous break.

When we use the *CN* command, it looks to see which breakpoint was encountered and starts from there; so it must not be moved in the meantime. *CN* will restart the program, cancelling the first breakpoint and displaying the registers again as it encounters the next one. Here we should see that the registers have been altered by the appropriate amount.

The operation may be seen more clearly if the trace function is used. Remove the breakpoint at 400412 by setting the address of that breakpoint to 0 using *Bn*. Now start the program using *TR*.

Enter 400400 for both trace and program start. Registers should now be continuously displayed after each instruction is executed. Execution can be suspended by control-S.

Leave it running for a while and see what happens to d_1. The *add* instruction on this register is byte-length only so it will be seen that when the count passes FF it wraps around to 00. The upper six digits always remain unchanged.

Example 2

Our second example illustrates monitor calls and how the 40/80 column formatting may be used.

The *lea* instruction loads a_6 with the address of the start of the string. Then *pdatam* is called with the two lines . . .

trap #11
data 0, pdatam

The word *data* is an assembler directive which means 'form a byte containing the value of 0 and *pdatam*'; *pdatam* is equated to 6, so the assembler inserts this value.

After printing the string, which is terminated by the null byte, the next *trap* instruction causes a return to the monitor.

Try first running this program with the column mode at 80, then at 40. You will see that in the 40-column mode an extra new line is inserted after the word 'is'. This is due to the data line h '8d', h '8a' which are the Ascii codes for carriage-return and line-feed with bit 7 set to 1. The description of *pdatam* explains the difference.

Example 3

The MC68230 peripheral interface/timer i.c. is not used by the monitor, so this example will check whether the device is working or not (if fitted).

The base address of the p.i.t. is h 'A00001' and the first line sets a_0 to this value. All references to the p.i.t. are then made using the 'register indirect with offset' addressing mode. The three registers of the device we are going to access are equated to their offset from the base address of the device.

The next line sets up the mode of operation of the p.i.t. (refer to the manual) and line after sets the data direction register for port A of the 68230 to all eight lines as outputs.

Then the program enters a loop where the port A outputs are set alternately to 01010101 and 10101010 with a delay in between. This delay is about one second with a 10MHz clock and pro-rata for other clock frequencies. On

```
LOC    OBJECT   M  STAT E LINE SOURCE LINE

                         1 *
                         2 * example 3
                         3 *
                         4 * Gives a simple example of accessing the MC68230 PI/T
                         5 * it sets Port A as all outputs, then puts 'h'55' and '0xaa' alternately
                         6 * on the Port, with a pause between each change
                         7 *
                         8 pit      equ     h'a00001'       ! Base address of pi/t
                         9 pacr     equ     h'c'            ! Port A control register offset from base
                        10 paddr    equ     h'4'            ! Port A data direction register offset
                        11 padr     equ     h'10'           ! Port A data register offset
                        12 *
                        13 lab      asect   rom
000000                  14          org     h'400490'
                        15 *
400490 207C00A0    1    16          movea.l #pit,a0         ' set 'a0' with PI/T base address
       0001
400496 117C0000    2    17          move.b  #0,pacr(a0)     ' set mode 0, submode 00
       000C
40049C 117C00FF    3    18          move.b  #h'ff',paddr(a0) ' set Port A as all outputs
       0004
                        19 *
4004A2 117C0055    4    20 loop     move.b  #h'55',padr(a0) ' set Port A to  01010101
       0010
4004A8 610A        5    21          bsr.s   delay
4004AA 117C00AA    6    22          move.b  #h'aa',padr(a0) ' and now to  10101010'
       0010
4004B0 6102        7    23          bsr.s   delay
4004B2 60EE        8    24          bra     loop            ' and do forever
                        25 *
4004B4 203C000F    9    26 delay    move.l  #1000000,d0
       4240
                        27 *
4004BA 5380       10    28 delay1   subq.l  #1,d0           ' loop round killing time
4004BC 66FC       11    29          bne     delay1
                        30 *
4004BE 4E75       12    31          rts
                        32 *
                        33 *
4004C0                  34          end
```

```
LOC    OBJECT   M  STAT E LINE SOURCE LINE

                        1 * Example 4
                        2 *
                        3 * Demonstrates how to talk directly to the DUART and how user vectored
                        4 * interrupts are handled on 'Kaycomp'
                        5 * The DUART is connected to IPL1 giving a level 2 interrupt
                        6 *
                        7 duart    equ     h'800001         * base address of DUART
                        8 imr      equ     h'a'             * offset from base of interrupt mask reg.
                        9 ivr      equ     h'18'            *  "     "    "   " interrupt vector reg.
                       10 trba     equ     6                *  "     "    "   " tx/rx buffer reg. A
                       11 isr      equ     h'a'             *  "     "    "   " interrupt status reg.
                       12 cra      equ     4                *  "     "    "   " command reg. A
                       13 *
                       14 lab      asect   rom
000000                 15          org     h'4004c0'
                       16 *
4004C0 2C7C0080    1   17          movea.l #duart,a6        * point 'a6' at base of DUART
       0001
                       18 *
4004C6 107C0040    2   19          move.b  #64,ivr(a6)      * put vector #64 in int. vector reg.
       0018
                       20 *
                       21 * put first the 'JMP.L' opcode and then the absolute address of exception
                       22 * handling routine in vector #64 RAM jump location
                       23 *
4004CC 33FC4EF9    3   24          move    #h'4ef9',h'400082'.l    * 'JMP.L' opcode
       00400082
400404 23FC0040    4   25          move.l  #excep,h'400084'.l      * address of exception handling routine
       04EA0040
       0084
                       26 *
4004DE 107C0002    5   27          move.b  #2,imr(a6)              * unmask interrupts for char. received
       000A
4004E4 027CF9FF    6   28          andi    #h'f9ff',sr             * set proc. int. mask to level 1
                       29 *
4004E8 60FE        7   30 hangup   bra     hangup       * hang up in loop here, exit when exception calls
                       31 *
                       32 * User Interrupt Vector #64 handling routine
                       33 * Executed when character received, gets it and prints hex equivalent of
                       34 * ASCII character
                       35 *
4004EA 102E0006    8   36 excep    move.b  trba(a6),d0      * get character in 'd0'
4004EE 4E4B        9   37          trap    #11
4004F0 0009            38          data    0,9              * call 'out2hx' to print it as two characters
4004F2 4E4B       10   39          trap    #11
4004F4 0003            40          data    0,3              * and add a 'space'
                       41 *
4004F6 107C0024   11   42          move.b  #h'24',cra(a6)   * reset receiver
       0004
4004FC 107C0005   12   43          move.b  #5,cra(a6)       * and re-enable
       0004
400502 4E73       13   44          rte                      * return from exception
                       45 *
400504                 46          end
```

Supplies for this project are available from Magenta Electronics, 135 Hunter Street, Burton-on-Trent, Staffordshire DE14 2ST. The p.c.b. alone costs £18.90; with eproms and monitor, £41.78; with assembler also, £58.38. Prices include v.a.t., but please add 60p for postage.

looking on the port A pins on P5 with a 'scope, logic probe or even a voltmeter, you should see each output toggling.

Example 4

Now on to the interrupts. The interrupt output of the duart goes to the processor IPL1 input, the one on the Kaycomp wired for user-vectored interrupts. Accesses to the duart are made in a similar manner as in example 3 using 'register indirect with offset' addressing.

First the user interrupt vector number we are going to use, 64, is put into the interrupt vector register (i.v.r.) of the duart. This value is passed over the data bus during the interrupt acknowledge cycle to tell the processor which vector address to fetch. If the register is not set, it holds a default vector which points at the 'uninitialised interrupt vector'.

Later, try padding out this line with NOPs and see what happens, but operate 'reset' before running it.

Next in the program, the jmp.l instruction op-code and the address of the service routine are placed in the vector #64 ram block at h '400082'.

Finally, interrupts are enabled in the duart for characters received (refer to duart manual) and the processor's interrupt mask is set to level 1 — one lower than the level of the interrupt generated by ILP 1.

The program then hangs up in a loop waiting for an interrupt.

This may seem a little pointless (in practice the processor would be off somewhere doing something useful), but it serves to demonstrate the principle.

An interrupt will be generated when a terminal key is pressed and processing will jump to vector #64 location where it will find the ram address h '400082'.

There it will execute the jmp.l h '4004EA' instruction which is the start of the exception processing routine. This first gets the character from the transmit/receive buffer register (trba) of port A of the duart. The 'trap #11, 0009' call prints the two-character hex equivalent of the Ascii key; the next trap instruction adds a space after them.

The duart receiver is then reset and re-enabled, because the previous monitor calls (which were not designed to be used at the same time as duart interrupts) upset the receiver operation.

The 'return from exception' instruction then causes processing to return to the next instruction after where it left off, the 'hang-up' loop again, until the next interrupt.

```
LOC    OBJECT   M  STAT E LINE SOURCE LINE

                          1 *
                          2 * example 5
                          3 *
                          4 * Demonstrates using a G64 peripheral card and handling autovectored interrupts
                          5 * in this case the G64-IRQ, which goes to the processor IPLO.
                          6 *
                          7 base    equ     h'fff801'       * base address of ADC2 card
                          8 adc     equ     8               * offset from base of a-d read address
                          9 ddc     equ     h'c'            *   "    "    "  "  digital data channel
                         10 *
                         11 lab     asect   rom
000000                   12         org     h'400510'
                         13 *
400510 33FC4EF9     1    14         move    #h'4ef9',h'400016'.l    * put 'JMP.L' code in autovector 1
       00400016
400518 23FC0040     2    15         move.l  #excep,h'400018'.l      * and abs. addr. of handler routine
       053E0040
       0018
                         16 *
400522 207C00FF     3    17         movea.l #base,a0        * point 'a0' at base address of SYN-ADC2 card
       F801
400528 117C0000     4    18         move.b  #0,ddc(a0)      * select channel zero, interrupt disabled
       000C
40052E 11400008     5    19         move.b  d0,adc(a0)      * start conversion (store anything)
400532 117C0080     6    20         move.b  #h'80',ddc(a0)  * enable adc2 interrupt output
       000C
400538 027CF8FF     7    21         andi    #h'f8ff',sr     * set processor int. mask to level 0
                         22 *
40053C 60FE         8    23 hangup  bra     hangup          * and wait
                         24 *
40053E 7000         9    25 excep   moveq   #0,d0           * clear 'd0'
400540 01080008    10    26         movep.w adc(a0),d0      * get conversion in 'd0'
400544 E848        11    27         lsr     #4,d0           * right justify it
                         28 *
400546 223C0000    12    29         move.l  #10000,d1
       2710
40054C C0C1        13    30         mulu    d1,d0           * multiply by 10000
40054E 223C0000    14    31         move.l  #4095,d1
       0FFF
400554 80C1        15    32         divu    d1,d0           * and divide by 4095 for answer in mV
400556 02800000    16    33         andi.l  #h'ffff',d0     * truncate remainder
       FFFF
                         34 *
40055C 4E48        17    35         trap    #11
40055E 0017              36         data    0,h'17'         * call 'binbcd'
400560 2001        18    37         move.l  d1,d0           * bcd result in 'd0'
400562 4E48        19    38         trap    #11
400564 0008              39         data    0,h'b'          * print as 8 hex digits (out8hx)
400566 4E48        20    40         trap    #11
400568 0000              41         data    0,0             * and back into monitor
                         42 *
                         43 *
40056A                   44         end
```

Example 5

This example shows one way of accessing a peripheral on the G64 bus.

The card I have chosen is the Syntel SYN-ADC2 which is an analogue i/o card having eight 12-bit analogue inputs and two 12-bit analogue outputs. It is unlikely that many readers will have this card, but I include the example to illustrate the principles of external bus access and handling auto-vectored interrupts.

The card must be configured as follows:
Address switches — all on ($FFF801_{16}$, bottom of VPA).

J1 : 1 — 3
J2 : 1 — 2 and 3 — 4
J5 : 1 — 2
J6 : 2 — 4

An analogue input should be provided on P2, pin 15 (positive) and P2, any even pin (negative) for channel 0.

The G64-VPA range on the Kaycomp is FFF801 to FFFFFF; that is, the top 2K-bytes of the memory map. This is so that accesses to these absolute addresses may be made with a word-length address operand.

One of the above jumpers connects the interrupt output to the IRQ line of the G64 bus, which is in turn connected to IPL0, giving a level 1 interrupt. The a-to-d card generates an interrupt when a conversion is complete.

Channel zero is selected on the a-to-d card in the program after the jmp.l instruction has been set up in the autovector 1 ram space, as with the previous example.

The conversion is then started by writing (it does not matter what) to the a-to-d register.

The ADC2's interrupt output is then enabled and the processor's interrupt mask set to its lowest level, 0, to allow interrupts at level 1. It then hangs up and waits for the interrupt to occur, which will be about 35μS later after the a-d has finished converting.

Processing than jumps via address 400016 to 'excep'. Here, after clearing d_0, the 12-bit conversion value is obtained from the card and placed in d_0. The 12 bits are obtained by reading two consecute addresses of the ADC2 card, the eight most significant bits from the first and the four least significant from the second.

However, because there is no a_0 line on the 68000, the processor a_1 output goes to a_0 on the G64 bus and so consecutive addresses appear at alternative addresses to the processor. So we need, in this case, to read FFF809 and FFF80B.

Here the *move p* (move peripheral) instruction comes to the rescue. It addresses alternate locations (odd or even), two or four depending upon the size attribute, word or long-word.

The read word is shifted right four bits to right-justify it as, through a peculiarity of this card, the data comes out left-justified.

The value read will be between 0 and FFF_{16} (4095) for an input range of 0 to +10 volts. So next it is scaled to represent millivolts by multiplying by 10000 and dividing by 4095.

The *divu* instruction exits with the result in d_0, bits 0-15 being the integer result and bits 16-31 the remainder. We are not interested here in the remainder, so bits 16-31 are forced to zero. Next this binary value is converted to b.c.d. and then displayed as eight decimal digits, being the rsult of the conversion in millivolts ■

SmartWatch real-time clock with ram

Building components into a socket gives a real-time clock and battery-backed ram that plugs into many modern microcomputers without hardware modifications.

With most computers, adding a real-time clock involves at least plugging in a separate p.c.b. Adding non-volatile ram can mean yet another p.c.b..

A computer real-time clock needs address decoding, a crystal, power-down switching and a battery. Unless expensive electricially-erasable proms are used, non-volatile ram also requires power-down switching and a battery. Normally add-on clock and non-volatile ram facilities constitute two separate p.c.bs.

With SmartWatch however — the subject of our special offer on page 65 — the clock and all its associated circuits are built into an 8mm-high socket. What is more, the clock's lithium battery and power-switching circuits also connect to the top of the socket so the 8K-by-8bit ram fitted becomes non-volatile and remains so for 10 years.

Timekeeping information includes hundredths of seconds, seconds, minutes, hour, day, date, month and year. At the end of the month, the date is automatically adjusted for months with fewer than 31 days, including correction for leap years. Whether the clock operates in 12-hour mode with a.m./p.m. indication or 24-hour mode is selected by software.

Manufacturer of SmartWatch, Dallas Semiconductor produces various 'sockets', some with a ram and battery but no clock and some with a clock but no ram back-up facility so that eproms can be fitted. Other products include electronic keys and tags, an add-on serial port, silicon delay lines and an 'intelligent battery'. These are all available through Joseph Electronics in the UK.

Accessing SmartWatch

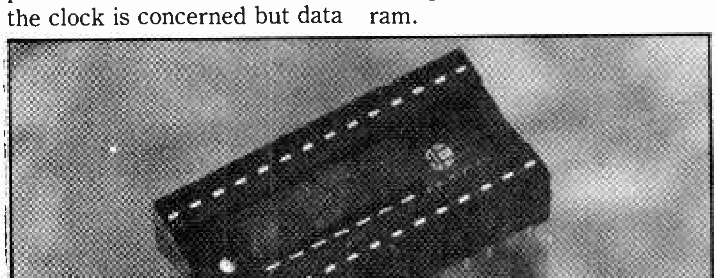
Plugged into a computer 8K-by-8bit ram socket, the device appears in the memory map as a normal 8K-by-8bit memory. Only when a unique 64bit data stream is sent to the socket does the clock respond. After this initiation stream, the next 64 bits written to or read from the memory area go to or from the clock.

This method of accessing the clock means that only one byte of processor address space is needed, and only when the clock is addressed. With many operating systems, the clock will only need to be read once when the computer is switched on. From then on, timekeeping can often be taken over by the computer.

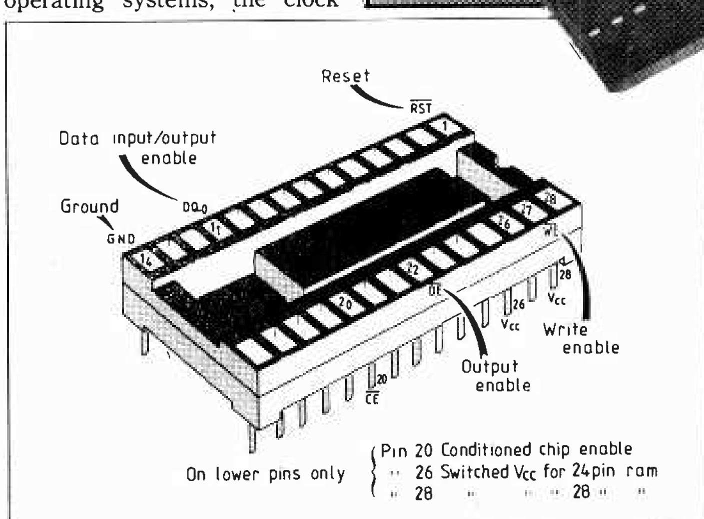
Any ram byte can be chosen for accessing the clock because the clock-access sequence through data-line zero depends only on states of the ram read, write, output enable and chip-enable lines, i.e. those lines indicated on the diagram. Address line transitions during this period are irrelevant as far as the clock is concerned but data is only transferred via data-bit zero. If need be, the one ram byte affected can be stored elsewhere temporarily while the clock is read.

Any read from the ram area sets the 64bit code pointer in the clock circuit to its first location, which means that when the clock is to be accessed, a read operation normally precedes the string of initialization bits to be written. It also means that should the initialization sequence ever be interrupted by a read operation, the pointer will be set back to the first code bit.

Minimum and maximum signal levels on all lines controlling the clock are 2.2V logic high and 0.8V logic low. Lines not controlling the clock go straight through the socket to the c-mos ram.



In some ram sockets, mainly in 6502-based computers, the output-enable signal is active during memory writing, which means that SmartWatch cannot be used without hardware modification. Next month we'll show such a modification and a SmartWatch control program for the BBC microcomputer.



All pins on the SmartWatch socket except pins 20, 26 and 28 pass straight through to the c-mos static ram.

by P.B. Unstead and A. Blunden

Eprom programmer for Apple II

The second in a series of laboratory add-ons for the Apple and other 6502 computers

Below: memory dump of the code generated by the main listing (right).

```
CC00   78 A9 00 8D C1 C0 8D C3
CC08   C0 8D C2 C0 A9 FF 8D C0
CC10   C0 A9 03 8D FE 03 A9 E0
CC18   8D FF 03 A9 3F 8D C3 C0
CC20   AD C2 C0 A9 34 8D C1 C0
CC28   AD C0 C0 58 A2 45 A0 15
CC30   84 23 20 4B CD 20 9D CF
CC38   29 03 D0 01 60 4A 4A 6A
CC40   85 F9 A2 30 A0 28 20 4B
CC48   CD A2 21 A0 99 20 4B CD
CC50   A9 A0 8D DE 07 8D DF 07
CC58   A9 C1 8D E1 07 A2 06 A0
CC60   15 20 08 CD A0 24 20 08
CC68   CD A0 95 20 08 CD A5 F9
CC70   10 20 20 2E CD 78 20 E6
CC78   CC A2 03 20 30 CD AD C2
CC80   C0 A2 04 20 30 CD A9 FF
CC88   8D C2 C0 A2 04 20 30 CD
CC90   A5 F9 05 FF 8D C0 C0 A2
CC98   08 20 43 CD 20 43 CD A5
CCA0   FE 8D C0 C0 A0 00 A5 F9
CCA8   10 14 B1 FA 85 E3 8D C2
CCB0   C0 20 2E CD A9 8B 20 A8
CCB8   FC 20 2E CD F0 0B 20 2E
CCC0   CD AD C2 C0 85 E3 20 2E
CCC8   CD 20 5C CD 20 7E CD F0
CCD0   0B 20 8B CD E6 FE D0 C7
CCD8   E6 FF D0 B4 A5 F9 10 03
CCE0   20 E6 CC 4C 00 CC A0 08
CCE8   A2 08 20 4B CD A5 FC 05
CCF0   FD D0 08 A9 C6 8D 56 07
CCF8   8D 57 07 20 3A CD A2 4C
CD00   20 4B CD 4C 9D CF EA EA
CD08   20 0B CD 20 9D CF 20 25
CD10   CD 0A 0A 0A 0A 95 F9 C8
CD18   20 9D CF 20 25 CD 15 F9
CD20   95 F9 C8 CA 60 C9 C0 90
CD28   02 69 08 29 0F 60 A2 08
CD30   48 8A 4D C3 C0 8D C3 C0
CD38   68 60 AD C3 C0 10 FB AD
CD40   C2 C0 60 8A 4D C1 C0 8D
CD48   C1 C0 60 98 48 BD FF C7
CD50   38 6A 99 4F 07 CA 88 90
CD58   F4 68 A8 60 A5 FC 29 07
CD60   D0 03 20 8E FD A5 E3 D1
CD68   FA 08 91 FA 20 DA FD A9
CD70   A0 28 F0 02 A9 DD 20 F0
CD78   FD A2 02 4C 4A F9 A5 FC
CD80   D0 02 C6 FD C6 FC D0 02
CD88   A5 FD 60 E6 FA D0 02 E6
CD90   FB 60
```

The real-time clock interface card which was described in last month's article included a 2K eprom programmed with firmware to run the clock. The remaining $1\frac{3}{4}$K-bytes are free to hold code to provide a variety of other useful functions, such as the one described here.

The 6821 p.i.a. consists of two parallel ports A and B each with two control lines $CA(B)_1$ $CA(B)_2$ and is located at the absolute address C0C0 using 7421 gates and 7425 gates to decode the address bus. The R/W (read/write) and E (enable) pins are driven directly from the edge connector of the Apple. The reset line, pin 34, is tied permanently high so that the chip can only be initialized under program control.

The eleven lines required to address the eprom are provided by the eight lines of port A programmed for output. For programming purposes the eprom is split into eight blocks each of 256 bytes.

These are accessed by latching the three highest address lines, A_8 to A_{10} through a 7475 latch (Fig. 1). The block is obtained through the p.i.a. outputs, PA_0 to PA_2, which are latched by control line CA_2 used as an output.

The latch-enables, which are active high, are obtained by taking CA_2 low-high-low under program control.

Having latched the block address, the eight data lines of port A provide the low byte of the address to the eprom, A_0 to A_7, whilst CA_2 is held low to disable the latch. The fourth bit of the latch allows PA_7 to be used, in conjunction with a 7432 gate, to control the PGM/READ pin of the eprom; again, CA_2 is

```
                    BLOWER     MODULE
0000CC00                       GLOBAL

000DC0C0            pia        =        $C0C0
0000C800            table      =        $C800
0000CF9D            keyin      =        $CF9D     for these subroutines
0000FCA8            wait       =        $FCA8     see April issue
0000FD8E            crout      =        $FD8E
00DDFDDA            prbyte     =        $FDDA
0000FDF0            cout1      =        $F0F0
0000F94A            prbl2      =        $F94A
00000023            wndbtm     =        $23
000000E3            val        =        $E3
000000F9            mode       =        $F9
000000F9            data       =        $F9
00000750            scrn       =        $750
000000A0            blank      =        $A0
000000C0            at         =        $C0       @ symbol
000000C1            A          =        $C1
000000C6            F          =        $C6
000000DD            brkt       =        $DD       square bracket [
0000CC00                       ORG      $CC00
0000CC00 78         entry0     SEI                initialize
0000CC01 A900                  LDA      #0
0000CC03 8DC1C0                STA      pia+1     data direction reg. A
0000CC06 8DC3C0                STA      pia+3     data direction reg. B
0000CC09 8DC2C0                STA      pia+2     port B = input
0000CC0C A9FF                  LDA      #$FF
0000CC0E 8DC0C0                STA      pia       port A = output
0000CC11 A903                  LDA      #3        set IRQV
0000CC13 8DFE03                STA      $03FE     to operating
0D00CC16 A9E0                  LDA      #$E0      system entry
0000CC18 8DFF03                STA      $03FF     at $E003
0000CC1B A93F                  LDA      #$3F      CB1 enabled
0000CC1D 8DC3C0                STA      pia+3     CB2 manual high
0000CC20 ADC2C0                LDA      pia+2     interrupt cleared
0000CC23 A934                  LDA      #$34      CA2 manual low
0000CC25 8DC1C0                STA      pia+1     A, B data ports
0000CC28 ADC0C0                LDA      pia       interrupt cleared
0000CC2B 58                    CLI
0000CC2C A245                  LDX      #$45
0000CC2E A015                  LDY      #$15
0000CC30 8423                  STY      wndbtm    lift text window
0000CC32 204BCD                JSR      prhdg     print options
0000CC35 209DCF                JSR      keyin     keyboard select
0000CC38 2903                  AND      #3
0000CC3A D001                  BNE      entry1
0000CC3C 60                    RTS                return if "exit"
0000CC3D 4A         entry1     LSR      A
0000CC3E 4A                    LSR      A
0000CC3F 6A                    ROR      A         mode=$80 for burn
0000CC40 85F9                  STA      mode      mode=0 for read
0000CC42 A230                  LDX      #$30
0000CC44 A028                  LDY      #$28
0000CC46 204BCD                JSR      prhdg     print heading for
0000CC49 A221                  LDX      #$21      input of data
0000CC4B A099                  LDY      #$99      in four-digit hex
0000CC4D 204BCD                JSR      prhdg
0000CC50 A9A0                  LDA      #blank    "eprom" changed to
0000CC52 8DDE07                STA      scrn+$8E  "ram" on second line
0000CC55 8DDF07                STA      scrn+$8F
0000CC58 A9C1                  LDA      #A        Ascii "A"
0000CC5A 8DE107                STA      scrn+$91
0000CC5D A206                  LDX      #6        input eprom start-addr
0000CC5F A015                  LDY      #$15      to data+5, data+6
0000CC61 2008CD                JSR      input4
0000CC64 A024                  LDY      #$24      input number of bytes
0000CC66 2008CD                JSR      input4    to data+3, data+4
0000CC69 A095                  LDY      #$95      input ram address
0000CC6B 2008CD                JSR      input4    to data+1, data+2
0000CC6E A5F9                  LDA      mode
0000CC70 1020                  BPL      addr      skip if read mode
0000CC72 202ECD                JSR      cb2       bring CB2 low
0000CC75 78                    SEI                remove protection
0000CC76 20E6CC                JSR      hivolt    call programming voltage
0000CC79 A203                  LDX      #3        disable CB1, but
0000CC7B 2030CD                JSR      crbx      make active low
0000CC7E ADC2C0                LDA      pia+2     clear interrupt
0000CC81 A204                  LDX      #4        DDRB
0000CC83 2030CD                JSR      crbx
0000CC86 A9FF                  LOA      #$FF
0000CC88 8DC2C0                STA      pia+2     port B is now output
0000CC8B A204                  LDX      #4        port B
0000CC8D 2030CD                JSR      crbx      data port
0000CC90 A5F9       nexthi     LDA      mode      mode in bit 7
0000CC92 D5FF       addr       ORA      data+6    high byte of eprom
0000CC94 8DC0C0                STA      pia       address bit 0
0000CC97 A208                  LDX      #8        of port A
0000CC99 2043CD                JSR      crax      strobe latch
0000CC9C 2043CD                JSR      crax      with CA2
0000CC9F A5FE       nextlo     LDA      data+5
0000CCA1 8DC0C0                STA      pia       low byte of eprom addr
0000CCA4 A000                  LDY      #0        out of port A
0000CCA6 A5F9                  LDA      mode
```

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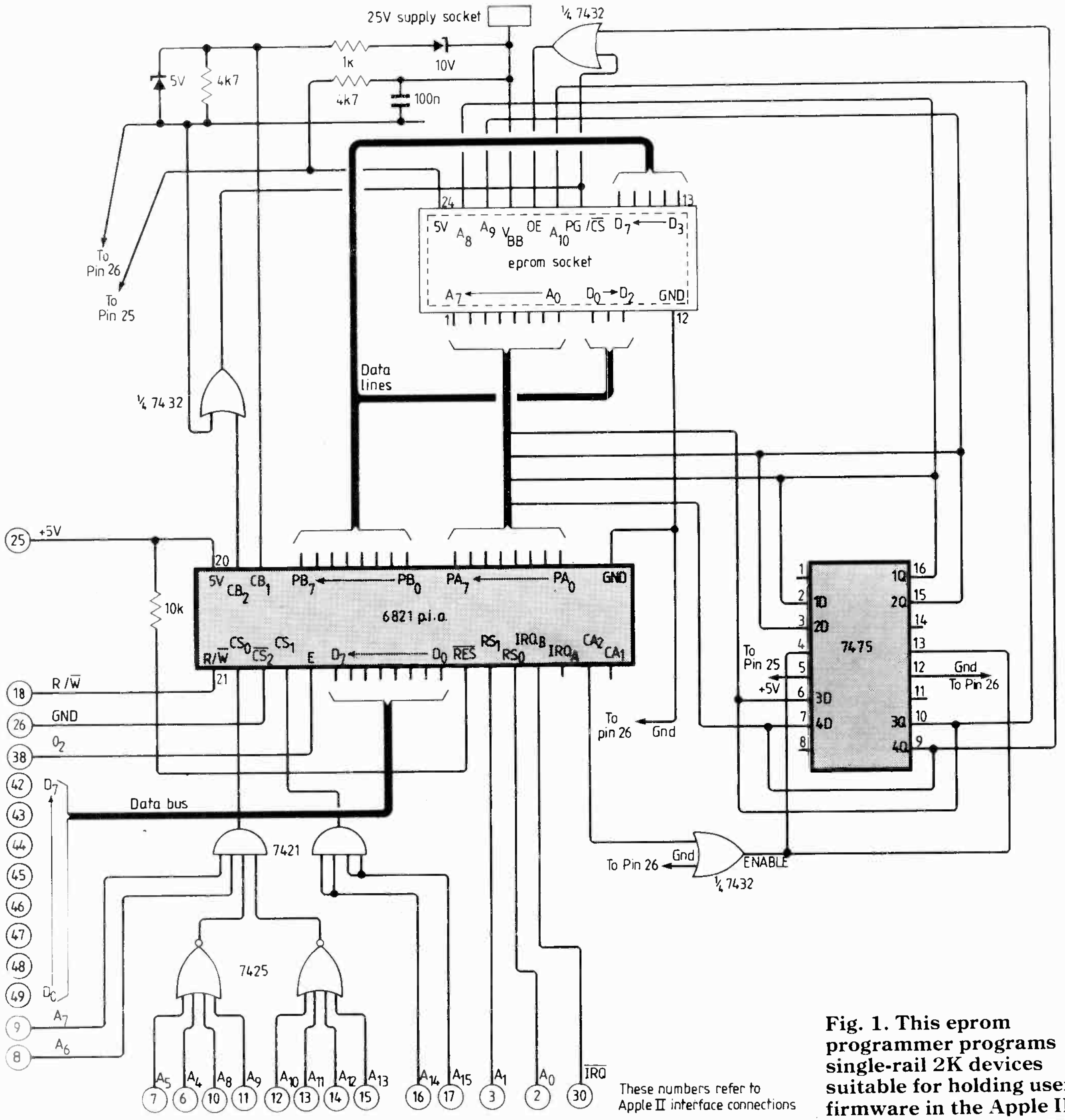


Fig. 1. This eprom programmer programs single-rail 2K devices suitable for holding user firmware in the Apple II.

```
0000CCA8 1014             BPL   read          skip if read mode
0000CCAA B1FA             LDA   (data+1),Y    data from ram
0000CCAC 85E3             STA   val           (temp. for v.d.u.)
0000CCAE 8DC2C0           STA   pia+2         output on port B
0000CCB1 202ECD           JSR   cb2           CB2 high
0000CCB4 A98B             LDA   #$8B
0000CCB6 20A8FC           JSR   wait          wait for 50ms
0000CCB9 202ECD           JSR   cb2           CB2 low
0000CCBC F00B             BEQ   display       skip
0000CCBE 202ECD  read     JSR   cb2           CB2 low
0000CCC1 ADC2C0           LDA   pia+2         read data to
0000CCC4 85E3             STA   val           temporary location
0000CCC6 202ECD           JSR   cb2           CB2 high
0000CCC9 205CCD  display  JSR   prval         print data
0000CCCC 207ECD           JSR   decnob        count number of bytes
0000CCCF F00B             BEQ   dataend       end if all done
0000CCD1 208BCD           JSR   incram        next ram location
0000CCD4 E6FE             INC   data+5        next eprom location
0000CCD6 D0C7             BNE   nextlo        if high byte same
0000CCD8 E6FF             INC   data+6        if high byte must
0000CCDA D0B4             BNE   nexthi        be incremented
0000CCDC A5F9    dataend  LDA   mode          if burn mode
0000CCDE 1003             BPL   end           then ask for
0000CCE0 20E6CC           JSR   hivolt        programming volts off
0000CCE3 4C00CC  end      JMP   entry0        repeat
                 ********************************
                 subroutines
0000CCE6 A008    hivolt   LDY   #8
0000CCE8 A208             LDX   #8
```

continued on page 30

Below: subroutines. For details, see April issue.

```
C800  41 64 6A AC 40 9E 9C 40  Adj,@..@
C808  A7 A8 82 A4 A8 40 82 88  '(.$(@..
C810  88 DC 40 92 9C 40 8A A0  .\@..@.
C818  A4 9E 9A 74 48 60 60 60  $..tH```
C820  60 40 9C 9E 5E 84 B2 A8  `@..^.2(
C828  8A A6 74 48 60 60 60 60  .&tH````
C830  61 5C 8A B0 92 A8 40 62  a\.0.(@b
C8C8  5C 86 9E A0 B2 40 64 5C  \.. 2@d\
C840  84 AA A4 9C 7E BB A4 8A  .*$.~;$.
C848  A8 AA A4 9C              (*$.
```

```
0000CCEA 204BCD            JSR   prhdg       print  25V off
0000CCED A5FC              LDA   data+3
0000CCEF 05FD              ORA   data+4      if no data left,
0000CCF1 D008              BNE   on          then skip
0000CCF3 A9C6              LDA   #F          Ascii F
0000CCF5 8D5607            STA   scrn+6
0000CCF8 8D5707            STA   scrn+7      change "ON" to OFF
0000CCFB 203ACD   on       JSR   poll
0000CCFE A24C              LDX   #$4C        wait until IRQB is set
0000CD00 204BCD            JSR   prhdg       print "RETURN" and wait
0000CD03 4C9DCF            JMP   keyin
0000CD06 EA                NOP
0000CD07 EA                NOP
                  ******************************
0000CD08 200BCD   input4   JSR   input2      input two hex digits
0000CD0B 209DCF   input2   JSR   keyin       character from keyboard
0000CD0E 2025CD            JSR   digit       one digit
0000CD11 0A                ASL   A
0000CD12 0A                ASL   A
0000CD13 0A                ASL   A           shift digit
0000CD14 0A                ASL   A           to top four bits
0000CD15 95F9              STA   data,X      and save
0000CD17 C8                INY               next screen location
0000CD18 209DCF            JSR   keyin       keyboard
0000CD1B 2025CD            JSR   digit
0000CD1E 15F9              ORA   data,X      join two digits and
0000CD20 95F9              STA   data,X      save as byte
0000CD22 C8                INY               next screen location
0000CD23 CA                DEX               next byte
0000CD24 60                RTS
                  ******************************
0000CD25 C9C0     digit    CMP   #at         Ascii @
0000CD27 9002              BCC   numc        if numeric, skip
0000CD29 6908              ADC   #8
0000CD2B 290F     numc     AND   #$F         select four low bits
0000CD2D 60                RTS
                  ******************************
0000CD2E A208     cb2      LDX   #8          manual level
0000CD30 48       crbx     PHA               save accumulator
0000CD31 8A                TXA
0000CD32 4DC3C0            EOR   pia+3       change selected
0000CD35 8DC3C0            STA   pia+3       bits of CRB
0000CD38 68                PLA
0000CD39 60                RTS
                  ******************************
0000CD3A ADC3C0   poll     LDA   pia+3
0000CD3D 10FB              BPL   Poll        wait until bit 7 is set
0000CD3F ADC2C0            LDA   pia+2       clear interrupt
0000CD42 60                RTS
                  ******************************
0000CD43 8A       crax     TXA
0000CD44 4DC1C0            EOR   pia+1       change selected
0000CD47 8DC1C0            STA   pia+1       bits of CRA
0000CD4A 60                RTS
                  ******************************
0000CD4B 98       prhdg    TYA
0000CD4C 48                PHA               save Y register
0000CD4D BDFFC7   next     LDA   table-1,X   read character
0000CD50 38                SEC
0000CD51 6A                ROR   A           (not inverse field)
0000CD52 994F07            STA   scrn-1,Y    print it
0000CD55 CA                DEX               next character
0000CD56 88                DEY               next screen location
0000CD57 90F4              BCC   next        odd value marks end
0000CD59 68                PLA               of message
0000CD5A A8                TAY
0000CD5B 60                RTS
                  ******************************
0000CD5C A5FC     prval    LDA   data+3      output <cr>
0000CD5E 2907              AND   #7          every eight bytes
0000CD60 D003              BNE   skip
0000CD62 208EFD            JSR   crout
0000CD65 A5E3     skip     LDA   val
0000CD67 D1FA              CMP   (data+1),Y
0000CD69 08                PHP
0000CD6A 91FA              STA   (data+1),Y  store data in ram
0000CD6C 20DAFD            JSR   prbyte      print data on v.d.u.
0000CD6F A9A0              LDA   #blank
0000CD71 28                PLP               mark if
0000CD72 F002              BEQ   same        old value differs
0000CD74 A9DD              LDA   #brkt       Ascii {
0000CD76 20F0FD   same     JSR   cout1
0000CD79 A202              LDX   #2          print two blanks
0000CD7B 4C4AF9            JMP   prbl2
                  ******************************
0000CD7E A5FC     decnob   LDA   data+3
0000CD80 D002              BNE   lobyte      decrement number of
0000CD82 C6FD              DEC   data+4      data bytes
0000CD84 C6FC     lobyte   DEC   data+3      zero flag is set
0000CD86 D002              BNE   return1     clear on return
0000CD88 A5FD              LDA   data+4
0000CD8A 60       return1  RTS
                  ******************************
0000CD8B E6FA     incram   INC   data+1      increment vector
0000CD8D D002              BNE   return2     to ram
0000CD8F E6FB              INC   data+2
0000CD91 60       return2  RTS
Assembly Complete
```

7	6	5	4	3	2	1	0
IRQA(B)1	IRQA(B)2	← CA(B)2 control →			DDRA(B)1 Access	← CA(B)1 control →	
Read only		Read/write					

Table 1 (above): control register fromat of the 6821.

Below: this Basic program modifies the code generated by the main listing so that the software can program its own eprom.

```
 10 FORI=26624 TO 28671
 20 X=PEEK(I)
 30 IF X=205 THEN X=93
 40 POKE (I-4096),X
 50 NEXT
 60 POKE 23763,91
 70 POKE 23887,87
 80 POKE 23672,92
 90 POKE 23778,92
100 POKE 23781,92
110 POKE 23607,95
120 POKE 23813,95
130 POKE 23821,95
140 POKE 23834,95
150 CALL (23552)
```

used as a latch enable.

For the read mode PA_7 is low and CB_2, programmed as output, is transmitted to pins 18 and 20 of the eprom. Data is then read through port B while CB_2 is pulsed low-high-low.

In programming mode, PA_7 is latched high and the or gate holds pin 20 high; CB_2 is pulsed high-low-high for 50ms while the data is held on port B output. Line CB_1 senses the 25V programming supply and so provides circuit protection through software.

Software

Externally the p.i.a. appears as four consecutive register locations, but internally there are six registers: three for each of the two ports. The data direction register DDRA(B) and the input/output register ORA(B) share a register location; the unique locations are occupied by the respective control registers. The shared addresses are Base (A port) and Base+2, (B port). The port is programmed by writing to the corresponding bit of the DDR; 0 configures a line for input and 1 configures it for output.

The register selected to appear at the shared address is controlled by the status of bit 2 of the appropriate control register. If bit 2 is cleared the DDR is accessed; if set, the i/o register is selected.

The control register format is given in Table 1. Bits 7 and 6 are interrupt flag bits for the $CA(B)_1$, $CA(B)_2$ control lines; the flag is set to logic 1 when the programmed transition occurs on the appropriate control line. If the interrupt is disabled the related IRQ line from the p.i.a. will not be taken low and the processor will not be interrupted. The flag bit will however be set; it is cleared by reading from or writing to the port.

In the same way, the $CA(B)_2$ control lines are programmed by switching bit 5; if bit 5=0, the line is an input. The $CA(B)_1$ lines operate only as inputs.

For input control lines, a further bit specifies which transition will set the IRQ flag bit. If the transition is to be 1 to 0, a zero must be written to the appropriate bit. The logic state written to the bit indicates the status of the line after the transition has occurred.

For $CA(B)_1$, bit 1 is used to control the transition whilst bit 4 indicates the required transition on those $CA(B)_2$ lines configured as inputs. When the lines $CA(B)_2$ are configured for output, if bit 4 is set to 1 the status of the control line is determined by the status of bit 3; if bit 3 is set the line is high.

Firmware

The 6502 code is entered by Call (52224). The user then selects Exit, Read or Burn. Exit may be followed by Call (52526): Poke 249,0 : Call (52290) in order to read a rom. The user next enters the eprom start address, number of bytes and ram start address in hex notation.

In Read mode, the program then copies the specified area of the eprom to ram and indicates whether the byte previously held in ram was the same, for verification. In programming mode, the program asks the user to insert the 25V connection and burns the code into the eprom, displaying the data as it does so.

Self-programming

With a few modifications, the code can be used to generate its own firmware. Enter the code into ram at \$6800-\$6FFF, then copy it, using the Basic program (table 4), into ram at \$5800-\$5FFF.

The program alters the high bytes of absolute addresses \$C7, \$CB, \$CC, \$CD and \$CF to new values (\$57, \$5B, \$5C, \$5D and \$5F). The eprom programmer may then be operated by calling the modified code with CALL (23552). ■

JAM TODAY

Unless a solution to the problems of deliberate interference can be found at the second session of the World Administrative Radio Conference for the planning of the h.f. broadcasting bands, due to be held at Geneva from January 27 to March 13, 1987, little progress is likely to be achieved and the conference may collapse. This pessimistic view was expressed by Bert Gallon, chief engineer of BBC External Services, in a recent "Waveguide" broadcast.

At peak listeining times as much as 60 to 70 per cent of available spectrum is being badly affected by jamming. This affects listeners in countries far beyond those to which the jamming is directed.

The Russians are currently jamming, in an extremely sophisticated manner, the Russian-language programmes of the BBC, Voice of America, Deutsche Welle, Radio Free Europe, Radio Liberty, Radio Israel and Radio Peking. The only other country jamming BBC transmissions is Poland. China jams programmes from the USSR. With the narrow 5kHz channel spacing and the mixture of very high and medium power transmitters on h.f., the jamming spreads over more than the target channel and can pause problems as far away as South America and Australia.

The USSR has an elaborate and costly network of ground-wave jammers for urban areas of more than 100,000 population and powerful sky-wave jammers to blanket suburban and rural area. Over the years, they have learned a great deal about the technique of jamming, seldom wasting power on what they regard as "harmless" programming but switching on very quickly when an "objectionable" programme begins, following any sudden changes of frequency promptly and effectively.

Non-deliberate interference arises mostly from poor spectrum management and lack of experience in some countries. The h.f. broadcast spectrum is the least well regulated of any of the broadcasting allocations, and is seen by many governments primarily in terms of national prestige and propaganda.

The jamming problem, unfortunately, could easily spread to the microwave bands for satellites, with their increasing use for such purposes as the world-wide television exchanges already in operation by the United States Information Agency, and the future possibility of high-power direct-broadcast satellites targetted at East Bloc countries. There is a popular view that d.b.s. is impossible to jam. In fact this could be done all too easily by squirting signals at the receiver of the satellite transponder.

Although jamming is contrary to the radio regulations, it could be argued that a United Nations recommendations on space broadcasting states that this should not be targetted towards another country without the agreement of the country concerned. It would, for instance, be one thing for the Federal Republic of Germany to put out their own national programmes on a satellite whose footprint extended over the whole of East Germany and beyond, but quite a different matter if the satellite carried programmes expressly for that area. A majority of viewers in East Germany can, in fact, already receive West German television from terrestrial transmitters, and viewers who take advantage of this are no longer harassed by the authorities as they once were. But then East German tv can be viewed as far west as Hamburg and I am told is popular because of the spectacular State-subsidized films with, as the cinema used to proclaim, "a cast of thousands".

USA IN THE RED

For many years one has thought of the USA as the heart-land of radio communications and electronics, the large domestic market giving the economies of scale that made their products sellable in every country that could find the dollars to pay for them. Yet in 1985, the USA had a world-wide electronics deficit of an estimated $8600-million, almost 40 per cent more than in 1984. The main reason is the enormous deficit of about $17,500-million with Japan, much of it due to importing $11,700-million worth of consumer products from that country. Only in computers did the USA achieve a worldwide positive balance. Japan's NEC has taken over from Texas Instruments as the world's largest supplier of integrated circuits. One result has been the hardening of the yen/dollar exchange rate by about 25 per cent in recent months, with Japanese firms trying to hold their market shares in capital equipment by not raising prices to an equivalent degree, but already losing some of their consumer-market to Korean industry.

ARCTIC LINKS

Providing communications in the Arctic presents severe problems both in terms of the very difficult h.f. propagation conditions (polar cap absorption and extreme multipath) and in the provision of light-weight, easily-powered radios that will continue working at the sort of extreme low temperatures that can cause co-axial cable, unless especially treated, to disintegrate at a touch.

The three-year "transglobe" expedition of 1979-82 under the leadership of Sir Ranulph Fiennes experienced their most difficult radio problems while in the Antarctic and later in the Arctic. I recall talking to Lady Virginia Fiennes, the base station operator, at Racalex 82. She explained that on occasions propagation was so bad that s.s.b. from the forward man-pack set had to give way to slow morse. The biggest worry was that of providing electric power for the portable units at times when the petrol-electric generators carried on the motorised sledges were not available.

During early March, Sir Ranulph Fiennes, with scientist Oliver Sheppard and radio engineer Lawrence Howell, left Heathrow on the first stage of a new probe into the Arctic to be made from a base camp on Ward Hunt island some 400 miles from the North Pole.

This time the plans include a satellite link from the base camp to the UK, plus the use of Racal 10-watt manpack sets and a 100-watt h.f. transmitter to maintain links with North America and Portishead Radio. The manpack sets have been tested down to temperatures as low as minus 45 degrees Centigrade. The team are using special lightweight (500 lb) sledges made by British Aerospace and designed to stay afloat should they fall through the ice with a full 600 lb load. They are seeking scientific information on atmospheric pollution and the structure of the ice shelf.

SPACE OUTLOOK

The UK may or may not have a high-power d.b.s. system in operation by 1989 or 1990. We shall have to wait and see what response there is to the IBA advertisements. Meanwhile the provisional timetable for other European high-power and intermediate-power satellites is that the French TDF-1 and West German TV-SAT could be launched later this year, both providing up to four channels from orbital position 19° East with transponders putting out more than 200 watts of r.f. If all goes well TDF-1 should be receivable over much of the UK with small dishes, and may have an English-language service provided by Robert Maxwell, but it is by no means certain that there will not be further delays. The Japanese Yuri BS-2b (not receivable in Europe) was launched in February with three 100-watt transponders, but it will be some time before anyone can be sure that these will not suffer a similar fate to two of those on BS-2a. The "intermediate power" Luxembourg SES satellite being built by RCA is expected to be launched in 1987 with a capacity of 16 television channels. With 45 watts per channel and an e.i.r.p. of 50dBW it should be receivable over most of west Europe on dishes of about 0.9 to 1.2-metre diameter. It has an Ariane launch booked. The American hold on geostationary launches following the Shuttle disaster seems bound to increase the pressure to get on to Ariane.

Papers presented at a recent IEE colloguium on "Operational experience in the use of the European communications satellites for television tansmission" was concerned exclusively with the use of the Eutelsat F1 (13° E) and F2 (7° E). F1 carries a number of the services for European cable systems. F2 includes EBU news and programme exchanges and occasional use for satellite news gathering (SNG).

Most speakers agreed that the Eutelsat systems have been very successful but equally it is clear there have been a number of problems. The drop in performance of the transponders used for Sky Channel and the Belgian film channel has so far not seriously affected the services, but has shown an unexpectedly high rate of degradation of two of the Telefunken travelling wave tubes.

There is also a difficulty in making meaningful cost comparisons between satellite and terrestrial links due to fluctuating exchange rates and the use of Swiss Gold Francs on terrestrial links and European currency units (ecus) on the leased space segments.

A major problem for SNG is the need for frequency co-ordination before a 14 GHz uplink can be used from a temporary site.

For equipment designers there is still the problem of the different transmission standards including deviation (bandwidth), pre-emphasis, audio, sub-carrier spacing, audio bandwidth plus the different colour encoding systems, etc. The outlook for a single European transmission standard is still unsettled, while a world transmission standard grows ever less likely. Latest contender to enter the h.d.tv stakes is a BBC concept called digitally assisted television (d.a.tv) that involves the transmission of analogue picture signals together with high data-rate digital signals carrying control or supplementary information about the picture and claimed to put an h.d.tv picture into home receivers, even when the bandwidth of the signal has been reduced.

TVI TURN-ROUND

What appears to be a major change in the official DTI approach to difficult cases of radio-frequency interference, following the phasing-out last year of free investigation by the Radio Investigation Service, was disclosed in a Parliamentary reply by Mr John Butcher, Secretary of State for Trade and Industry. The reply, combined with the belief that new licence regulations for amateurs are in the offing, is causing many rumours to circulate about future power restrictions.

Mr Butcher stated: "Problems can arise when high power radio transmissions are made in close proximity to radio and television sets, or indeed a range of electrical apparatus not designed to receive radio. Such problems can be exacerbated by equipment which is deficient in its ability to reject unwanted signals or in the case of radios and televisions which have an inadequate or defective aerial or no aerial at all. The problem is growing because more and more homes now contain a great range of electric equipment; and high power transmitting equipment is now more widely available to the growing number of amateur radio licensees.

"Radio amateurs generally take a responsible attitude to the problems their transmissions cause. Equally, manufacturers are keen to produce equipment which has adequate immunity. Regrettably, a few amateurs and manufacturers do not have a responsible attitude; it is they who cause problems.

"My officials are currently discussing with BREMA and the RSGB the implications for them of the new standard for television immunity currently under discussion internationaly and procedures for dealing with individual cases where interference is caused. I would like to see sensible immunity standards observed by all manufacturers and importers of radio receiving and radio sensitive equipment. Where possible and appropriate these will be enforced by order. Similarly, manufacturers and importers of radio and non-radio equipment should seek to ensure that their products do not cause interference to radio users. Orders exist for some types of equipment and where appropriate others will be made.

"Where it proves impossible to resolve individual problems and the affected apparatus has been brought up to a reasonable level of immunity, I intend to vary the terms under which the relevant amateurs are licensed; where necessary (and I hope it will not be necessary often) licences will be revoked.

"In this particular case (at Eastcote, near Pinner) I will vary the powers which the amateur is licensed to use and restrict his use of certain bands. If this does not resolve the problem, I shall further review the position."

While few amateurs would disagree with the DTI's analysis of the problem, many are extremely worried at the new threat of varying or revoking a licence where the transmitter is causing break-through and not harmonic interference. This reverses the procedure that has existed for many years. This has meant that an amateur causing breakthrough interference will not be prevented from operating within the terms of his licence except temporarily while the RIS team advise the viewer on a cure. Furthermore, only appliances *intended* to receive radio or television have been the concern of the D.T.I.

It is understood that British Standard BS905, intended to improve the immunity of tv receivers primarily against CB 27 MHz interference is being put aside in favour of the European specification. While this will help minimise the problem of breakthrough from low-power transmitters there may remain problems of breakthrough interference in close proximity to high-power transmitters unless the sets are fitted with additional filters as in the past. It seems likely that the DTI will wish to introduce regulations restricting the effective radiated power of amateur transmitters, particularly on microwave bands, where high-gain antennas can result in very high e.r.p. from relatively low-power transmitters.

THERMIONICS

The 50th anniversary of the introduction by RCA Radiotron of the 6L6 valve in 1936 has sparked off a good deal of nostalgia among radio amateurs who still recall with something approaching genuine affection the series of beam tetrodes that included the 6L6, 807 and 813 that filled so many transmitter sockets over many years. I wonder if solid state devices will come to be remembered in this way? How long before we are talking nostalgically of the 555 or even the OC171?

For many amateurs, the valve is still the easiest and surest way to obtain lots of r.f. watts. The 813 is still in demand for s.s.b. linear amplifiers, along with the modern high-perveance valves that can be decidely more temperamental unless carefully handled.

I note that the British Vintage Wireless Society is sponsoring a three-day, 15-lecture course on "Early Wireless — the thermionic age past and present" at Imperial College, London SW7, July 7 to 9. A snag for retired engineers and amateurs is that the fee, including lecture notes etc, is £85. Course organizer is Dr L.L. Freris, Electrical Engineering Department, Imperial College, London SW7 2BT.

Looking through the list of topics one wonders how many of the present generation of amateurs are familiar with such techniques as reflex, neutrodyne and superinductance. But the use of the valve in modern transmitters and hi-fi equipment is also to be covered. The possibility of a considerable return to thermionics as a protection against equipment damage from nuclear electromagnetic pulses is still on the cards, with the American Naval Research Laboratory claiming to be working on microminiature thermionic devices.

PAT HAWKER, G3VA

CIRCUIT IDEAS

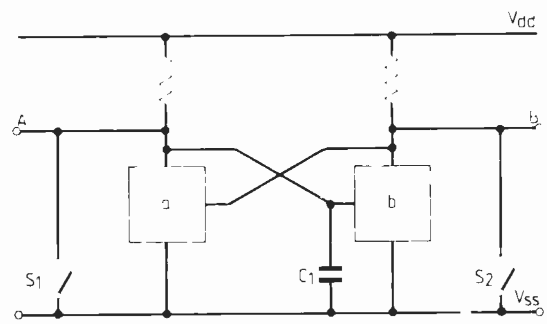
Quad switch as SR latch

A set/reset bistable latch can be configured from two sections of a 4016 or 4066 c-mos quad bilateral switch.

Two transmission gates are cross-coupled as shown. Closing S_2 causes gate a to be non-conducting; point A is therefore high and so gate b conducts. Because gate b is conducting, point B is low, holding gate a open when S_2 is released.

When S_1 is closed, gate b is open circuit, point B goes high and gate a conducts, making point A low and so holding gate b non-conducting. The truth table is shown.

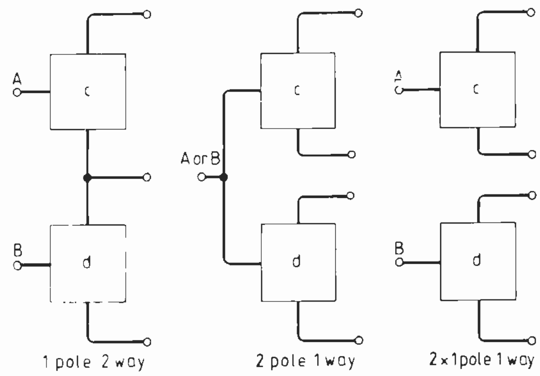
If a known power-up condition is required, C_1 may be added across S_1 to make sure that gate a is conducting and gate b is open circuit at switch on.



S1	S2	A	B
L	H	L	H
H	L	H	L
L	L	L	L

The remaining two transmission gates may be arranged as a one-pole two-way switch, a two-pole one-way switch or as two one-pole one-way switches, and may be driven by SR latch outputs at points A and B.

J. E. Noakes
Camberley
Surrey



Automatic power switch and headphone amplifier

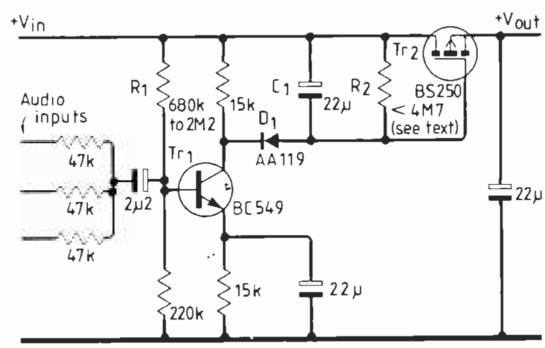
I have used this battery-power switch and the headphone amplifier for about a year now with my Sony Walkman DD and Sennheiser HD430 headphones. Amplification is needed as the Walkman has a 32Ω output and the headphones are 600Ω.

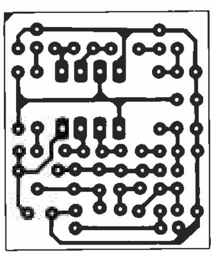
Audio is amplified by Tr_1, rectified by D_1 and charges C_1 to switch on the mosfet Tr_2. Resistor R_2 determines delay between loss of audio and switch off, which is usually greater than 1min.

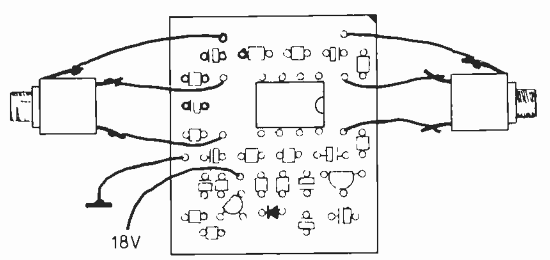
Value of R_1 is determined by fitting a 2.2MΩ potentiometer in its place and adjusting it so that V_{out} is zero with no audio, rising to V_{in} within a few seconds when audio appears.

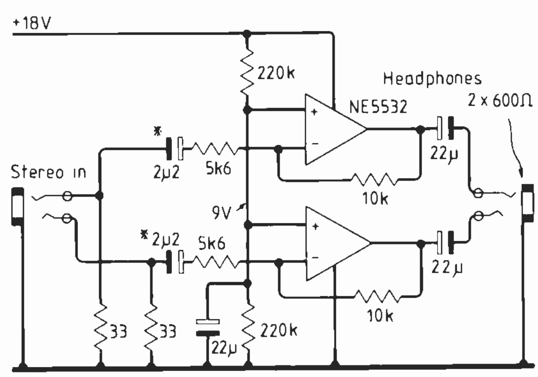
Power consumption is 5mA when switched on and about 130μA when off; if the unit is switched off for long periods, add a normal power switch.

Philip Bosma
Enschede
The Netherlands









* All capacitors except these are tantalum.

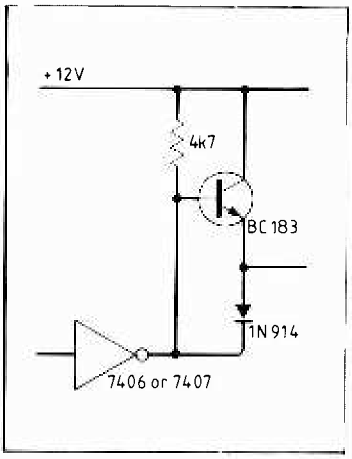
Line driver

In order to drive c-mos at a distance, an active pull-up is required.

Active current sinking is provided by a high-voltage t.t.l. 7406 inverter or 7407 buffer while the BC183L acts as a current source when the t.t.l. output goes high.

This circuit has been used to drive a c-mos input at 2MHz over 3m of twisted pair.

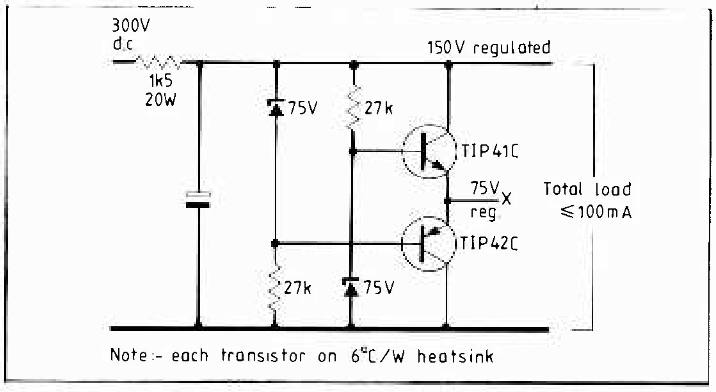
J. Shaw
Dunfermline
Fife



Inexpensive 150V regulator

Using a 100V complementary pair as a shunt regulator provides a solid-state alternative to neon stabilizers. Point X is held at 75V relative to either rail, providing 150V. At 100mA, amplification of the TIP41C/42C pair is greater than 100.

David Hoare
Leicester



Development interface

This Z80 Spectrum interface reads most single-rail eproms and reads and writes non-volatile rams and battery-backed eprom emulators such as the GR2716.

We use assembly language on the Spectrum for developing industrial control applications software. Code is assembled then transferred to an emulator using the interface.

To transfer eprom content to ram starting at $C000_{16}$,

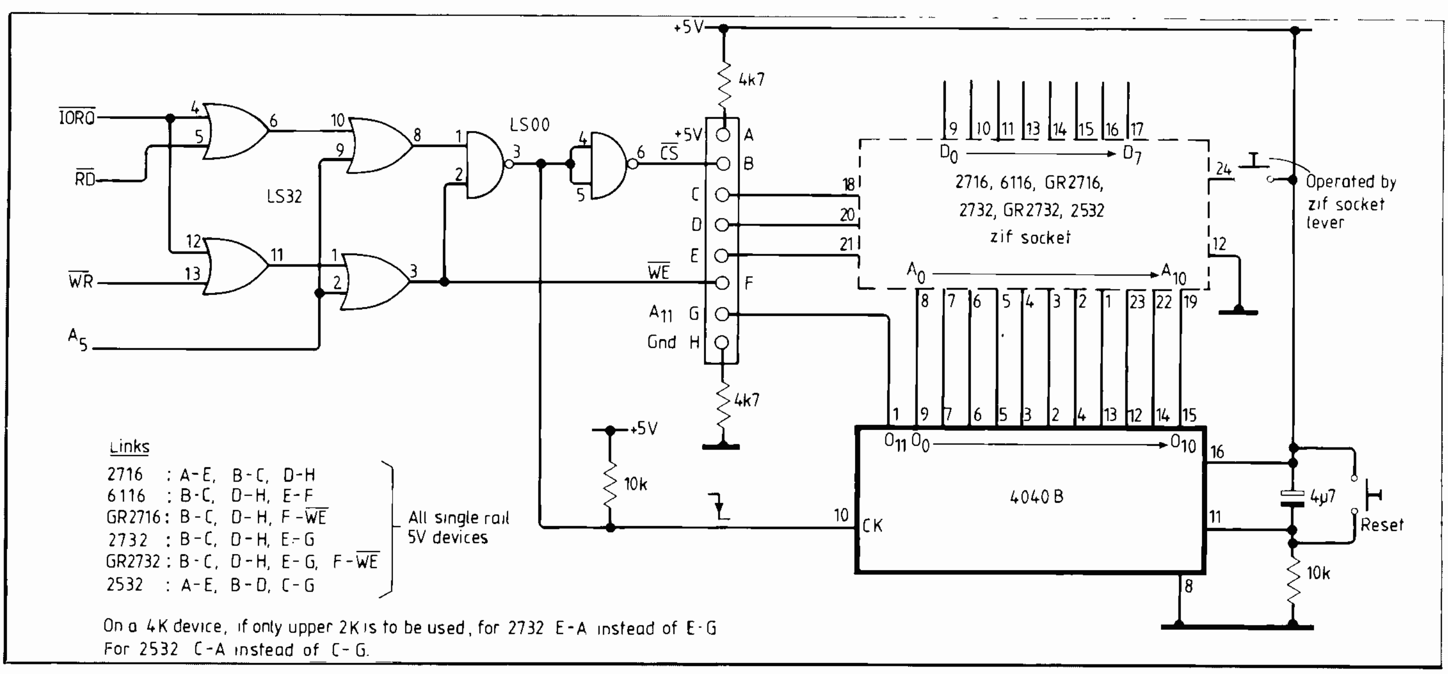
```
        ORG   B000
        LD    BC,0800   ;1000 for
        LD    HL,C000    4K devices
LOOP1   IN    A,(1F)
        LD    (HL),A
        INC   HL
        DEC   BC
        LD    A,B
        OR    C
        JR    NZ,LOOP1
        RET
```

or to transfer contents from C000 onwards to an emulator,

```
        ORG   B030
        LD    BC,0800   ;1000 for
        LD    HL,C000    4K devices
LOOP2   LD    A,(HL)
        OUT   (1F),A
        INC   HL
        DEC   BC
        LD    A,B
        OR    C
        JR    NZ,LOOP2
        RET.
```

Supply switching linked to the zero-insertion force socket allows eproms to be inserted and removed while the computer is powered.

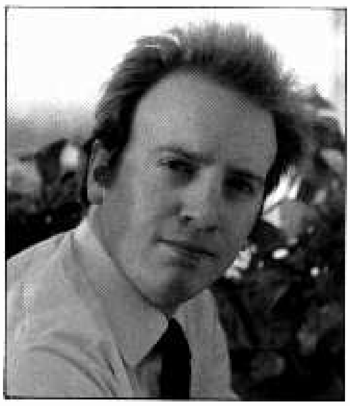
Hamid Mustafa
Sola ADC Lenses
Ireland



by H. W. Gleaves

An introduction to 3D graphics

Principles for producing three-dimensional images in perspective are discussed, with an implementation example in QL Basic.



Hugh Gleaves initially trained as an Electronics Engineer, became interested in computing, and took a position as a computer programmer for London-On-Line Local Authorities, L.O.L.A., in Enfield, Middlesex. There he learnt how to produce structured modular program using PL/1, and also the fundamentals of data-base programming.

Hugh's main interest however is in computer applications rather than data processing and he took the opportunity of studying for an HNC in cad/cam at Merton College in Surrey, having been with L.O.L.A. for 3 years.

Hugh's other interests include computer graphics, electronics and artificial intelligence.

Many personal computer users regard computer graphics — especially 'three dimensional' computer graphics — to be both complex and specialized. For these reasons many people avoid one of the most interesting and effective applications of a personal computer.

To fully understand the subject requires great effort and study; modern state-of-the-art computer graphics, is a highly developed subject, demanding the highest performance possible from computers.

Forming an introduction to the subject, this article demonstrates how a microcomputer graphics system for constructing object outlines is developed. These outlines, or 'wire frames', are in perspective and can be constructed in any position and orientation.

Superbasic on the Sinclair QL is used to show how the graphics system is implemented. Elementary algebra and trigonometry are used but you can skip over these and just use the programs without studying their internal workings if you wish.

Applications for such graphics software are up to you; one obvious use is games, but time taken to compute the images has to be taken into account. It would be interesting to see how the software presented here performs when written in assembly language or speeded up by some other method such as compilation.

Because we want to be able to view objects in the graphics system from any position and orientation, a description of the objects must be present. This description takes the form of a numerical model of objects in the artificial world, or environment.

Three-D artificial environment

Such a model constitutes what is termed a 'three dimensional artificial environment', or simply 3D a.e. Given a 3D a.e. and appropriate software, it is possible to produce perspective images of the environment from any position and orientation. The environment used in this system has an hierarchical structure as shown in Fig. 1.

Every object in the 3D a.e. is referred to as a body. Each body is referenced by its body number and constructed from a number of polygons. A cube for example has six polygons. Furthermore each polygon has a number of vertices.

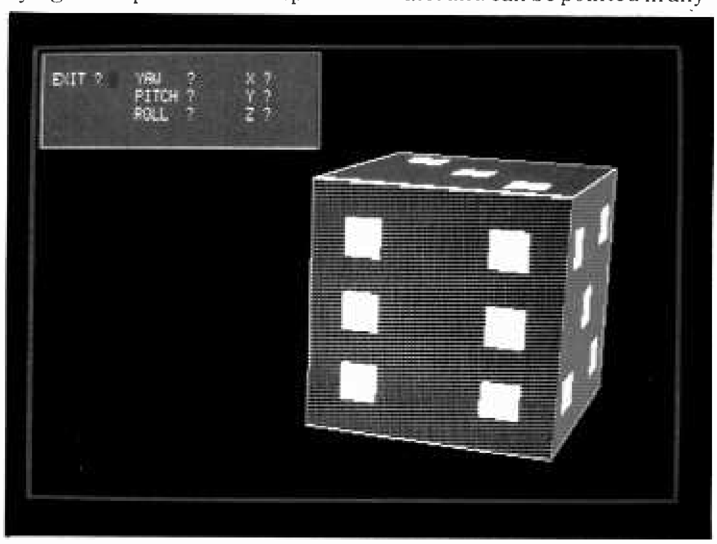
Finally each vertex has three coordinates uniquely identifying its position in space. Because our 3D a.e. takes this form, it means that all objects in the 3D a.e. must be constructed from plane, that is flat, polygons, but this is not a significant restriction.

Thus the 3D a.e. contains the description of real, material objects and does not relate to the viewer in any way. It is a generalized description of the objects to be viewed.

The 3D a.e. is a data-base, but is implemented in Superbasic as a number of arrays. Since the 3D a.e. only contains array references, integer arrays can be used to save memory and increase system speed.

The viewing process

Now comes the problem of constructing an image of the region of the 3D a.e. in view. Imagine that you are inside a tv camera that floats freely in the 3D a.e. and can be pointed in any



desired direction and in any orientation.

The imaginary camera itself has coordinates, C_x,C_y,C_z, as well as three orientation components, roll, pitch, and yaw. Parameters roll, pitch and yaw are three angles that uniquely specify the imaginery camera's direction, and are measured with respect to the camera's co-ordinate system.

There are thus two coordinate systems. The first describes all points in the 3D a.e. including camera position and the second is an identical coordinate system that is fixed with the camera, i.e. each point in the environment has two sets of coordinates, those relating to its position in the 3D a.e. and those relating to its position relative to the camera.

To compute the image seen by the camera, the position of all points in the environment relative to the camera needs to be known. These relative co-ordinates depend on the camera position and orientation in the 3D a.e. and can be calculated from the real coordinates.

The process of obtaining these coordinates is transformation — a mathematical term to describe the process of obtaining coordinates in one system given the coordinates in another system.

Transformation takes place in two stages in the program (to follow). In the first stage, translation, the second coordinate system is placed at the specified position with axes parallel to the original coordinate system. New co-ordinates of any point can then be found very simply, as Fig. 2a shows.

The second stage takes the previously found coordinates of a point and rotates the coordinate system through the specified angles. New coordinates of any point relative to the coordinate system can then be calculated as shown in Fig 2b.

A similar set of equations exists for three dimensions. Our imaginary camera can now be placed anywhere in the 3D a.e. pointed in any direction, and coordinates of any point in the 3D a.e. with respect to the camera can be calculated. Calculation takes place in two steps as described above.

Given the camera's position and orientation, six numbers in all, the position of any point in the 3D a.e., relative to the camera can be calculated. But this is only half the story. A two-dimensional picture still has to be constructed from the 3D data. This final stage of the 3D a.e. manipulation involves finding screen coordinates of a point given its 3D coordinates in space. This is simply another transformation process, Fig. 3.

Several types of transformation are available that allow a two dimensional image to be produced. This article is primarily concerned with a class of transformations known as perspective transformations.

In a perspective transformation, a point in space known as the focal point is designated and a surface is introduced, in our case a plane surface, between the focal point and the scene to be viewed. Now, an image is 'projected' onto the plane or screen.

Projection takes place as follows. For every point in the 3D a.e., or portion of the environment being viewed, construct a straight line from that point to the focal point. The position on the screen that this line penetrates is the projection of the point in the 3D a.e. If this process is carried out for every point in the scene, and points on the screen joined in the same order that they are joined in the scene, then a perspective image will have been produced on the screen.

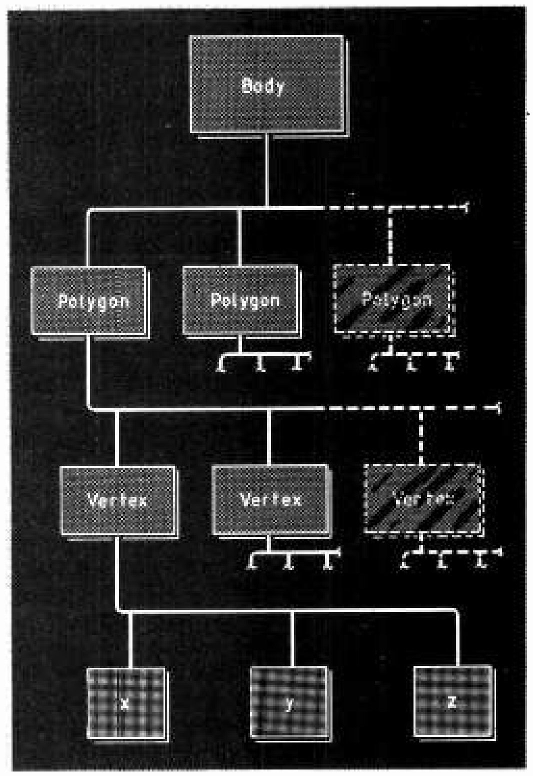


Fig. 1. Hierarchical structure of the 3D a.e. data base.

Perspective transformation

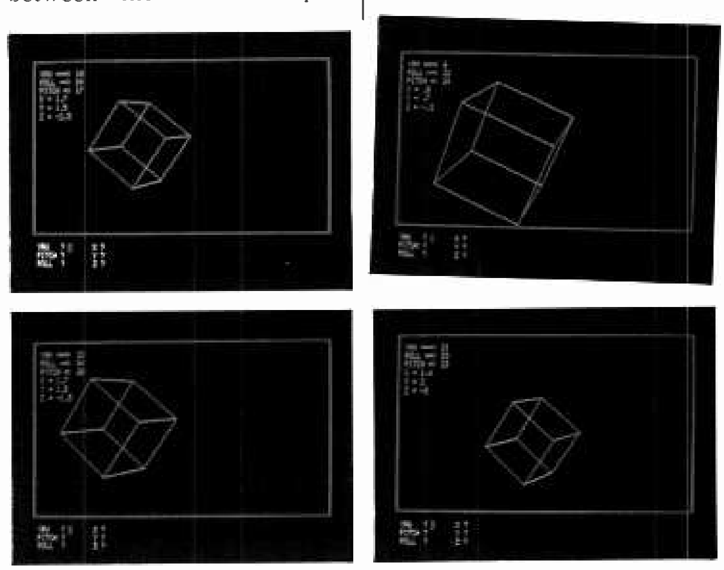
There is a simple mathematical relationship between the point's true coordinates and the coordinates of its projection. The equation relating this is derived with reference to Fig 3.

The diagram shows the simple geometrical relationship between the true and per-

The cover photograph is an example of an advanced 3D graphics processor. Software producing this picture — the subject of a future article — is based on the principles and programs dealt with in this issue. Wire-frame objects, like those on the right, are produced using software to be shown in the next issue.

Shown left is an object drawn in full perspective 3D. The system supports full colour, polygon outlining, back face removal, and hidden feature removal. An automatic surface area calculator is included that can calculate the total surface area of any 3D body in the system, which brings it into the realm of simple CAD.

The photograph is taken directly from the monitor, and shows just one facility of the powerful menu orientated system. Other facilities are object Load/Save on microdrive, and an improved form of motion control. How the system works and is implemented are discussed in a future issue, together with details of how you can obtain copies of the software.



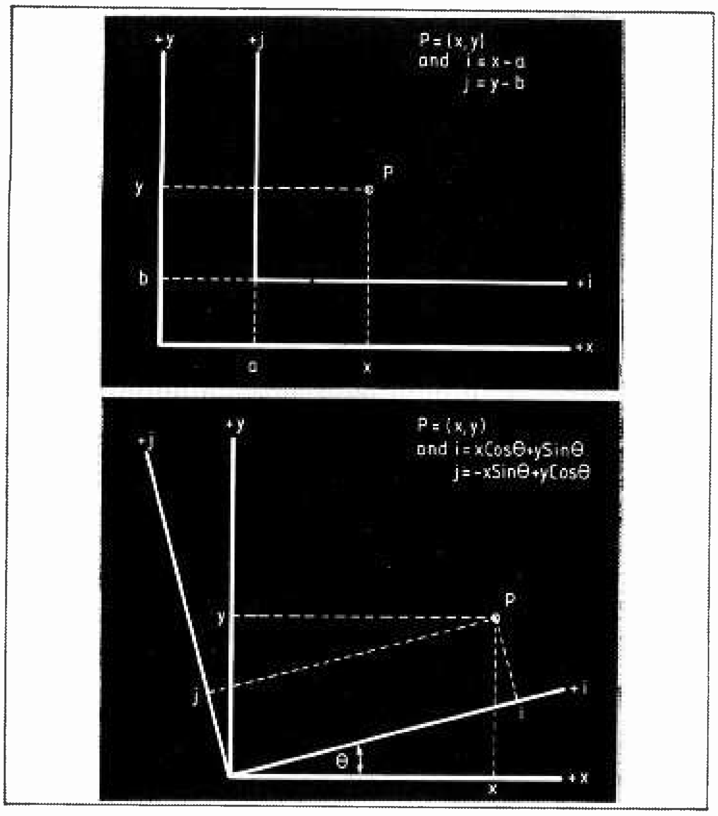
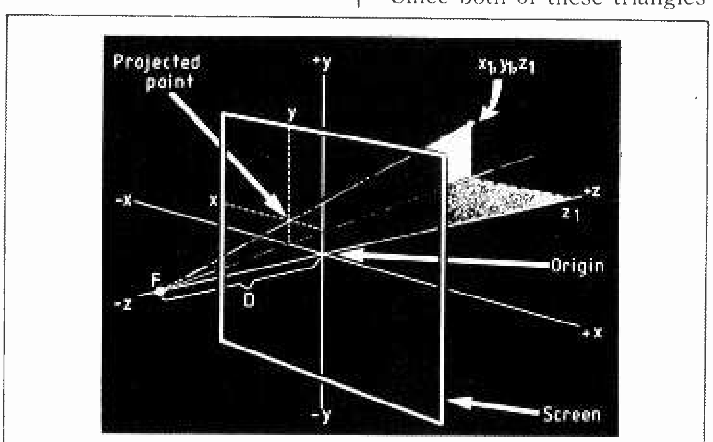


Fig. 2. Translation of (ij) coordinate system (a) and rotation of the (ij) coordinate system (b).

Vertex	x	y	z
1	0	−1	0
2	−1	0	0
3	0	0	−1
4	1	0	0
5	0	0	1
6	0	1	0

Table 1. Example coordinates.

Fig. 3. Principle of perspective transformation.



spective points. Returning to the imaginary camera, you can see that it is merely a screen and an imaginary focal point. Coordinates of the camera are simply the coordinates of the screen.

The diagram also shows that the screen is located at the origin of its own coordinate system. It is in relation to this system that all points in the 3D a.e. are specified, after the aforementioned transformations are carried out.

Now, x and y coordinates of a point projected onto a screen have to be determined, say x_1,y_1,z_1. From Fig. 3 you can see that a triangle is formed by F,(x_1,y_1,z_1) and the z axis. It should also be evident that a triangle is formed by points F, (x,y) and the origin.

Since both of these triangles form the same angle at F, they are similar triangles. This means that the ratio of any two sides, is the same for both triangles. So for the point x,y

$$\frac{y}{D} = \frac{y_1}{D+Z_1}$$

which means that

$$y = \frac{D \times y_1}{D+Z_1} = \frac{y_1}{1+(Z_1/D)}$$

A similar argument applies to the x coordinate of any point on the screen. So that you can see for a given point x,y,z in the 3D a.e., its projection, i,j is given by

$$i = \frac{x}{1+(Z/D)}$$

and

$$j = \frac{y}{1+(Z/D)}$$

This final transformation allows points to be plotted on the QL's screen, and if the points are joined in accordance with the 3D a.e. data-base, a line or 'wire frame' image in perspective will be produced on the screen.

Software for wire-frame drawings

We are now in a position to examine some preliminary software for producing wire frame images of objects of any shape provided that they can be constructed from straight lines.

Program List 1, to be shown in the next article, is modular which allows the important functions and procedures to be used in any program. The main role of this program is a to allow objects to be set up in the 3D a.e., and to view those objects from desired position. When 'viewing', you should try to prevent the camera from turning its back on the scene, since this program does not make any attempt to prevent transformation of invisible points.

The first procedure, SETUP, allows a rudimentary method of defining the 3D a.e. data-base. The next major procedure, VIEW places the camera at the origin of the 3D a.e. The image from this position is then drawn, and the user prompted for camera commands.

Entering positive x, y and z values causes the camera to move right, up or forward respectively by the desired amount. Negative values will move the camera in the opposite sense.

If you imagine that you are sitting in your chair facing the QL screen, then the orientation commands are described as follows. Entering a negative value causes the camera to turn towards the right, up through the specified angle, entering a negative pitch value causes the camera to turn upwards through the specified angle and entering a negative roll value causes the camera to rotate along its axis of viewing in a clockwise direction through the specified angle. Positive values will turn the camera in the opposite direction.

If you adjust the orientation and not the position then it is as if the camera has not moved, but simply turned about its centre.

Octahedron example

To give you an idea of how the program works, try the octahedron example, firstly using the SETUP facility to describe the octahedron to the 3D a.e. data-base.

Because 'wire frame' images are used, it is not essential to describe every face of the body, i.e. you make a cube from just four wire frame squares, the two remaining faces appear automatically. This can be a great saving for many bodies, the octahedron being the case in point.

In fact only four faces of the octahedron need be described to give a correct image. Try entering the following data, after first entering ERASE and SETUP. The octahedron has four polygons, 1, 2, 3 and 4. Polygon 1 has vertices 1, 4 and 5, polygon 2 has vertices 1, 2 and 3, polygon 3 has vertices 4, 3 and 6 and polygon 4 has vertices 5, 2 and 6.

Table one gives the x,y and z coordinates of each vertex. When you have finished describing the body, the program will end and tell you so. You should now enter VIEW.

Software for producing wire-frame images will be presented in the next section.

LANGREX SUPPLIES LTD

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SEMICONDUCTORS

AA119	0.10
AAY30	0.17
AAZ13	0.30
AAZ15	0.30
AAZ17	0.30
AC107	0.55
AC125	0.35
AC126	0.35
AC127	0.40
AC128	0.35
AC141	0.35
AC141K	0.45
AC142	0.40
AC142K	0.45
AC176	0.35
AC187	0.35
AC188	0.35
ACY17	2.25
ACY18	1.55
ACY19	1.80
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ACY21	1.55
ACY39	4.00
AD149	1.00
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AD162	0.60
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ADZ12	12.50
AF106	0.60
AF14	3.50
AF115	3.50
AF116	3.50
AF117	4.00
AF139	0.55
AF186	0.75
AF239	0.65
AFZ11	3.75
AFZ12	5.00
ASY26	1.40
ASY27	1.00
ASZ15	2.20

ASZ16	2.00
ASZ17	1.60
ASZ20	4.50
ASZ21	4.75
AUY10	3.50
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BAW62	0.05
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BAX16	0.06
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BC109	0.14
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BC114	0.12
BC115	0.12
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BC126	0.25
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BC137	0.22
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BC159	0.12
BC167	0.10
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BC214	0.11
BC237	0.09
BC238	0.09
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BC303	0.36
BC307	0.09
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BC327	0.09
BC328	0.09
BC337	0.09
BC338	0.09
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BCY31	3.75
BCY32	3.75
BCY33	2.50
BCY34	2.50
BCY39	3.60
BCY40	3.00
BCY42	0.32
BCY43	0.45
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BCY72	0.21
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BD183	0.75
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BDY20	1.50
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BF152	0.16
BF153	0.19
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BF241	0.12
BF244	0.35
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BF338	0.30
BFS21	4.00
BFS28	2.50
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BFS98	0.30
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BFX88	0.28
BFY50	0.28
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BFY52	0.28
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BFY90	0.65
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BTY79 400K	3.00
BU205	1.20
BU206	1.20
BU208	2.00
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BY126	0.15
BY127	0.15
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Series	
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Series	
BZY93	0.12
Series	
BZY95	1.64
Series	
BZY96	2.00
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CRS3 40	0.75
CRS3 60	0.90
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GEX541	6.50
GJ3M	3.00
GM0378A	1.75

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MJE371	1.05
MJE520	0.75
MJE521	0.73
MJE2955	2.25
MJE3055	2.00
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MPF104	0.55
MPF105	0.55
MPSA06	0.17
MPSA56	0.17
MPSU01	1.11
MPSU06	1.33
MPSU56	1.71
NE555	0.45
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NK1404	4.00
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OA7	0.75
OA10	0.55
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OA79	0.21
OA81	0.21
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OC24	3.00
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OC45	0.85
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OC74	1.40
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OC141	18.00
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ZTX314	0.25
ZTX500	0.14

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ZTX531	0.20
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2G306	1.50
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2N1132	0.35
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2N2221	0.22
2N2222	0.20
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2S024	35.00
2S025	35.00
2S026	40.00
2S103	2.50
2S302	5.50
2S303	5.50
2S322	5.00
2S324	4.90
2S701	12.50
2S745A	1.75
2S746A	1.75

VALVES

A1834	9.00
A2087	13.50
A2134	17.50
A2293	16.00
A2426	35.00
A2521	25.00
A2900	15.00
A3343	45.00
AZ31	2.75
AZ41	2.60
BK448	114.90
BK484	155.35
BS90	58.00
BS810	60.00
BT5	58.95
BT17	185.00
BT19	44.05
BT29	349.15
BT69	354.80
BT95	129.90
CBL31	4.00
CL33	4.00
CY31	3.00
C1K	20.00
C3A	22.00
C3JA	22.00
DA41	25.00
DA42	18.70
DAF91	1.75
DAF96	1.75
DET22	35.00
DET24	49.00
DF91	1.75
DF96	1.75
DK91	1.75
DK92	2.00
DK96	1.75
DL92	2.00
DL94	1.75
DL96	1.75
DLS10	14.00
DLS15	12.50
DLS16	12.50
DLS19	12.50
DM70	2.00
DM71	2.00
DM160	4.75
DY87	1.50
DY802	1.50
E55L	50.00
E80CC	15.00
E80CF	11.27
E80F	14.19
E80L	13.73
E81CC	8.00
E81L	13.27
E82CC	8.10
E83CC	8.40
E86C	8.25
E88C	8.25
E88CC	10.33
E90CC	9.47
E90F	9.90
E91H	6.25
E92CC	8.75
E99F	9.10
E130L	18.50

E180CC	10.50
E180F	12.05
E182CC	13.25
E186F	11.50
E188CC	8.91
E280F	22.51
E283CC	12.00
E288CC	17.50
E810F	35.48
EA52	32.25
EA76	2.50
EABC80	1.25
EAC91	3.50
EAF42	2.50
EAF801	2.00
EB41	4.00
EB91	1.50
EBC33	2.50
EBC41	2.50
EBC81	1.50
EBC90	1.25
EBF80	1.50
EBF83	1.75
EBF89	1.50
EBL31	10.00
EC90	1.25
EC91	8.00
EC92	1.75
EC157	462.00
ECC33	4.50
ECC35	4.50
ECC40	5.50
ECC81	1.75
ECC82	1.75
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ECC85	1.75
ECC86	2.50
ECC88	3.50
ECC89	2.00
ECC91	8.93
ECC189	2.10
ECC807	1.75
ECC808	3.00
ECF80	1.50
ECF82	1.50
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ECH84	2.50
ECL80	1.50
ECL81	1.75
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ECL84	1.50
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ECL86	1.75
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EF39	2.75
EF40	5.00
EF41	3.50
EF42	4.50
EF50	2.50
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EF80	1.75
EF83	4.00
EF85	1.75

EF86	3.50
EF89	2.50
EF91	2.95
EF92	6.37
EF93	1.50
EF94	2.50
EF95	5.99
EF98	2.00
EF183	2.00
EF184	2.00
EF804S	12.00
EF805S	15.00
EH90	1.75
EK90	1.50
EL32	2.50
EL33	4.00
EL34 Mull	4.00
EL36	2.50
EL41	2.80
EL42	2.50
EL81	5.25
EL83	6.00
EL84	2.25
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EL500	3.00
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EL822	13.97
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EM34	8.00
EM80	2.50
EM81	2.50
EM84	2.00
EM85	2.75
EM87	2.50
EN32	25.00
EN91	6.50
EN92	6.96
EY51	2.75
EY81	2.50
EY83	2.50
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EY86	1.75
EY88	1.75
EY500A	3.00
EY802	1.75
EZ35	1.75
EZ40	2.50
EZ41	2.50
EZ80	1.50
EZ81	1.50
EZ90	3.00
FW4-500	3.50
FW4-800	3.50
G1/371K	35.00
G55/1K	12.00
G180/2M	17.50
G240/2D	12.00
G400/1K	17.50
GN4	9.00
GN4A	9.00
GN4A	9.00
GS16	16.00
GT1C	25.00
GU50	20.00
GU51	20.00

GXU1	15.35
GXU2	30.00
GXU3	25.40
GXU4	44.50
GXU50	20.00
GY501	3.00
GZ32	4.00
GZ33	4.75
GZ34	4.00
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KT61	5.00
KT66	15.00
KT77 Gold Lion	12.00
KT88 Gold Lion	20.00
KTW61	2.50
KTW62	2.50
KTW63	2.50
M8079	12.34
M8080	8.25
M8081	9.82
M8082	9.69
M8083	10.25
M8091	10.43
M8096	6.80
M8097	8.10
M8098	8.15
M8099	8.00
M8100	10.30
M8136	11.75
M8137	12.25
M8140	6.00
M8141	6.50
M8142	8.75
M8144	7.50
M8149	6.50
M8161	9.35
M8162	11.75
M8163	8.25
M8190	5.00
M8195	10.85
M8196	7.50
M8204	7.05
M8212	11.37
M8223	6.00
M8224	6.30
M8225	4.50
M8248	14.03
MD290H	115.00
MU14	2.50
MX119	55.00
MX123	76.00
MX145	56.70
MX151	17.25
MX152	131.25
MX161	152.25
MX163	20.25
MX164	25.52
MX166	147.00
MX168	50.00
N78	15.00
OA2	3.25
OA3	2.50
OA4	6.00
OB2	4.35
OB3	2.50
OC2	4.35
OC3	2.50

OD3	2.50
OZ4	3.50
PC86	2.50
PC88	2.50
PC95	1.75
PC97	1.75
PC900	1.75
PCC84	1.50
PCC85	1.50
PCC88	2.00
PCC89	1.75
PCC189	2.50
PCC805	1.60
PCC806	1.60
PCE82	2.00
PCF80	2.00
PCF82	1.50
PCF86	2.50
PCF87	2.00
PCF200	3.25
PCF201	3.25
PCF801	2.50
PCF802	2.50
PCF805	1.70
PCF806	1.70
PCF808	1.70
PCL82	2.00
PCL83	3.00
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PCL86	2.50
PCL805/85	2.50
PD500	6.00
PE06-40N	45.00
PFL200	2.50
PL36	2.50
PL81	1.75
PL81A	2.00
PL82	1.50
PL83	2.50
PL84	2.00
PL504 5	2.50
PL508	5.50
PL509	6.00
PL519	6.00
PL801	1.50
PL802	6.00
PY33	2.50
PY81	1.50
PY82	1.50
PY83	1.25
PY88	2.00
PY500A	4.00
PY800	1.50
PY801	1.50
QF451	82.50
QQV02-6	35.70
QQV03-10	26.25
QQV03-20A	48.38
QQV06-40A	46.00
QQZ06-40A	62.20
QU37	12.50
QV03-12	6.80
QV04-7	3.50
QQV07-50	76.65
QV08-100	197.40

QY3-65	63.24
QY3-125	75.60
QY4-250	74.00
QY4-400	84.00
QY5-500	208.00
QY5-3000A	495.00
QZ06-20	32.70
R10	6.00
R17	3.00
R18	3.00
R19	9.24
R20	2.50
RG3-1250	59.50
RG3-250A	32.68
RG3-1250	59.00
RG4-1250	61.60
RG4-3000	99.45
RR3-250	40.00
RR3-1250	45.75
S11E12	65.00
S130	6.00
S130P	6.00
STV280-40	14.00
STV280-80	21.00
SU41	5.00
SU42	10.00
TD03-10	35.00
TD03-10F	35.00
T15	50.00
TT21	37.50
TT22	37.50
TT100	60.00
TY2-125	78.75
TY4-400	88.20
TY4-500	115.50
TY5-500	236.00
TY6-800	231.00
TY6-5000A	540.00
TY6-5000B	395.00
TY6-5000W	446.00
TY7-6000A	579.00
TY7-6000W	579.00
TZ40	25.00
U18.20	3.50
U19	13.75
U25	2.50
U26	2.50
U37	12.00
UABC80	1.25
UAF42	2.50
UB41	3.00
UBC41	2.25
UBF89	1.50
UCC84	1.75
UCC85	1.85
UFC80	2.00
UCH42	2.50
UCH81	2.50
UCL82	1.75
UCL83	2.75

UF41	2.00
UF42	2.10
UF80	1.75
UF85	1.75
UF89	2.00
UL41	5.00
UL84	1.75
UM80	2.00
UY41	2.25
UY85	2.25
VLS631	15.00
XG1 2500	100.00
XG5 500	30.00
XG2-6400	185.00
XR1-1600A	53.75
XR1-3200	110.00
XR1-3200A	
XR1-6400	150.00
YD1120	395.00
YD1240	490.00
Z803U	25.00
Z859	25.00
ZM1081	8.00
ZM1020	9.00
ZM1021	9.00
ZM1022	9.00
ZM1023	9.00
ZM1040	19.36
ZM1041	16.66
ZM1042	17.77
1B3GT	3.00
1B24	25.00
1B35A	48.00
1B63	64.00
1R5	1.75
1S5	1.75
1T4	1.75
2AS15	11.50
2C39A	60.00
2C43	70.00
2D21	3.25
2E26	8.25
2J42	98.00
2J55	245.00
2J70A	383.00
2J70B	336.00
2K25	125.00
3400Z	115.00
3500Z	100.00
3A5	3.00
3B24	11.00
3B28	15.35
3B29	20.05
3B240M	17.50
3B241M	17.50
3C23	25.00
3C24	12.00
3CX100A	47.00
3E29	45.00
3S4	2.00
3V4	1.75
4-65A	60.00
4-125A	60.00

4-250A	80.00
4-400A	87.00
4B32	20.00
4C35	120.00
4CX250B	58.00
4CX350A	105.00
4X150A	60.00
4X150D	56.00
5B254M	35.00
5B255M	35.00
5C22	160.00
5118H	1650.00
5R4GY	5.50
5U4G	3.00
5U4GB	2.50
5V4G	2.50
5Y3GT	2.50
5Z3	4.00
5Z4G	2.50
5Z4GT	2.50
6-30L2	1.75
6AB4	1.75
6AB7	3.00
6AC7	3.00
6AF4A	4.25
6AG7	3.00
6AH6	5.00
6AK5	5.99
6AK6	2.50
6AL5	1.50
6AM4	4.00
6AM5	9.69
6AM6	6.02
6AN5	4.75
6AN8A	3.50
6AQ5	3.25
6AS6	8.66
6AS7G	8.75
6AT6	1.25
6AU5GT	5.00
6AU6	2.50
6AV5GA	4.50
6AV6	1.50
6AX5GT	3.00
6B7	3.25
6B8	3.25
6BA6	1.50
6BA7	5.00
6BA8A	4.00
6BC4	4.00
6BE6	1.50
6BH6	2.50
6BJ6	2.25
6BK4	4.50
6BL6	85.00
6BL7GT	4.50
6BM6	115.00
6BN6	2.00
6BQ7A	3.50
6BR7	6.00
6BR8A	3.50
6BS7	6.00
6BW6	6.00
6BW7	1.50
6BX7GT	5.00
6BZ6	2.75
6C4	1.25
6CB6A	2.50
6CD6GA	5.00

6CG7	2.50
6CH6	13.00
6CL6	3.75
6CW4	8.00
6D2	1.50
6DK6	3.00
6DQ6B	4.75
6EA8	3.00
6EH8	2.50
6EW6	2.25
6F6	3.00
6F23	1.60
6F28	1.60
6F33	33.50
6H1	14.00
6H2N	2.75
6H3N	2.75
6H6	3.00
6J4	5.50
6J6	8.93
6J7	4.75
6JE6	7.50
6K4N	2.50
6K6GT	2.75
6K7	3.00
6K8	3.00
6KD6	7.00
6L6G	3.00
6L6GA	3.50
6L6GC	5.75
6L6GT	3.00
6L7	2.50
6N2P	2.50
6N3P	2.50
6N7	3.00
6P22S	4.00
6Q7	3.75
6R7	3.25
6RHH8 6KN8	10.00
6SA7	3.00
6SC7	2.75
6SF7	2.50
6SH7	3.00
6SJ7	3.25
6SK7	3.50
6SL7GT	3.00
6SN7GT	3.00
6SQ7	3.40
6SR7	4.00
6SS7	2.75
6U5G	3.50
6U8A	2.25
6V6GT	4.25
6X4	3.00
6X5GT	1.75
7B7	2.50
7C5	4.00
7C6	2.50
7H7	4.00
7R7	4.25
7S7	3.50
7Y4	2.25
7Z4	2.00
12AH8	5.00
12AT6	1.50
12AT7	1.75
12AU6	2.50

12AU7	1.75
12AV6	2.50
12AW7	3.50
12AX7	1.75
12AY7A	4.00
12B4A	3.50
12BA6	2.50
12BE6	2.50
12BH7	2.75
12BY7	3.00
13E1	170.00
12E11	28.00
12E14	65.00
12E1	170.00
19H4	27.50
19H5	47.50
24B9	67.25
30C15	2.00
30C17	2.00
30C18	2.00
30F5	1.60
30FL1	1.38
30FL12	1.80
30FL14	2.00
30L1	1.50
30L15	2.00
30L17	2.00
30P4	2.50
30P19	2.50
30PL1	3.00
30PL13	1.80
30PL15	1.80
35W4	1.00
50C5	1.50
75B1	6.05
75C1	4.50
85A1	7.50
85A2	6.45
90AG	20.00
90AV	20.00
90C1	6.00
90CG	14.54
90CV	15.45
92AG	20.00
92AV	20.00
95A1	8.45
150B2	6.50
150B3	8.35
150C2	3.25
150C4	6.00
211	35.00
723AB	125.00
803	25.00
805	45.00
807	3.75
811A	18.33
812A	35.00
813 valve	65.00
833A	193.16
866A	20.03
872A	20.00
922	6.00
931A	18.50
1624	4.00
1625	3.50
2050	7.50
4212E	300.00
4212H	300.00
5544	110.00

5545	150.00
5551A	120.00
5552A	155.35
5642	9.00
5654	3.00
5651	4.45
5670	4.50
5675	28.00
5687	6.00
5696	4.50
5718	7.50
5725	5.50
5726	11.37
5727	7.05
5749	2.50
5751	4.00
5763	4.50
5814A	4.00
5840	4.00
5842	12.00
5876A	31.50
5879	5.00
5886	17.50
5963	2.50
5965	3.50
6005	2.25
6021	4.50
6057	12.25
6058	12.34
6059	6.00
6061	6.00
6063	3.75
6064	10.25
6067	11.75
6072	6.00
6080	14.00
6097A	235.00
6097B	200.00
6146A	12.00
6146B	12.00
6159B	19.00
6189	9.50
6201	11.40
6442	20.00
6550	8.00
6883B	12.50
6973	7.50
7025	3.00
7027A	8.00
7551	6.25
7586	15.00
7587	23.00
7609	56.00
7868	6.00
7895	12.00
8068	16.50
8136	2.50
8417	6.00
18042	11.53
18045	10.49
18046	11.53

Tested
Ex-Equipment
4CX250B 8.50
CV Devices
Large stocks
Prices on
application

BASES

B7G unskirted	0.40
B7G Skirted	0.50
B9A Unskirted	0.40
B9A Skirted	0.50
B9D	0.55
Int Octal	0.40
Loctal	0.55
Nuvistor base	2.00
Valve screening cans all sizes	0.40

CRTs

2AP1	8.50
2BP1	9.00
3BP1	20.00
3DP1	5.00
3LG1	10.00
3FP7	6.00
3GP1	6.00
3JP1	8.00
3JP2	8.00
3JP7	10.00
3KP1	15.00
3RP1	35.00
3WP1	20.00

5ADP1	55.00
5CP1	10.00
5CP1A	40.00
5P15A	15.00
5UP7	25.00
DG7 5	63.32
DG7 31	58.07
DG7 32	58.07
DG7 36	65.00
DH3 91	56.83
DH7 11	113.12
VCR138	12.00
VCR138A	12.50
VCR139A	8.00

VCR517B	10.00
VCR517C	10.00

CRT sockets
Prices on
application
I/C sockets
Texas
low profile

8 pin	10p
14 pin	10p
16 pin	10p

INTEGRATED CIRCUITS

7400	0.16
7400	0.35
7401	0.36
7402	0.36
7403	0.36
7404	0.42
7405	0.42
7406	0.48
7407	0.55
7408	0.36
7409	0.36
7410	0.36
7411	0.40
7412	0.42
7413	0.36

7416	0.48
7417	0.48
7420	0.48
7422	0.36
7423	0.36
7425	0.36
7427	0.36
7428	0.36
7430	0.36
7432	0.36
7433	0.55
7437	0.36
7438	0.36
7439	0.36

7440	0.36
7441	0.48
7442	1.25
7450	0.30
7451	0.30
7453	0.30
7454	0.30
7460	0.30
7470	0.48
7472	0.30
7473	0.48
7474	0.36
7475	0.65
7476	0.48
7480	0.32

7483	0.48
7484	0.72
7486	0.54
7490	0.72
7491	0.36
7492	0.54
7493	0.54
7494	0.78
7495	0.65
7496	0.60
7497	3.90
74100	0.84
74107	0.36
74109	0.54
74110	0.48
74111	0.51
74116	1.50
74118	1.20

74119	1.50
74120	0.75
74121	0.54
74122	0.70
74123	0.60
74125	0.60
74126	0.54
74128	0.55
74136	0.70
74141	0.46
74143	1.30
74145	0.72
74147	1.50
74148	1.40
74150	1.60
74151	0.36
74154	1.40
74155	0.60

74156	0.48
74159	1.75
74170	1.20
74172	4.00
74173	0.72
74174	0.60
74175	1.00
74176	1.00
74180	1.48
74190	1.20
74191	1.20
74192	1.10
74193	0.60
74194	1.10
74195	0.72
74196	1.00
74197	1.00
74198	2.20

74199	2.20
TAA570	1.75
TAA630S	1.75
TAA700	3.00
TBA480Q	1.50
TBA520Q	1.50
TBA530	1.50
TBA550Q	1.75
TBA560Q	1.75
TBA673	1.75
TBA700	1.50
TBA700Q	1.75
TBA750Q	1.50
TBA800	1.00
TBA920	1.75
TBA990	1.50
TCA270Q	1.00
TCA760A	1.25

Terms of business: CWO. Postage and packing valves and semiconductors 50p per order. CRTs £1.50. Prices excluding VAT, add 15%.
Price ruling at time of despatch.
In some cases prices of Mullard and USA valves will be higher than those advertised. Prices correct when going to press.
Account facilities available to approved companies with minimum order charge £10. Carriage and packing £1.50 on credit orders.
Over 10,000 types of valves, tubes and semiconductors in stock. Quotations for any types not listed. S.A.E.

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Telex 946708
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Open to callers Monday-Friday 9 a.m.-5 p.m. WW1

CIRCLE 25 FOR FURTHER DETAILS.

RAEDEK ELECTRONICS

RE

Tel 021-474 6000
Telex No 312242
MIDTLX G.

SERVING THE COMMUNICATIONS AND ELECTRONICS INDUSTRIES

102 PRIORY ROAD, SCRIBERS LANE, HALL GREEN, BIRMINGHAM, B28 OTB. ENGLAND.

TRANSISTORS:

TYPE	LIST £	TYPE	LIST £
2N3375	10.90	2SC1978	6 40
2N3553	1.60	2SC2053	0 80
2N3632	12 95	2SC2237	6.00
2N3733	12 95	2SC2287	9.60
2N3866	1.20	2SC2290	20.00
2N4416	0.75	MRF240	20 70
2N4427	1 40	MRF245	33.00
2N5090	10 90	MRF247	33.30
2N5109	1.95	MRF433	9.00
2N5160	3 00	MRF449A	10.15
2N5589	7.60	MRF450	11.50
2N5590	7.90	MRF450A	13.80
2N5591	9 50	MRF454	17.25
2N5641	6.95	MRF454A	17.25
2N5642	9.30	MRF455	16.50
2N5643	11.85	MRF458	17 20
2N5913	2 50	MRF475	2.30
2N5944	7.85	MRF476	2.15
2N5945	10.10	MRF644	22.50
2N5946	10 80	MRF646	27 00
2N6080	6.65	MRF648	32 70
2N6081	8 40	MRF901	2.75
2N6082	10.50	SD1013	9.75
2N6083	11.20	SD1019-STUD	23 10
2N6084	12.00	SD1019-5	22.80
2SC1729	12.50	SD1127	3.10
2SC1945	3.45	SD1134-1	2.25
2SC1946A	16.00	SD1136	11.90
2SC1947	8.50	SD1143	9 40
2SC1969	1.80	SD1219	14 70
2SC1970	1.40	SD1272	10 95
2SC1971	3.50	SD1278	13.75
2SC1972	9 50		

INDUCTION AND DIELECTRIC HEATING SPARES

INCL.

CERAMIC CAPACITORS	SOLID STATE RECTIFIERS
VACUUM CAPACITORS	RECTIFIER VALVES
GRID LAMPS	OSCILLATOR VALVES
CARBON FREE HOSE	COOLING FANS/FILTERS
WATER FLOW SWITCHES	etc. etc.

VALVES:

TYPE	LIST £	TYPE	LIST £	TYPE	LIST £	TYPE	LIST £	TYPE	LIST £
AH211A	137.50	EF94	2 00	OA3	2.50	6AU5GT	3 70	813	30 00
AH2511	90.00	EF95	1 60	OB2	2 50	6AZ8	3 80	934	18 00
AH2532	31 50	EF183	1 90	OB3	2.50	6BA6	1 50	935	41.20
BT5	52 50	EF184	1 80	OC3	2 50	6BE6	1 95	2050	4 80
BT5B	52.50	EK90	1 40	2C39A	39 90	6BH6	2 15	2050A	4 80
BT17	142 00	EL34	3 90	2C39WA	42 00	6BJ6	2.00	5544	81 00
BT17A	130.00	EL36	2 30	2D21	2 00	6BK4C	4 50	5545	95 00
BT95	125.00	EL84	1 60	2E26	7 50	6BN8	3 50	5557	24 50
C3J	30.00	EL86	2.10	2K25	114 00	6BZ6	2.50	5559	52 50
C3JA	30 00	EL519	7 70	3-400Z	78.00	6C4	1 95	5727	2.95
E55L	56 00	EL803S	9 95	3-500Z	85 00	6CB6A	1 80	5867A	140.00
E80CC	14 00	EL821	13.75	3B28	15.00	6CJ3	2.30	5879	6.15
E80L	21 00	EN32	16 25	3C45	24.50	6CW4	6 30	5965	2.20
E88CC	3 90	EN91	2.00	3CX100A5	35.00	6DC6	2 45	5991	32.00
E90CC	7 50	EZ80	1 60	4-65A	52 50	6E5	4.20	6130	24 50
E130L	21 25	EZ81	1.50	4-125A	60 00	6EA8	2.25	6146A	9 00
EB91	1 35	EZ90	1 50	4-250A	76.00	6GK6	2.50	6146B	9.00
EBC91	1 10	FG17	24.50	4-400A	80.00	6HF5	4.25	6360A	4.95
EBF89	1.35	FG105	160 00	4-400B	80 00	6HS6	3 95	6550A	7.25
EC90	1.25	GXU1	15.00	4-400C	80.00	6JB6A	4 20	6883B	8.70
ECC32	3 25	GXU4	45.00	4B32	30.50	6JE6C	6.25	6973	3 95
ECC81	1.60	GZ34	2 10	4C35A	135 00	6JS6C	4 70	7027A	6 50
ECC82	1.60	KT66	9 00	4CX250B		EK7	2 50	7199	4 20
ECC83	1.60	KT77	8 75	EIM AMP	55.00	6K11	2 25	7247	3.20
ECC85	1 85	KT88	24 95	4CX250B		6KD6	5.90	7262A	26.00
ECC88	2.00	ML8536	275 00	NAT	48 00	6KD8	2 00	7360	12 20
ECC91	2.00	ML8741	265.00	4CX350A	87.00	6L6GC	3 90	7586	11.50
ECC189	2 00	NL SERIES		4X150A	33 70	6LQ6	6.25	7587	35 00
ECF80	1 50	QQV02-6	22 00	5AR4	2 10	6Q11	2 25	7591A	4.65
ECF86	1 65	QQVO3-10	5 30	5AS4A	2 10	6SL7GT	2.25	7815AL GE	48.00
ECF801	1 80	QVO3-12	7 00	5R4GYA/B	3.50	6SN7GTB	3.05	7815R	53 00
ECH81	2 30	QY3-65	57 50	5U4GB	2 10	6U8A	2 00	8122	101 00
ECL82	1.90	QY3-125	63.00	5V4GA	2.50	12AT6	1.50	8906AL	55 00
ECL86	1 60	QY4-250	69 80	6AH6	2 30	12AU6	1 70	150B2	6.50
EF80	1 70	RG1-240A	10.00	6AK5W	2 50	12AV6	2 00	572B	52 00
EF85	3 00	RG4-3000	90 00	6AK6	1.95	12BA6	1.80	807	2 90
EF86	2 30	XG1-2500	52.50	6AL5W	1.80	12BA7	2.35	810	75 00
EF89	2 30	XG5-500	24 50	6AQ5A	1 75	12BE6	2 00	812A	36 85
EF91	2.95	XR1-3200	72 50	6AQ5W	1 80	12BY7A	2.70		
EF92	2 20	XR1-6400	120 00	6AS6	2.40	12BZ6	3 70		
EF93	1 50	OA2	2 00	6AS7G	4 30	12DW7	3 75		

WE ALSO SUPPLY EIMAC TUBES AND ACCESSORIES

1000's of VALVES/TRANSISTORS/IC'S IN STOCK. PLEASE ENQUIRE ON TYPES NOT LISTED.

SERVICE AIDS

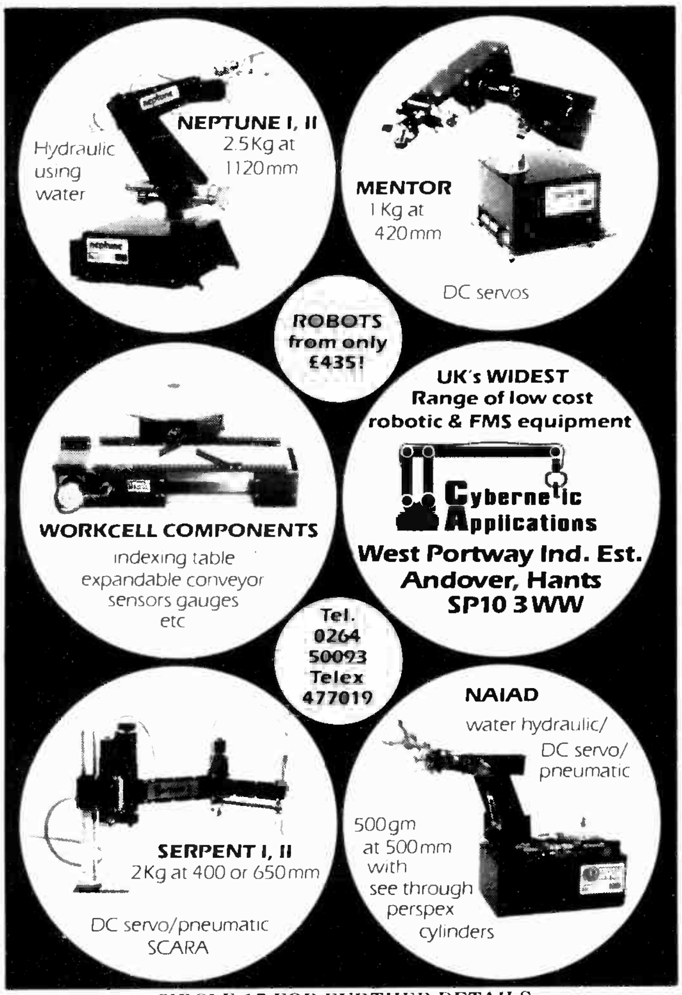
CONTACT CLEANER — 1.00
FREEZE IT AEROSOL — 1.25

HEATSINK COMP (100g) — 1.50
SILICONE GREASE — 1.50
LARGE RANGE OF SOLDERING IRONS AND ACCESSORIES

PRICES — CORRECT AT TIME OF GOING TO PRESS

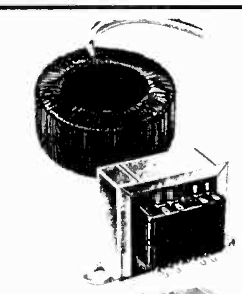
TERMS — PLEASE ADD £1.00 P&P AND VAT @ 15% to orders.

CIRCLE 36 FOR FURTHER DETAILS.



CIRCLE 15 FOR FURTHER DETAILS.

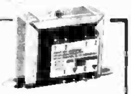
Toroidal & E.I. Transformers



As manufacturers we are able to offer a range of quality toroidal and laminated transformers at highly competative prices
Quantity Prices and delivery on request.

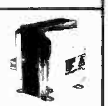
MAIL Order Price List
(prices inclusive of VAT & Postage)

Toroidal transformers
15VA **7.95**, 30VA **9.18**, 50VA **10.16**, 80VA **11.36**, 120VA **12.07**, 160VA **14.20**, 225VA **15.51m** 300VA **17.04**, 500VA **22.10**, 625VA **24.66**, 750VA **28.75**, 1000VA **44.82**.
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 10amp) primary 240 volt.
Also available 1k2, 1k5, 2k, 2k5, 3k. Prices on request.



E.I. transformers (clamp)
6VA **2.90**, 8VA **3.40**, 12VA **4.20**, 15VA **4.75**, 25VA **5.40**, 50VA **6.50**, 100VA **13.02**.
Available in the following voltages: 6-0-6, 9-0-9, 12-0-12, 15-0-15, 20-0-20, 25-0-25. Primary 240 volt.

Printed circuit mounting transformers. (E.I.)
3VA **2.38**, 6VA **2.99**, 8VA **3.75**, 12VA **4.66**.
Available in the folowing voltage: 6-0-6, 9-0-9, 12-0-12, 15-0-15, 20-0-20. Primary 240 volt.



Auto transformers
240 volt input 115 volt USA socket outlets (fully shrouded)
150VA **11.00**, 300VA **15.00**. 500VA **27.00**, 1000VA **34.00**, 1500VA **48.00**. 2000VA **53.00**

Portable isolating transformers
Input 240 output 110V. rating continous/tool
500/750VA **53.84**, 1000/1500VA **72.57**, 1000/1500VA **76.59**, 1500/2500VA **85.54**.
Input 240 output 240
250/400VA **57.40**, 500/750VA **65.25**.

AIR LINK

Air Link Transformers.
Unit 6, The Maltings, Station Road, Sawbridgeworth, Herts. Tel: 0279-724425

CIRCLE 44 FOR FURTHER DETAILS.

Fibre Optics '86

If you don't think fibre optics is for you this event should convince you otherwise.

The Fibre Optics '86 Exhibition, held in hall D of the Earls Court exhibition centre, is part of British Electronics Week consisting of four exhibitions taking place simultaneously at Earls Court and Olympia. It aims to bring together leading manufacturers of fibre optic components and systems to show their latest products to a 'broadly based audience of engineers, managers and commercial staff', and includes lasers, local area networks and optical sensors. It is open from 28 April to 1 May in hall D of the Earls Court exhibition centre — a different venue from last year's Olympia — and a list of exhibitors accompanies our stand plan.

For about a £100 a day an accompanying conference, held at the nearby London West Hotel 29 April to 1 May, discusses recent developments in fibre components and applications in both sensing and communications. If you are unable to attend you will be able to buy a set of conference papers after the event (only abstracts are available at the event from, strangely, publishers in the USA — SPIE*), and if you want copies of previous conference papers (all British) you'll have to buy them from America. To help newcomers get down to basics there are tutorial sessions on 'Basic fibre optics' (28 April), and 'Optical fibre sensor technology' (29 April), both of which cost around £100 but for companies wishing to acquire the basics quickly this is probably a cost-effective way. (There is also 'Business opportunities in fibre optics', which the brochure shows as a listing of applications, and 'Industrial applications of expert systems', which connection with fibre optics isn't at all clear.)

* PO Box 10, Bellingham, Washington, 98227-0010, USA.

● K-Tech claim a typical loss of less than a decibel for all Diamond SA single-mode connectors, using 6/125μm fibre, including new types MMS40 to BT spec and MMS11 the first to be approved to DIN standard. Also new are optical attenuators for single to multimode and *vice versa* use with values from 2.5 to 30dB, and several tool sets. **EWW 301 for further details.**

● Kaptron, a new principal for Centronic Sales, specialise in fibre optic components and specialist test gear including Polytrope, an IBM PC-controlled automatic fibre alignment equipment. **EWW 302 for further details.**

● BICC Optical Components Unit at Prescot are to introduce a series of test equipment, the first of which is a stabilized light source for accurate on-site attenuation measurements. The emitter is a 1300nm edge-emitting l.e.d. whose output is chopped at 270Hz (the normal power meter frequency) but which can be externally modulated or operated c.w. We're told the price of £3,450 is about half that of its (laser-based) competition. **EWW for further details.**

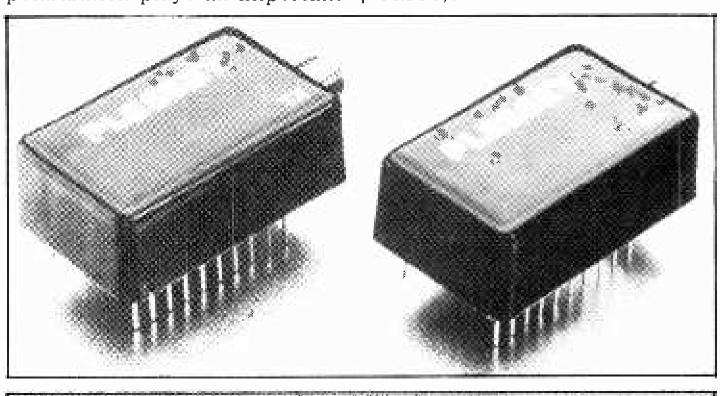
● Fused couplers for fibre sizes of 62.5 and 85/125μm are now made by ADC Fiber Optics in addition to existing types for 50/125, 100/140μm graded-index and 100/140, 200/240μm step-index fibre. **EWW 304 for further details.**

● Belling and Lee Intec fibre components, modules and connectors are to be distributed by Cirkit Distribution following an agreement signed at FO '86.

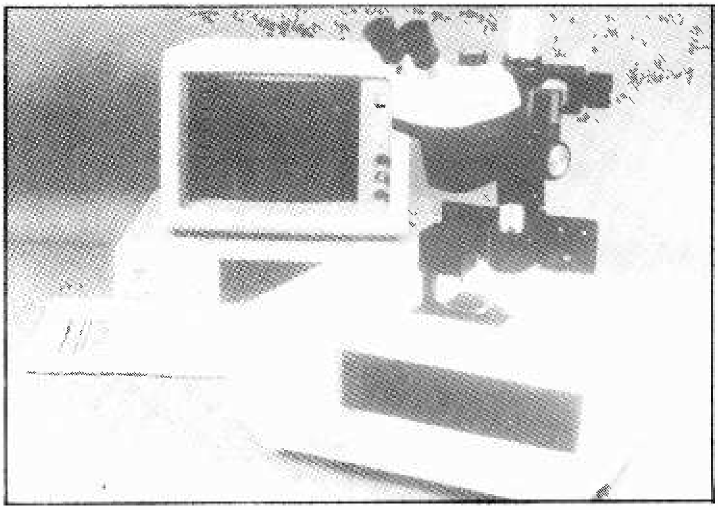
● Cossor's optical time domain relectometers will be marketed in the USA by Wilcom Products, a subsidiary of communications co. Plantronics Inc.

New at Electro-Optics, Brighton

● As well as standard single mode optical fibres York Ventures and Special Products of Chandler's Ford make both ultralow and high birefingent fibres. The high birefringent type avoids polarization noise and signal fading in fibre gyroscopes and other interferometric sensors, for links to polarization-sensitive devices and for coherent communication. York's fibre has a beat length of less than 2mm: beat length is a measure of polarization holding ability. (Any phase difference between the two orthogonal modes gives rise to beats.) Ultra-low birefringence is useful in devices where the polarization plays an important



Data link modules typical of those currently available for point-to-point use and local area networks. This Plessey pair can operate up to 125Mbit/s in either NRZ or Manchester biphase encoding (50Mbit/s) at distances of up to 2km.

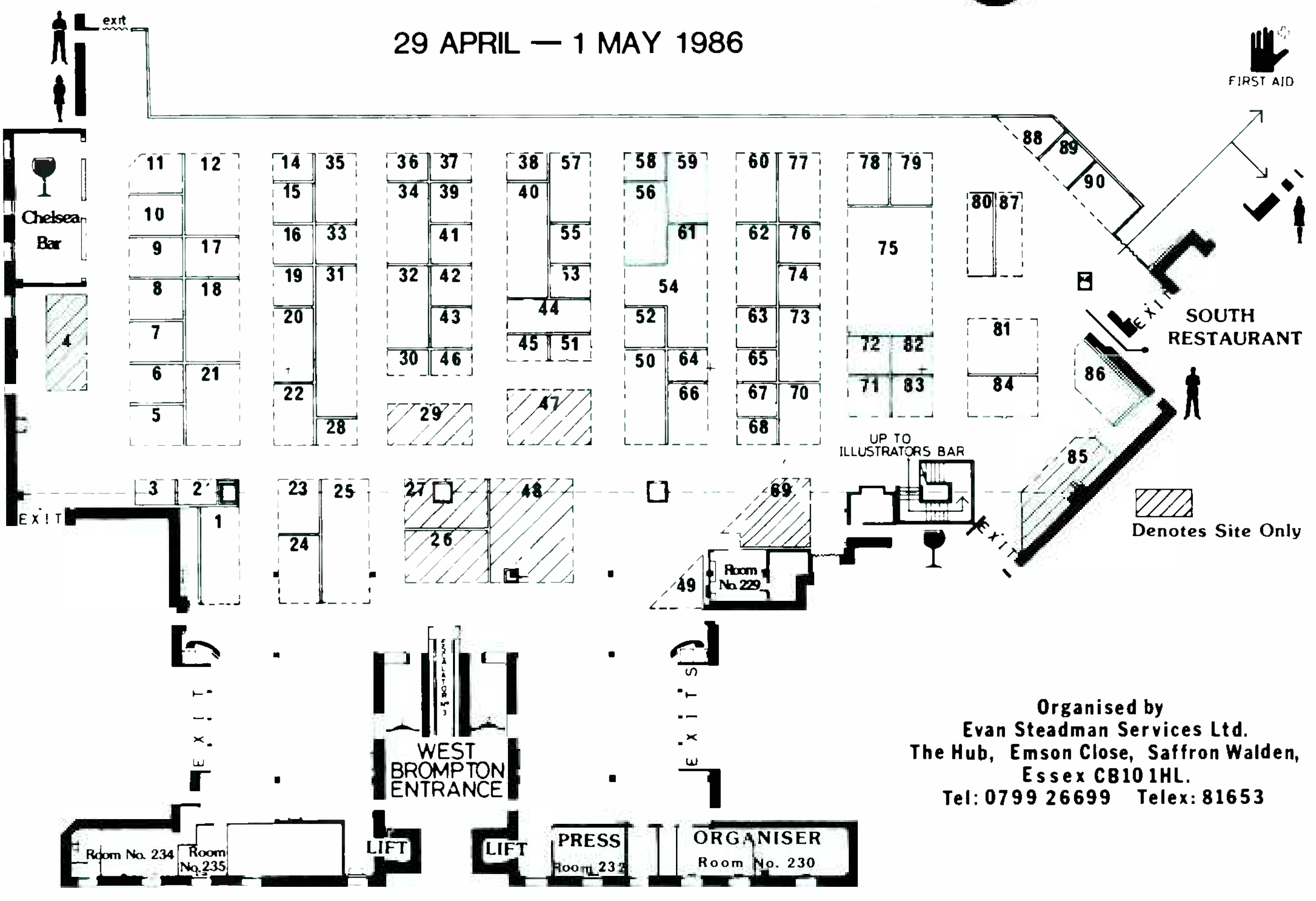


IBM PC-controlled fibre optic alignment aid by Polytrope (Centronic Sales).

FIBRE OPTICS

EARLS COURT — HALL D — LEVEL 2

29 APRIL — 1 MAY 1986



Exhibitor	Stand	Product code
Accris Electronics	45	
ADC Europe	24	C
AG Electro-Optics	52	C
All-Inspection NDT	36	I
Ando — see Aspen		
Anritsu Europe	47	TM
Aspen Electronics	40	TM,C
Bausch & Lomb UK	51	I
Belling Lee Intec	79	C,S
Bentham Instruments	41	I
BICC Group	48	F,S,TM
Buehler	81	M
Burleigh Instruments	16	C
Centronic Sales	75	C,TM
Centronic	75	C
Codenoll — see Thorn EMI		
Comtec Cable Associates	73	I
Cossor Electronics	26	TM
Datarange Communications	43	S
Delta Controls	83	I
Ealing Electro-Optics	30	C,I
Electroustic	76	S
Engis	89	M
Epitaxx Inc	32	C
Fibre Data	44	C,F
Fibre Optic Links	23	S
Fibre Optic Systems	37	S
Focom Systems	61	S
Fotec — see Centronic		
Fujitsu Microelectronics	66	C
Galvoptics	68	C,I
GEC Optical Fibres	70	F
General Optronics	42	
Grass Valley Group	35	
GTE Slyvania	63	
Hall and Watts	67	
Hirschmann — see Electroustic		
Honeywell Control Systems	62	C,S
Holtek Optronics	14	
ICI Stratos		C
Instruments Technology	2	I
Kendal Hyde	71	M
K-Tech Micro Precision	80	C
Lambda Photometrics	4	TM,I
Laser Lines	31	C,TM,I,S
Lasertron	21	C
Leetec	22	C
E.Leitz (Instruments)	46	TM,I
Lightwave	74	
Logitech	39	M
Melles Griot (UK)	50	C
Micron Semiconductor	28	C
Microwave Systems	49	
Mullard	88	C
National Physical Lab	57	
NEC Electronics (UK)	60	C
NKT (UK)	29	S

role for example in electric or magnetic sensors. In ordinary single-mode fibres birefringence is generally sensitive to temperature, pressure and vibration making calibration of polarization difficult. York's fibre, made by a preform spinning process patented at the University of Southampton, can have zero birefringence in nearly all situations; linear retardance is less than a degree, with no variation of polarization with temperature. **EWW 305 for further details.**

• Radiall fibre optics connectors are now available through Norbain Electro-Optics, following a distribution agreement with the French manufacturer. Covered are the SMA style connectors for five sizes of p.c.s. multimode fibre, the new FMA types, and the very low loss Optaball range also suitable for monomode fibre. Emitting and photodiodes from RCA, TRW, Siemens, and EC&G's Vactec were newly shown at Brighton but a surprise announcement was the exclusive rental agreement with STC for its range for time domain reflectometers.

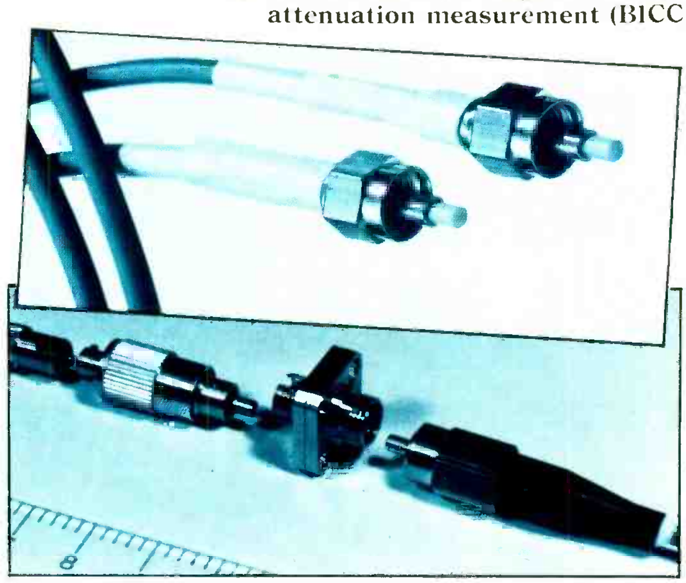
• Temporal disperser is the name Hamamatsu give to their 30GHz long wavelength optical oscilloscope. Based on a sychronized streak camera, it connects with a conventional camera — TV or still — and temporal analyser for real time operation together with other peripheral equipment to allow measurement of chromatic dispersion of single-mode fibres. The multidimensional detectors are able to record time, position or wavelength, and light intensity, and allow time-resolved spectroscopy up to a wavelength of 1.6μm. Observations of long wave phenomena have been impossible with conventional streak cameras because of the low efficiency of the photocathode in the range 1.3 to 1.6μm. The streak unit, type C1587, uses a synchroscan tube in which a sinusoidal sweep voltage aplied to the tube's deflection plates is synchronized with repetitive light pulses, for example from a dye laser. Integration of streak images occurs on the phosphor screen or by direct readout. Hakuto International, **EWW 306 for further details.**

• Gallium aluminium arsenide emitters and a p-i-n photodetector are newly available from Motorola distrubutors Gothic Crellon. Designated type MFOE3200 and 3201 and MFOD3100, the devices are housed in a new low-cost rugged plastics-capped package that fits standard device receptacles. The two emitters launch 10 and 20μW into 100μm fibre and are 850nm diodes with a bandwidth (60MHz) claimed to be higher than any other emitter in the price range. **Enter EWW 307 for further details.**

Norbain Electro Optics	11	C
Oceonics SPL	84	S
Optical Fibres	56	F
Optical Publishing Co	6	
Optilas	18	C
Optronics	69	C
Oriel Scientific	53	C,I
Philips Kommunikations	85	
Photon Control	33	I
Pirelli General	54	F
Plessey Optoelectronics	25	C
Prior Scientific Instruments	55	I
Radiall Microwave Components	38	C
RCA	34	C
REL	78	S
Rofin-Sinar Laser	5	TM
Sira	3	TM
Special Gas Controls	87	C,F
Spectrolab	15	I
Stratos — see ICI		
Sumitomo Electric Europe	77	C,F
System Donner — see Thorn EMI		
TBL Fibre Optics Group	64	F
Thorn EMI Measurements	90	C,S
Vickers Instruments	1	TM
Walmore Electronics	82	C,S

Product codes: connectors/components — C; fibres/cables — F; test and measurement — TM; systems — S; optical instrumentation — I; coating and lapping — M.

Stabilized modulated light source for attenuation measurement (BICC).



SMA-style connectors, often referred to as the 'industry standard' of connectors, are frequently used in data transfer applications. The range of Radiall SMA types now available from Norbain, together with the Optaball range which have average losses as low as 0.35dB. New ceramic-ferrule SMA types are added to the Optical Fibre Technologies range from Walmore, as are two new biconical types with ceramic capillary. Multimode version is field-installable using procedures for Dorran Photonics connectors, with which they are mateable. Telecommunciation systems usually use flat contact (FC) connectors such as Sieko's NTT type. Their latest development is the point contact (PC) type, bottom, in which the end surface is polished to a convex spherical shape, said to "drastically reduce" connection and return loss compared to the similarly constructed FC connectors. EWW 308 (Radiall) EWW 309 (Walmore).

by John Lidgey

SENSITIVITY ANALYSIS

— WHAT IS IT AND WHAT CAN IT DO?

Whilst generally used for filter analysis, the sensitivity analysis is just as valid in many other branches of electronics.

Sensitivity analysis is a fairly simple mathematical technique that is most often used in electronics as an aid to help establish whether a particular active filter will perform to the required specification, and if so, what tolerance and temperature coefficient the components should have.

Though quite useful in this context, sensitivity analysis is a very useful technique that may be applied to many circuit problems and the results obtained are valuable to the circuit designer.

Definition

The informal (not absolutely precise) definition of the sensitivity function is

$$S_X^Y \approx \frac{\Delta Y}{Y} \Big/ \frac{\Delta X}{X} \qquad (1)$$

and it is the ratio of the normalized variation of parameter Y to the normalized variation of parameter X. If the variation ΔX is infinitely small, then

$$S_X^Y = \frac{X}{Y} \cdot \frac{\partial Y}{\partial X} \qquad (2)$$

Equation 2 is the formal definition. To illustrate the meaning of S_X^Y consider the following example.

Suppose X represents temperature, T, and Y represents a resistor value R, the value of which is inversely proportional to temperature, i.e. $R = A/T$, where A is a constant. Then using equation 2 gives

$$S_T^R = \frac{T^2}{A} \cdot \frac{\partial(A.T^{-1})}{\partial T}$$

$$S_T^R = -1.$$

Using the informal definition in (1), the fact that $S_T^R = -1$ means that if the temperature were to increase by 1% then the resistance would decrease by about 1%. As can be verified using equation 2, if the resistor happened to be inversely proportional to T^4 then the value of $S_T^R = -4$ and then the change of R would be four times as great.

Mathematical relationships

A very helpful relationship in simplifying calculations of sensitivity values is derivet neit.

Suppose Z is defined by the expression $X = c^Z$ or $Z = \ln X$. Differentiating gives

$$\frac{\partial X}{\partial Z} \cdot \frac{\partial X}{\partial \ln X} = e^Z$$

or

$$\frac{\partial X}{\partial \ln X} = X \qquad (3)$$

Similarly

$$\frac{\partial Y}{\partial \ln Y} = Y. \qquad (4)$$

Rewriting equation 2 using 3 and 4

$$S_X^Y = \frac{X}{Y} \cdot \frac{\partial Y}{\partial X} = \frac{\partial X}{\partial \ln X} \cdot \frac{\partial \ln X}{\partial Y} \cdot \frac{\partial Y}{\partial X}$$

$$S_X^Y = \frac{\partial \ln Y}{\partial \ln X} \qquad (5)$$

To illustrate the value of this formulation of S_X^Y, consider the following example. Suppose $Y = AX^P$, where A and P are not functions of X, then from equation 5

$$S_X^Y = S_X^{AX^P} = \frac{\partial \ln AX^P}{\partial \ln X} = \frac{\partial \ln A}{\partial \ln X}$$

$$S_X = +P.\frac{\partial \ln X}{\partial \ln X} = P.$$

This is the proof of the first identity shown in the Appendix, and the others can be verified in a similar way. The identities ease the complexity of evaluating S_X^Y using the definition of (2).

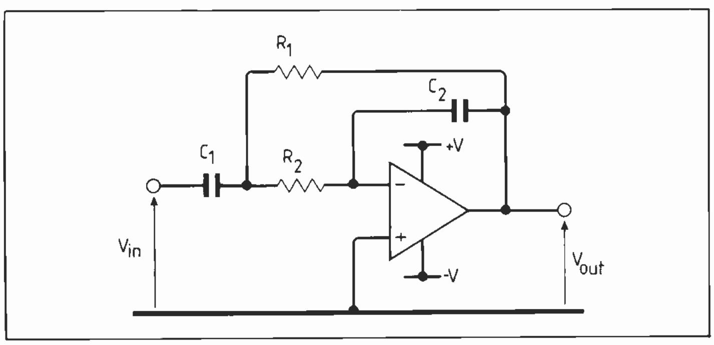
Application to negative feedback systems

Negative feedback results in a lower overall system gain and closed-loop gain in much less sensitive to open-loop amplifier performance. This classical result can be simply shown by evaluating the sensitivity of the closed-loop gain to the open-loop gain. If we use the symbol A_F for the feedback gain and A for the open-loop gain with β for the feedback factor, then the standard relationship between these parameters is

$$A_F = \frac{A}{(1+\beta A)} \qquad (6)$$

$$S_A^{A_F} = \frac{A(1+\beta A)}{A} \cdot \frac{\partial\left(\frac{A}{(1+\beta A)}\right)}{\partial A}$$

Dr F. J. Lidgey is Principal Lecturer in Electronics, Oxford Polytechnic



$$= \frac{1}{(1+\beta A)}$$

$$S_A^{A_F} = \frac{A_F}{A}. \qquad (7)$$

The closed-loop gain is almost the same as the inverse of the feedback network gain, provided that the open-loop gain is much larger than the closed-loop gain. This fact is clear from equation 6, and from equation 7 this makes

$$S_A^{A_F} = \frac{A_F}{A} \rightarrow 0.$$

Turn now to a standard op-amp non-inverting amplifier with closed-loop voltage gain of

$$\frac{V_o}{V_{IN}} = A_F = (1 + R_2/R_1),$$

where R_2 and R_1 are the feedback resistors linking the output to the op-amp with the inverting input terminal and the inverting input terminal and earth respectively.

To establish the sensitivity of A_F to each of the resistors without much effort and no differentation, use the identities shown in the Appendix:

$$S_{R_2}^{A_F} = \left(\frac{A_F - 1}{A_F}\right) = S_{R_1}^{A_F}. \qquad (8)$$

Clearly if $A_F \gg 1$ then the sensitivity values given in equation 8 approach unity in magnitude.

On the face of it none of these results are particularly surprising nor startling. However, if the values obtained were not small but yielded figures of 10 or more we might well be alarmed as this would suggest a large change of the circuit parameter Y as a result of a change in circuit component X. This does occur if positive rather than negativee feedback is used in a particular application.

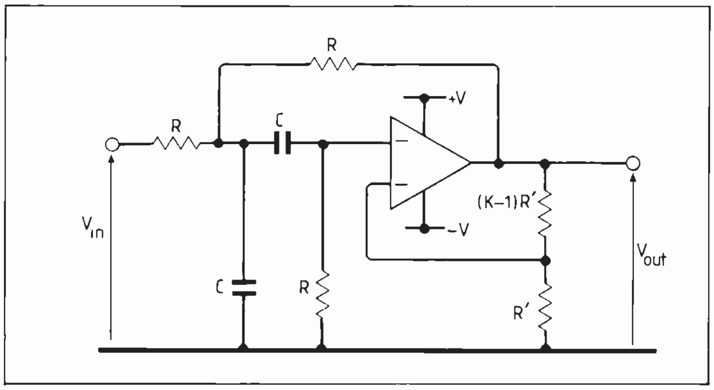
Application to active filters

The circuit shown on Page 46 is of a second-order band-pass filter and from analysis the centre frequency f_o, the quality factor Q, and the centre frequency gain A_o are given by the following expression:

$$f_o = \frac{1}{2\pi} \cdot \frac{1}{\sqrt{C_1 R_1 C_2 R_2}}$$

$$A_o = -\frac{C_1}{C} \cdot \frac{R_1}{(R_1 + R_2)}$$

$$Q = \frac{1}{(R_1 + R_2)} \cdot \sqrt{R_1 R_2} \cdot \sqrt{C_1/C_2}$$



The table shows that the S_X^X values are reasonable with no high sensitivity effects evident. In fact, they are all within the range −1 to +1. Other constraints permitting, if R_1 were set to equal R_2, then

$$S_{R_1}^Q = 0 = S_{R_2}^Q$$

and

$$S_{R_1}^{A_o} = \tfrac{1}{2} = -S_{R_2}^{A_o}.$$

If the sensitivity tabulation resulted in any values being five more it would be wise to consider discarding the circuit in favour of an alternative yielding lower sensitivity to componnent variation.

The second-order active band-pass filter shown above has the characteristics:

centre frequency

$$f_o \frac{1}{2\pi} \frac{\sqrt{2}}{R.C}$$

centre frequency gain

$$A_o = \frac{K}{(4-K)}, \text{ and}$$

quality factory

$$Q = \frac{\sqrt{2}}{4-K}.$$

One of the poorest aspects of this particular circuit comes to light when evaluating the sensitivity of Q to variations in amplification gain K. It is relatively easy to show that

$$S_K^Q = 2\sqrt{2}.Q - 1.$$

Clearly if Q is 10 say, this gives a value of $S_K^Q \approx 27.3$.

This is intolerably high as a +1% change in K results in about 27% change in Q! Having discovered this most disastrous feature for moderately high values of Q, the designer would be well advised to abandon this circuit completely and seek a replacement to achieve the desired band-pass response.

X=	R_1	R_2	C_1	C_2
$S_X^{f_o}$	$-\frac{1}{2}$	$-\frac{1}{2}$	$-\frac{1}{2}$	$-\frac{1}{2}$
$S_X^{A_o}$	$1-\frac{R_1}{(R_1+R_2)}$	$1-\frac{R_2}{(R_1+R_2)}$	+1	−1
S_X^Q	$\frac{1}{2}-\frac{R_1}{(R_1+R_2)}$	$\frac{1}{2}-\frac{+R_2}{(R_1+R_2)}$	$+\frac{1}{2}$	$-\frac{1}{2}$

Appendix

Useful identities for sensitivity analysis

Definition

$$S_X^Y = \frac{X}{Y} \cdot \frac{\partial Y}{\partial X} = \frac{\partial \ln Y}{\partial \ln X}.$$

1. $Y = AX^P$, where A and P are not functions of X
   $S_X^Y = P$
2. $S_X^Y = -S_X^{1/Y}$
3. $S_X^{Y_1Y_2} = S_X^{Y_1} + S_X^{Y_2}$
4. $S_X^{Y_1/Y_2} = S_X^{Y_1} - S_X^{Y_2}$
5. $S_{Y^N}^Y = \frac{1}{N} \cdot S_X^Y$
6. $S_X^{Y_1+Y_2} = \frac{Y_1 S_X^{Y_1} + Y_2 S_X^{Y_2}}{Y_1 + Y_2}.$

Introducing the S/58 bus

Simpler communications between computers.

The notoriously difficult art of getting computers and their peripherals to talk to one another is about to become a great deal easier, with the launch of the S5/8 serial interface.

After extensive preparatory work by Government bodies and British industry, a detailed specification of S5/8 has just been published by the British Standards Institution.

The new arrangement is certain to receive a warm welcome from anyone who has to struggle with RS232 and its endless permutations of data format and electrical connections. For with S5/8, incompatibility has been designed out.

All physical and electrical aspects of S5/8 (it stands for serial, 5 volt, 8-pin) are defined in the published proposals: as far as the user is concerned, it is a 'plug and run' interface. There is only one kind of interconnecting cable and only one permissible signalling format and data rate.

But S5/8 offers further benefits: in place of the costly 25-way connector, it is based on cheap, compact eight-pin DIN connectors. Logic levels are compatible with 5V c-mos i.cs and are appropriate for portable and other low-power equipment.

Already, six manufacturers are using S5/8 in their products and many more have said they will adopt it when it becomes a British Standard.

We hope to publish shortly an article giving full details of S5/8. But in the meantime, the specification is available under the BSI reference number DD 153. BSI Sales Department, Linford Wood, Milton Keynes MK14 6LE.

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60	10.96	2.31
100	12.79	2.59
200	18.12	3.10
250	21.91	3.24
350	27.10	3.40
500	33.76	3.66
1000	61.22	4.62
1500	78.97	5.95
2000	95.01	6.36
3000	133.23	OA
6000	284.66	OA

*115 or 240V sec only

400/440 to 200/240 CT
(60-1000VA Tap Secs)

VA	Price	P&P
60	10.98	2.31
100	12.79	2.59
200	18.12	3.10
250	21.91	3.24
350	27.10	3.40
500	33.76	3.66
1000	61.22	4.62
2000	95.01	6.36
3000	133.23	OA
6000	284.66	OA

24/12V or 12-0-12V
2×12V Secs. pri. 240V

12V		24V	Price	P&P
0.3A		.15	2.78	1.10
1		.05	3.68	1.60
2		1	4.90	1.70
4		2	5.66	1.90
6	A	3	8.87	2.05
8	M	4	10.37	2.10
10	P	5	11.34	2.10
12	S	6	12.57	2.25
16		8	14.98	2.60
20		10	20.16	3.04
30		15	25.06	3.10
60		30	51.35	4.90
83		41	59.13	5.65

96/48V. Pri 2×120V
Secs 2×36/48V
60, 72, 84, 96, 360-0-36
or 48-0-48V

72/96		36/48V	Price	P&P
1		2	10.31	1.99
2	A	4	16.96	2.54
3	M	6	20.54	2.75
4	P	8	26.22	2.89
5	S	10	37.22	3.70
6		12	46.61	3.99
8		16	50.85	4.20

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	4.77	1.76
1		2	5.80	1.90
2	A	4	10.32	2.20
3	M	6	11.95	2.25
4	P	8	16.34	2.58
6	S	12	20.80	2.79
8		16	29.42	3.15
10		20	34.91	3.60
12		24	41.78	3.80

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	5.42	1.85
1		2	8.26	1.91
2		4	10.62	2.20
3	A	6	15.35	2.34
4	M	8	17.50	2.55
5	P	10	22.12	2.78
6	S	12	25.24	3.02
8		16	35.48	3.65
10		20	41.30	3.99
12		24	47.40	4.65

EQUIPMENT TYPES

Sec V	Amp	Price	P&P
3-0-3V	0.2	3.26	.96
6×2	1A×2	3.12	1.30
0-0-9	0.1	2.72	.96
9×2	0.33×2	2.53	.96
8-9×2	.5×2	3.53	1.30
8-9×2	1A×2	4.48	2.31
15×2	2×2	2.53	96
12-0-12	.05	3.11	96
20×2	15×2	3.55	1.30
15-27×2	.5	5.88	1.70
15-27×2	1A	7.66	.50
0-CT×15V	.5	2.66	.96
0-CT-15V	4A	2.28	1.08

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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
0.5		1	3.68	1.41
1		2	4.99	1.70
2		4	8.07	1.92
3		6	9.35	2.10
4	A	8	11.16	2.20
5	M	10	13.80	2.31
6	P	12	15.62	2.55
8	S	16	20.90	2.60
10		20	24.11	2.84
12		24	26.73	2.95
15		30	30.75	3.51
20		40	41.16	5.95

AUTOS
105, 115, 220, 230, 240V
For step-up or down

VA	Price	P&P
80	5.58	1.70
150	8.09	1.85
250	9.85	1.98
500	15.35	2.68
1000	27.42	3.25
1500	32.54	3.68
2000	48.66	4.62
3000	82.74	5.72
5000	125.08	OA
7500	193.06	OA
10KVA	228.12	OA

CASED AUTOS
240V Cable Input
115V USA socket outlets

VA	Price	P&P
20	7.94	1.76
80	10.79	1.87
150	13.97	2.20
250	17.02	3.02
500	27.92	3.19
1000	38.97	4.34
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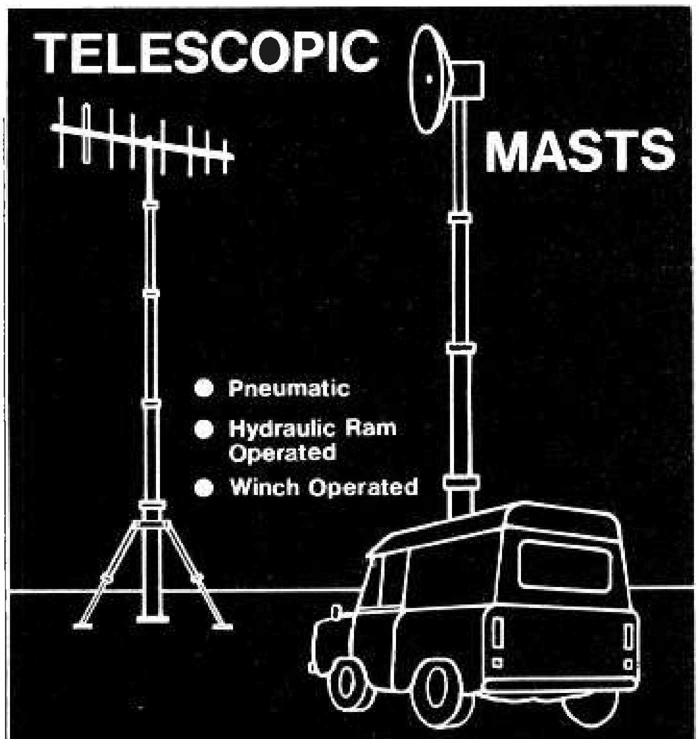

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CIRCLE 40 FOR FURTHER DETAILS.

Timing by remote control

by Peter Ferris

Contruction, testing and setting up of a versatile Z80 timer that uses coded r.f. bursts through the mains wiring

Veroboard could be used as the board layouts are not critical; though having built the prototype on Vero strip-board, I don't recommend it for the processor board.

The usual anti-static precautions should be taken with the m.o.s. i.cs in the system. As long as a good quality earthed soldering-iron is used, the only ic that needs to be in a socket is the eprom (so that the program can be changed).

Assuming all three boards have been built, do not connect them together until the 5 volt supply rail has been checked. If that is o.k., switch off and connect the processor board. Switch on again, and check for a 601Hz squarewave at inter-board connection 16. This indicates that the c.t.c. is generating interrupts, and that the processor is servicing them to multiplex the display. (If the squarewave is not there, refer to the section on fault-finding). Next, check that there is a 601Hz rectangular waveform at connection 17, and that its duty-cycle can be varied between 10% and 90% with the brightness control.

If all is well, switch off, connect the display/keyboard and switch on again. With any luck the first four seven-segment digits will be reading 00:00 and all the day leds will be flashing. This is the clock display, and the flashing leds indicate that the clock needs setting. Set the clock as described in the Operation section, and check that it keeps reasonable time over a minute (i.e. that it isn't running at half or double the proper rate).

The clock accuracy over long periods depends entirely on the crystal oscillator. This can be set by measuring the processor clock frequency at pin 6 of IC_1, and adjusting C_{t1} to trim it to exactly 1MHz. Note that an accurate frequency counter is necessary for this job; a residual gain or loss of one second per day (which should be achievable), is equivalent to only 11.6Hz error in 1MHz.

If an accurate counter is not available, all you can do is to adjust the trimmer by trial and error until the daily gain or loss is acceptable. I had to use this method myself, and it only took six tweaks of the trimmer to reduce the initial error of 18 seconds per day to about two seconds per week.

Carrier frequencies

To determine the best carrier frequencies for a particular location, the impedance/frequency characteristic of the mains wiring has to be measured. To do this, enable the transmitter by temporarily disconnecting link E between the processor and transmitter boards (or, if the interboard links are made with ribbon cable, lift one end of R_{210} and R_{213} out of the board). Connect a 1kΩ resistor in series with C_{206}, and monitor the transmitted signal on the neutral wire with an oscilloscope. The chances are that a large 50Hz component will prevent proper triggering of the oscilloscope; if so, connect a 10nF capacitor in series with the oscilloscope input, and 7.5kΩ resistor across it, to filter out the 50Hz. Now adjust the 'on-frequency' potentiometer, and watch for a peak in the output amplitude. There should be one somewhere between 100 and 500kHz, and its actual frequency can be measured approximately on the oscilloscope. If there are two or more peaks, use the one with the largest amplitude, or if they are the same, use the one at the lowest frequency. Once the peak has been found, remove the 1kΩ resistor and reconnect C_{206} directly to the neutral mains wire. Adjust 'set output level' for a peak-to-peak amplitude of 4 volts.

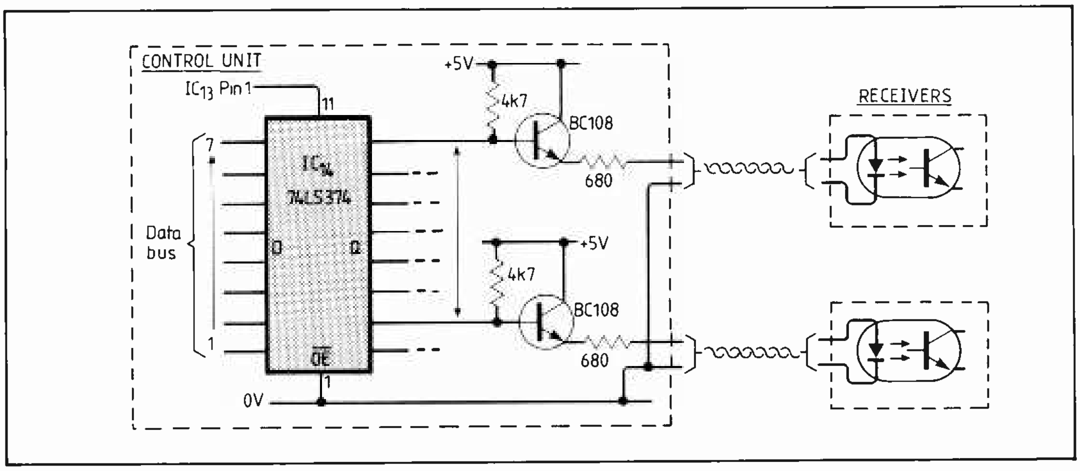
Table 1 gives the receiver filter frequencies obtained with various preferred resistor values in the filter circuit. Find the frequency nearest to your measured peak, and use the ones either side of it for the carrier frequencies. The frequencies given are theoretical; actual values are likely to be slightly lower due to phase shifts within the op-amps and stray capacitance on the printed-circuit board.

Rather than trimming each filter to an accurately defined carrier frequency, it is simpler to build the first receiver using preferred value components, and then trim the carrier frequencies at the transmitter to match. As long as 1% tolerance components are used for the filters, and the same construction is used for all receivers, the filters should all match each other without individual trimming.

Connect an oscilloscope to the output of IC_{301} in the receiver. Disable the transmitter, and adjust 'set Q' (upper) from the clockwise end until the filter stops oscillating. Enable the transmitter, and adjust 'set off frequency' on the transmitter board for maximum amplitude on the oscilloscope. The other carrier is selected by temporarily connecting a 4.7kΩ resistor between the base of Tr_{201} and the 5 volt rail. Transfer the oscilloscope probe to the out of IC_{302}, and adjust 'set Q' (lower) from the clockwise end until the filter stops oscillating. Then adjust 'set on frequency' for maximum amplitude.

Once the filters have been set up, the rest of the circuit can be checked against the waveforms

The author asks us to point out two alterations to the transmitter circuit on page 67, February issue: the preset potentiometer at Tr_1 should have a 100kohm value, not 10k, and a 100nF capacitor, C_{10}, was omitted between the bases of Tr_7 and Tr_8. (One constructor found that a 100pF ceramic capacitor connected between Tr_6 and Tr_8 bases cured his 1MHz oscillation.) And in the receiver circuit, page 68, C_1 should be returned to the neutral line, not to the earth line. Incidentally, two of IC_6 gates had the wrong symbol: the type number is correct. The line that leaves the address bus at IC_{8a} on page 65 is A_2; the brightness control is a 47kohm logarithmic potentiometer; and on IC_9 it is the inverting inputs that are grounded.



If all the appliances to be controlled are in the same room as the control unit the f.s.k. control unit can be dispensed with. Instead of IC_{13} this circuit provides a directly-connected signal to operate each opto-coupled switch. Tables below refer to the receiver circuit on page 68 of the February issue.

Table 1

Filter resistors	Frequency (kHz)
3.0k	531
3.3k	482
3.6k	442
3.9k	408
4.3k	370
4.7k	339
5.1k	312
5.6k	284
6.2k	257
6.8k	234
7.5k	212
8.2k	194
9.1k	175
10k	159
11k	145
12k	133
13k	122
15k	106
16k	99.5

Table 2

Channel	R319
1	11k
2	22k
3	33k
4	43k
5	56k
6	68k
7	75k

of (February). To do this, reconnect link E between the processor and transmitter boards (or refit R_{210} and R_{213}). Put the control unit in Normal (clock display) mode if it isn't already, then press 'next step' and 'last step' together, which invokes the Test 1 function; the system transmits the output status word 20 times per second, making the receiver waveforms readily visible on the oscilloscope. (This is achieved by toggling channel 0's output at 20Hz, so make sure there isn't an appliance plugged in to the control unit).

At this stage, it is worth checking the duration of the transmitted r.f. burst (the junction of C_{301} and R_{301} is a convenient place to look). It should be about 16.5 ms. it doesn't matter if the trailing edge judders a little, so long as the burst length never falls below 15 ms.

The timing pre-set should be adjusted to make the trailing edge of the pulse at IC_{305} pin 7 coincide with the centre of the receiver's data bit, in the waveform at IC_{307} pin 10. To help identify which part of the waveform corresponds to a particular channel, press the corresponding timer enable key, and that channel will be toggled at 1Hz. This is also useful for checking that a receiver does not respond to changes in adjacent channels.

The last check to be made with the oscilloscope is to confirm that the trailing edge of the pulse at IC_{305} pin 9 is well clear of both the channel 7 data bit and the end of the transmission.

As a final check when the lid has been fitted to the receiver box, press the up-key (with the control unit in Test 1 mode), to invoke Test 2. The system now transmits once per second instead of twenty times. Set the timer enables so that all the channels are toggled at 1Hz, then use the output on/off keys to put the channel under test in the opposite state to that of the other channels. Any missed or wrongly-received codes will now be easy to spot by watching the receiver led. Don't worry if an occasional code is missed, for instance when the fridge motor cuts in and out — that just indicates that the noise-rejection logic works. But not more than two consecutive codes should be missed.

When you're convinced that all the recievers are working correctly, press the normal key to stop the transmissions and return the control unit to the clock display.

Fault-finding

The following is necessarily only a brief outline of the sort of problems most likely to be encountered in a system of this type. It is based on the assumptions that all the components have been correctly fitted, and that the eprom contains the published machine code.

If there is no 601Hz waveform on interboard connection 16, check for a clean 1MHz squarewave on in 6 of the processor chip. If it isn't there, check the 2MHz waveforms at the outputs of $IC_{8c,\,d}$. You may find only one of these waveforms present — an impossible situation at first glance. But what is really happening is that the oscilloscope probe is adding enough extra capacitance to make the circuit oscillate when it is applied to one of the outputs, but not the other. The solution is to fit a small capacitor (between 10 and 30pF) between the apparently working output and 0V.

If you have a 1MHz clock but still no 601Hz at point 16, the most likely culprit is the power-up reset circuit (C_1, D_1, R_8 and Tr_1). Try momentarily shorting Tr_1 collector to 0V. If the 601Hz waveform appears, experiment with the values of C_1 and R_8; the aim is to increase the length of the not-reset pulse, because it must remain low for some time after the clock oscillator has started up. As a last resort, wire a reset pushbutton across C_1. The software can distinguish a reset from a power-up, so you won't lose your stored timer settings if the button is pushed accidentally; though you will have to reset the clock.

Software

The timer's operating program occupies the first 2K bytes of the processor memory map, i.e. from 0000 to 07FF. If a 2732 or 2732A eprom is used, the next 2K bytes, from 0800 to 0FFF, are available for additional functions.

The 1K byte ram occupies addresses 8000 to 83FF. The stack grows downwards from 807F; it is difficult to predict how far down it grows, because it depends on exactly when a key is pressed, which key it was, which step routine is implemented, whether another interrupt was being serviced at the time, etc. Running the program on a simulator, I have only caught the stack pointer as far down as 805E, i.e. 17 levels, so with 64 levels available it is unlikely ever to run out of ram.

Addresses 8080 to 80BF are used as a general scratch pad area and display store. the interrupt vectors are also kept here rather than in rom to allow the software to change the function of an interrupt; the Test function, for example, operates by changing the 20Hz interrupt vector.

Addresses 80C0 to 80DF (32 bytes) are reserved for future use. The hundred timer settings are stored in blocks of eight bytes each, from 80E0 to 83FF, the highest ram address. Table 3 shows the storage format and the scratchpad allocations. The time digits are stored in packed b.c.d. form in the setting blocks, to use the ram space efficiently. In the display blocks, it is more important to minimize the execution time of the multiplexing routine (which runs 601 times per second); so the digits are stored in seven-segment form, ready to be written to the display leds.

Interrupt structure

Although there are only two sources of interrupts, namely the 20Hz and 601Hz c.t.c channels, the priority between them had to be carefully defined to meet the following requirements:

- To maintain a regular rate of multiplexing the display, which is essential to avoid visible flicker, the 601Hz channel must be allowed to interrupt any routine currently in progress — including its own keyboard service routines, which in some cases can take tens of milliseconds to run.
- To maintain accurate timekeeping, the 20Hz channel must be allowed to interrupt keyboard services; fortunately it need not interrupt the display multiplexing/keyboard scanning routine, which only takes about 330μs.
- When the clock minute increments, the 20Hz interrupt service routine (i.s.r.) has to search for, examine, and possibly act upon, all the active timer settings; a process which can take more than the 50 ms interval between interrupts. The 20Hz channel must therefore be able to interrupt its own service routine.
- The 601Hz i.s.r. cannot be allowed to enter a keyboard service routine if it has interrupted a 20Hz i.s.r because the 20Hz routine will be using the c.p.u. registers. (The original contents, needed for keyboard servicing, are saved on the stack at the start of the 20Hz routine and replaced at the end).

The first three of these requirements are easily met by clearing the c.t.c. channel's interrupt flag and enabling further interrupts, (using the EI and RETI instructions), before entering a potentially time-consuming routine. The 20Hz i.s.r. takes care of the fourth requirement by manipulating the Key Enable status in ram location 80BE. This location is set to FF (key services disabled) before the 20Hz i.s.r. enables interrupts, and the original contents and reinstated at the end of the 20Hz i.s.r. along with the processor register contents.

Flowchart

Space does not permit publication of a fully commented assembly-language listing of the software. However, such a listing would only be of more use than the flowcharts to constructors who intend to modify the program, and such people are likely to have sufficient knowledge of Z80 assembler and machine code to disassemble small blocks of code. To assist in this, each block in the flowcharts has alongside it the eprom address of the first instruction corresponding to the process written inside the block. The following paragraphs should also help.

Most accesses to the scratchpad area of ram are made using indexed addressing via the IX register; the first byte of the instruction is always DD, and the third byte is the displacement, which in this application is the same as the lower half of the ram address. For example, at eprom address 216 is the machine code DD 7E BB, which disassembles as LD A, (IX +BB). This loads the accumulator from ram address 80BB, whose function can be looked up in Table 3.

Testing for a keyboard row or for a particular key is done with bit test instructions, which are recognisable by the fact that the first byte is always CB. The meanings of the individual bits in registers C, D and E are given in Table 4.

If the existing code is moved around to make room for additional functions, remember that the seven-segment look-up table must remain on a 256-byte page boundary. Also, beware of relative jumps which go past your added code. The safest, if not the most elegant, way of adding code into the middle of a routine is to insert a Call instruction inplace of the last three bytes (or more if necessary to make up a complete instruction) before the place where you want to put the added code. The Call is to an address above the end of the existing program, and at that address should be the instructions replaced by the Call, followed by your additional code.

Table 3. Scratchpad ram allocations and setting storage format

	8080	Password to distinguish
	8081	Reset from power-up
	8082	Interrupt vector for
	8083	601hz CTC channel
	8084	Interrupt vector for
	8085	20Hz CTC channel
	8086	Interrupt vector for
	8087	spare CTC channel
	8088	Counter 2 (5 to 1Hz divider)
	8089	Counter 1 (20 to 5Hz divider
FLASHER CONTROL	808A	Enable 1/2
	808B	Not used
	808C	Pointer 1
	808D	Pointer 2
	808E	Temp. store 1
	808F	Temp. store 2
	8090	Search store
NORMAL (CLOCK) DISPLAY	8091	Not used
	8092	Day (bits 6 to 0)
	8093	Tens-of-hours
	8094	Units-of-hours
	8095	Tens-of-minutes
	8096	Units-of-minutes
	8097	Not used
	8098	Tens-of-seconds
	8099	Units-of-seconds
	809A	Not used
	809B	Timer enables
	809C	Output status
	809D	Repeat transmission password
809E to	80AC	Not used
REAL TIME CLOCK	80AD	Today (bits 6 to 0)
	80AE	Hours
	80AF	Minutes b-c-d
	80B0	Seconds
SETTING DISPLAY	80B1	Active/suspended/cancelled
	80B2	Repeat (bit 7) and days
	80B3	Tens-of-hours (On Time (7-seg))
	80B5	Units-of-hours (On Time (7-seg))
	80B5	Tens-of-minutes (On Time (7-seg))
	80B6	Units-of-minutes (On Time (7-seg))
	80B7	Tens-of-hours (Off Time (7-seg))
	80B8	Units-of-hours (Off Time (7-seg))
	80B9	Tens-of-minutes (Off Time (7-seg))
	80BA	Units-of-minutes (Off Time (7-seg))
	80BB	Channels
	80BC	Output status
	80BD	Not used
	80BE	00: keys enabled, FF: disabled)
	80BF	Keyboard debounce counter

The 601Hz ISR compares the contents of 809C and 80BC to determine whether any out-put change is required. If they are different, the contents of 809C are transmitted and copied into 80BC.

Storage Format

Bit	7	6	5	4	3	2	1	0
P+0	0	0	0	0	0	0	S	A
P+1	0	S	S	M	T	W	T	F
P+2	0	LAST DAY						
P+3	0	0	HOURS ON (BDC)					
P+4	0	MINUTES ON (BCD)						
P+5	0	0	HOURS OFF (BCD)					
P+6	0	MINUTES OFF (BCD)						
P+7	CHANNELS							

Ram address, where P is any multiple of 8 from 80E0 to 83F8.

Variations

A number of simple modifications may be made, either to reduce the cost of the system or to change its operation in some way. For example, if all the appliances to be controlled are in the same room as the control unit, a substantial cost saving may be achieved by dispensing with the f.s.k. remote control. Instead of IC_{13} on the processor board, the circuit opposite provides a directly-connected signal to operate each opto-coupled switch. It would even be possible to mount some or all of the switches inside the control unit, to save on boxes, and to connect the appliance

Table 4. Flags

Register C

Bit	Meaning of Flag (when at logic 1)
7	Seconds count is enabled
6	Minutes count is enabled
5	The CHECK subroutine is enabled
4	Non-control keys are enabled
3	Settings for a particular CHANNEL are being examined/altered
2	Settings on a particular DAY are being examined/altered
1	REATed settings are being examined/altered
0	A NEW setting is being entered

Register D

Bit	Pressed Key		
7	Set clock	Repeat	Channel 7
6	Last step	Saturday	Channel 6
5	Next setting	Sunday	Channel 5
4	Down	Monday	Channel 4
3	Jp	Tuesday	Channel 3
2	Next step	Wednesday	Channel 2
1	Normal	Thursday	Channel 1
0	New setting	Friday	Channel 0

Register E

Bit	Key Row
7	Control
6	Days & repeat
5	Timer enable/disable
4	Output on/off
3-0	Not used

mains leads to the control unit, either with standard mains plugs and sockets, or via "chocolate-block" connectors or barrier strips. But remember that the total current for all the appliances is then supplied from a single wall socket, and must therefore be limited to 13 amps.

Flowchart

Copies of the flowchart annotated with eprom addresses and too extensive to print here are available from the editorial office in return for a stamped and addressed envelope marked 'Remote timer'. Included is the hexadecimal listing, some notes on battery backup, components lists and p.c.b. hints.

Operation

To set the clock when power is first applied (the day leds should be flashing):

1. Set the day by pressing the appropriate key.
2. Press 'next step'. This makes the tens-of-hours digit flash; use the up and down keys to change it if required.
3. Use the next step up and down keys to step through and change the other three clock digits in the same way. 'Last step' can be used to correct a previous digit if a mistake is made.
4. With the right-hand digit flashing, press 'next step' or 'normal' on a time signal. The seconds start counting from zero at this point.

To correct the clock time:

1. Press 'set clock', which makes the seconds digits flash.

2a. If the clock is less than half a minute fast or slow, press 'normal' on a time signal. This sets the clock seconds to zero, and if the clock was slow, (i.e. if the displayed seconds were 30 or more), the clock time is incremented by one minute.

2b. If the clock is out by more than half a minute, press 'next step' repeatedly to step through days, hours and minuts, using the day keys or the up and down keys to correct whichever part of the display is flashing. The seconds count is not affected unless the units-of-minutes digit is altered; in which case the seconds are set to zero and will resume counting when 'next step' is pressed again. If the tens-of-minutes digit is altered, the minute will not increment when the seconds change from 59 to 00. The minute count is re-enabled on returning to normal mode, which is done by pressing 'next step' while the units-of-minutes digit is flashing.

To enter a new timer setting:

1. Press 'new setting'. If the display shows 'full', there are already a hundred settings stored, and one must be cancelled to make room for the new one (see below). Normally, the active led flashes, and the on-time is set to 00:00. At this stage the up key may be used to change active to suspended if required.
2. Press 'next step', which makes the repeat led and all the day leds flash. Any combination of days may be selected; the last one you select is stored as the last day, and its led flashes to remind you which one it is. If the last day is deselected, the nearest selected day to the left becomes last day instead.

   If repeat is selected, the repeat led flashes. By definition, there is no last day stored in the setting ram, but the last selected day is still held in a register, and becomes last day if repeat is deselected.

   If there is only one day selected, it cannot be deselected because a setting with no days would be pointless; another day must be selected first. 'Next step' will also be ignored until at least one day has been selected.
3. Press 'next step' four more times to step through the four digits of the on-time, using the up and down keys to change each one while it is flashing.
4. Pressing 'next step' again causes the on-time to be copied into the off-time. In most cases this means that some of the off-time digits can be skipped, or only need to be incremented by one or two. At this stage the tens-of-hours-off digit is flashing; the off-time is corrected to the exact time required in the same way as the on-time.
5. With the units-of-minutes-off flashing, pressing 'next step' causes the channel leds (which double as timer enable leds in the normal clock display) to flash. Any combination of channels may be selected, though in practice it is unusual to select more than one.
6. Press 'normal' or 'next step' to return to the clock display.
7. If 'normal' is pressed at any stage when no channels are selected, the setting is cancelled and the display goes blank except for the cancelled led, the colon and any output leds which were already on. Press 'normal' again to return to the clock display, or press 'new setting' to start again.

To examine and alter stored settings:

1. Press 'next setting'. The repeat led and all the channel and day leds flash.
2. To examine all settings for a particular day or channel, or all repeated settings, press the corresponding key; to examine all stored settings regardless of content, press 'next setting' again. The first appropriate setting (if there is one) is displayed with active or suspended flashing. If the setting is not a repeated one, the last day also flashes. If there are no such settings stored, the display shows 'none'.
3. Use the 'up' and 'own' keys to rotate the active/suspended/cancelled status if required. 'Next step' may be used to step through the rest of the setting; whichever part is flashing may be altered. ('Next step' is ignored if the cancelled led is on, as there is no point in altering a setting if you're going to cancel it).

4a. At any stage in the above, 'next setting' may be used to display the next appropriate setting (if there is another one). If the previously displayed setting was left with no channels selected or with the cancelled led on, it is deleted from the setting ram. If there are no further stored settings appropriate to the group selected at '2' above, the display shows 'none' with a day, repeat or channel led lit to remind you which settings you were examining. If you were looking at all stored settings, all the channel leds are lit.

4b. Pressing 'normal' at any stage restores the clock display, unless the last setting to be displayed was left with no channels selected or with the cancelled led on. In those cases, the setting is deleted from the setting ram, and the display is blanked except for the chancelled led, the colon and any output leds which were already on. Press 'normal' again to restore the clock display; or press 'next setting' to return to step '2' above; or press 'new setting' to set up a new setting from scratch.

Measuring tape speed

by M. E. Theaker, B.Sc., M.I.E.R.E.

A simple and accurate method of ensuring the correct tape speed

It is often important to ensure that the speed of a cassette recorder is reasonably close to its correct speed, either to ensure the correct pitch of music or the correct frequency of relayed data.

One method of doing this is to use a standard-frequency tape and measure the output of the cassette recorder on a frequency meter. Having neither at my disposal, I devised a method which only requires a watch, a pair of vernier calipers and a cassette. Basically, the method consists of measuring the thickness of the tape and then measuring the time for a given number of revolutions of the cassette when playing the recorder or player. The cassette used should preferably be a C60 (although a C90 will do), it must be of screwed construction and the tape hubs should be clearly visible. (The latest range of Sony cassettes are particularly good for the purpose as the tape clamp provides a very easy reference when counting the hub revolutions.)

Measuring tape thickness

If your cassette recorder doesn't have a counter, this will be the most laborious part of the process. Run the cassette from start to finish and count the total number of revolutions of the take-up hub. Most cassette recorders, however, have a counter driven from the take-up hub, and this makes the process much easier.

First, the ratio of the hub revolutions to the counter is found by noting the change in counter reading for, say 20 revolutions of the take-up hub and then dividing the change of reading into 20 — $k = n/c$. Now play the cassette from one end to the other and note the change in the counter reading. The number of revolutions of tape (including the leaders) is k times the change in counter reading.

With the cassette wound to one end, unscrew the cassette and measure the diameter of the empty hub (h) and the diameter of the full spool (f) using the vernier calipers. The total thickness of the tape on the full spool is (f-h)/2, and if the number of revolutions is nT, then the thickness of the tape, $t = (f-h)/2nT$.

It is wise to do all of your calculations in one set of units, preferably millimetres, so if your calipers measure in inches don't forget to convert the measurements to millimetres first. Tape thicknesses are, typically, 18 μm (0.018mm) for C90 cassettes and 12μm (0.012mm) for C90s.

Tape speed

If the counter on the recorder is coupled to the feed hub instead of the take-up hub then see Method 2 (later). Having reassembled the cassette, rewind it to the start. Either by direct counting or using the recorder's counter, count the number of revolutions of the hub for, say, 5 minutes (using a watch or stop watch). Do not time the first few revolutions, since this will lead to starting errors, but do note the exact number of revolutions n_1 at which you start to time. After timing for a duration d seconds (the longer the better) note the number of revolutions n_2. If you are using the recorder's counter don't forget the conversion factor k. The tape speed is,

$$s = \pi (n_2 - n_1) \frac{[h + (2nT + 2 - n_2 - n_1)t]}{d} \quad \text{mm/s}$$

and, since the correct speed of cassette recorders is 47.625 mm/s ($1\frac{7}{8}$ i.p.s.) the speed error is

$$e = \frac{(s - 47.625)}{0.47625}\%$$

These calculations can easily be carried out with the aid of a scientific calculator, but for those who need to carry out the calculation many times (for example, when adjusting the speed of a recorder or player) a short computer program is included at the end of this article. Although written for the Spectrum, it can easily be adapted for any other computer. The tolerance permissible for professional recorders is ±0.5% and for domestic recorders ±2%.

Method 2. If the counter is driven from the feed spool instead of the take-up spool then the same basic timings are made, but the equations used are

Tape speed

$$s = \pi (n_2 - n_1) \frac{[h + (2nT + 2 - n_2 - n_1)\,t]}{d}$$

Error

$$e = \frac{(s - 47.625)}{0.47625}\%$$

```
10 REM Tape speed program
20 INPUT "Counter factor (revs/count)?"; k
25 INPUT "Counter on take-up, y/n?"; a$
30 INPUT "Full spool diameter (mm)?"; f
40 INPUT "Input hub diameter (mm)?"; h
50 INPUT "Total revolutions?"; nT
60 LET t = (f-h)/(2*nT)
70 LET L = PI*nT*(h + (nT - 1)*t)/1000
80 PRINT "Tape thickness + "; t; "mm"
90 PRINT "Tape length = "; L; "metres"
100 INPUT "Start count?"; c1
110 LET n1 = k*c1
120 INPUT "End count?"; c2
130 LET n2 = k*c2
140 INPUT "Time (sec)?"; d
150 IF d = 0 THEN GOTO 20
170 IF a$ = "n" THEN GOTO 200
180 LET s = PI* (n2 - n1)*(h + (n2 + n1 - 1)*t)/d
190 GOTO 210
200 LET s = PI*(n2 - n1)*(h + ((2*nT) + 2 - n1 - n2)*t)/d
210 LET e = (s - 47.625)/0.47625
220 PRINT "Tape speed = "; s; "mm/s"
230 PRINT "Error = "; e; "percent"
240 GOTO 100
```

If the hub revolutions are counted directly, then enter 1 for the counter factor. To change the cassette and recorder conditions enter 0 for "Time" and this will take you back to the start of the program.

Making a speed test tape

Having determined the speed of a recorder, it is now possible, with the aid of an audio signal generator and a frequency meter, to make a standard speed tape. Using the frequency meter, set the signal generator frequency to 1kHz × (100 + e)/100 and then record several minutes of this signal. When replayed on any machine the speed error will be indicated on a frequency meter, the tens of Hertz indicating units of percentage error and units of Hertz indicating tenths of one percent error. For maximum stability of the test tape a C60 (or shorter) cassette must be used.

Derivation of the formula

The length of tape on the first revolution of the hub is πh, where h is the diameter of the hub. The length of the second revolution is greater since its diameter is larger by twice the thickness of the tape (t). Its length is $\pi\,(h + 4t)$ and so the length of the nth revolution is $\pi\,[h + 2(n\text{-}1)t]$

The total length of the first n revolutions of tape is equal to the sum (addition of the lengths of each revolution. This sum is an arithmetic series whose first term is π and whose common difference is $2\pi t$. The total length of tape for n turns is $L=\pi.n(h+(n-1)t)$

Using this equation and the information found when measuring the thickness of the tape, you can calculate the total length of the tape in the cassette by making n equal to the total number of revolutions of the cassette (nt) The nominal length for a C60 cassette is 90m and for a C90 is 135m, plus a leader of about 0.5m at each end. The length of tape between n_1 and n_2 revolutions is

$$L_2 - L_1 = \pi n_2[h+(n_2-1)t] - \pi n_1[h+(n_1-1)t] - = \pi(n_2-n_1)[h+(n_2+n_1-1)t]$$

Similarly, if the revolutions of the feed spool are counted, then the length of tape is

$$L=\pi n[h+(2nT+1-n)T]$$

where nT is the total number of turns on the cassette. The length of tape between revolutions n_1 and n_2 in this case is

$$\pi n_2[h+(2nt+1-n_2)t] - \pi n_1[h+(2nt+1-n_1)t] = \pi(n_2-n_1)\times[h+(2nt+2-n_1-n_2)t]$$

Accuracy

The accuracy in measuring the speed error (and the speed) is dependent upon the accuracy with which the various measurements have been made. If the difference between the full-spool diameter and the hub diameter is measured to within 0.1mm then the apparent speed error will be 0.05% An error of 1 in determining the total number of revolutions will introduce an error of 0.02% The most critical is the measurement of the duration of the revolutions from n_1 to n_2. If the number of the revolutions for the entire side of a C60 cassette (30 mins) is timed with an accuracy of 0.5s, then an error of 0.03% will be introduced, which brings the total error of 0.1% If, however, the revolutions for the first 5 minutes are timed to an accuracy of 0.5s, then the resulting error is 0.15%, bringing the total error to 0.22%. It is important, therefore, to carry out the time measurement over as long a period as possible to achieve the highest possible accuracy.■

by T. Loughlin B.Sc. (Hons.)

10bit digital recorder

Using modern data conversion i.cs, very-low-frequency analogue signals can be recorded on tape with high accuracy.

My circuit for recording low-frequency analogue signals on ordinary audio quality tape recorders[1] has been used in medical establishments including the Royal Victoria Hospital and City Hospital in Belfast East Dulwich Hospital.

Response from users has suggested that increased resolution giving greater dynamic range would be desirable. This is particularly so when recording electrocardiograms where common-mode potentials can cause the e.c.g. to 'wander' — an effect known as base-line drift.

The circuit described here uses ten-bit conversion devicies while retaining the same basic recording technique as the 8bit recorder. This gives four times the resolution as before at the expense of sampling rate, which is reduced by around half, assuming the same data rate.

At 4800 baud, a rate which most reasonable recorders should handle, the sample rate is 267Hz, making the unit suitable for many data logging applications and certainly sufficient for most medical applications.

A digital recording technique is used to reduce the effect of tape recorder wow and flutter on the recorded signal. Good quality domestic audio recorders have a frequency range of approximately 50Hz-10kHz. To record signals from d.c.-100Hz, say, some form of modulation is required to shift the base-band frequency into the recorder audio band.

Analogue techniques such as frequency and pulse-width modulation may be used but these techniques suffer from the inherent disadvantage that tape wow and flutter causes a direct modulation of the carrier signal. Upon replay and demodulation, noise thus induced has a frequency range within the base band so it cannot be filtered out.

One technique used is to record a reference d.c. channel which upon demodulation is summed in antiphase with the signal channel thus reducing the noise component of the signal.

In the digital system however the effect of wow and flutter is eliminated since timing is established by a crystal controlled replay circuit which updates the analogue output at fixed intervals. Distortion is then a function mainly of quantizing noise and bit drop-out error. The quantizing/stepping effect can be reduced by filtering the output since the frequency of the error noise is equal to the sample rate (approximately).

The a-to-d converter used here is the Ferranti ZN432E which is reasonably priced. Input bias and offset resistors $R_{1\text{-}6}$ are chosen to give a 0 to +2.5V input voltage range at R_5, Fig. 1. For other ranges refer to the data sheets[2].

Op-amp IC_{16a} provides shifting and scaling for input signals while IC_{16b} provides some anti-alias filtering. The ZN432E draws typically 35mA so battery operation is not as practical as with the 8bit circuit using a c-mos 8703 converter.

The 10bit a-to-d converter requires a start-conversion signal closely synchronized to the clock driving its internal successive-approximation register (sar). Precise timing generation will be described later but the clock used is the 16 times baud rate clock derived from IC_{7a} through dividers IC_{3b} and IC_{11}. The data is then multiplexed into the uart IC_1 transmitter-buffer register through selector IC_5 and gates $IC_{6a,b,c}$ wired as a selector gate.

Data is placed on the tape as two nine-bit sequences per 10bit sample as shown in Fig. 2a. As can be seen from the diagram the uart is configured for a 6bit character length, one stop bit and even parity. Five character bits, $TBR_{1\text{-}5}$, are used for either the five most significant or five least significant bits of the sample word; character bit 6, TBR_6, known as 'Byte', is used to indicate most or least significant.

At power-up time, reset circuit IC_{2a}, Fig.1, resets the uart. When IC_{2a} pin 3 goes low again the transmit-register-empty (TRE) flag, IC_1 pin 24, goes high after 18 clock cycles on the clock falling edge (Fig.2c).

Transmitter-buffer-register-load ($\overline{TBRL}$), connected to TRE, then initiates transmission of the first character which will be invalid. On the next clock rising edge, data in the transmit register transfers to the transmit buffer causing TRE to go low.

Now assuming that 'Byte', IC_3 pin 1, is high then TRE is gated to start conversion on the ZN432E. This pulse will be closely aligned with a clock low pulse thus meeting the timing criteria for this device. The falling edge of TRE toggles the 'Byte' bistable device.

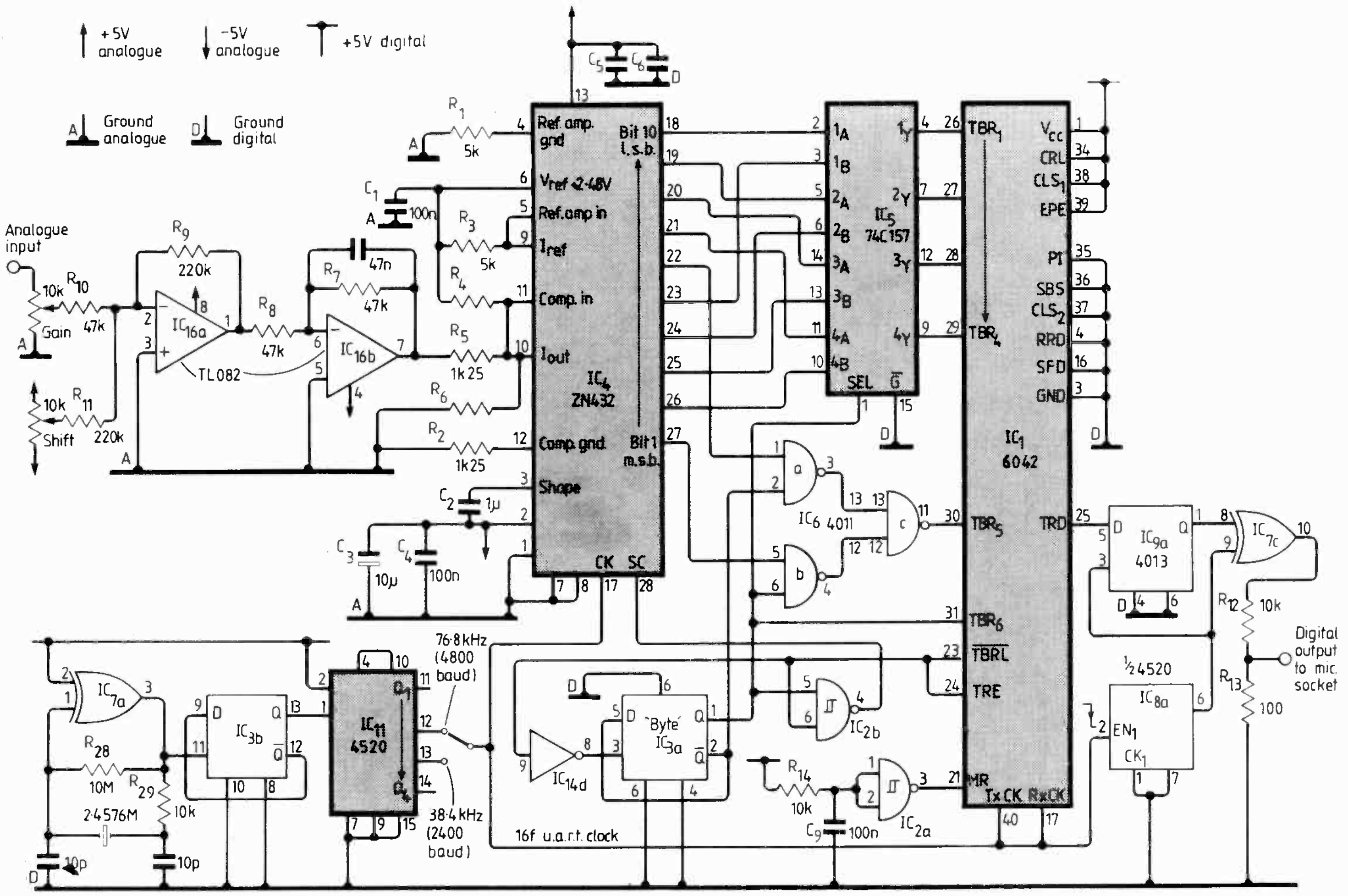
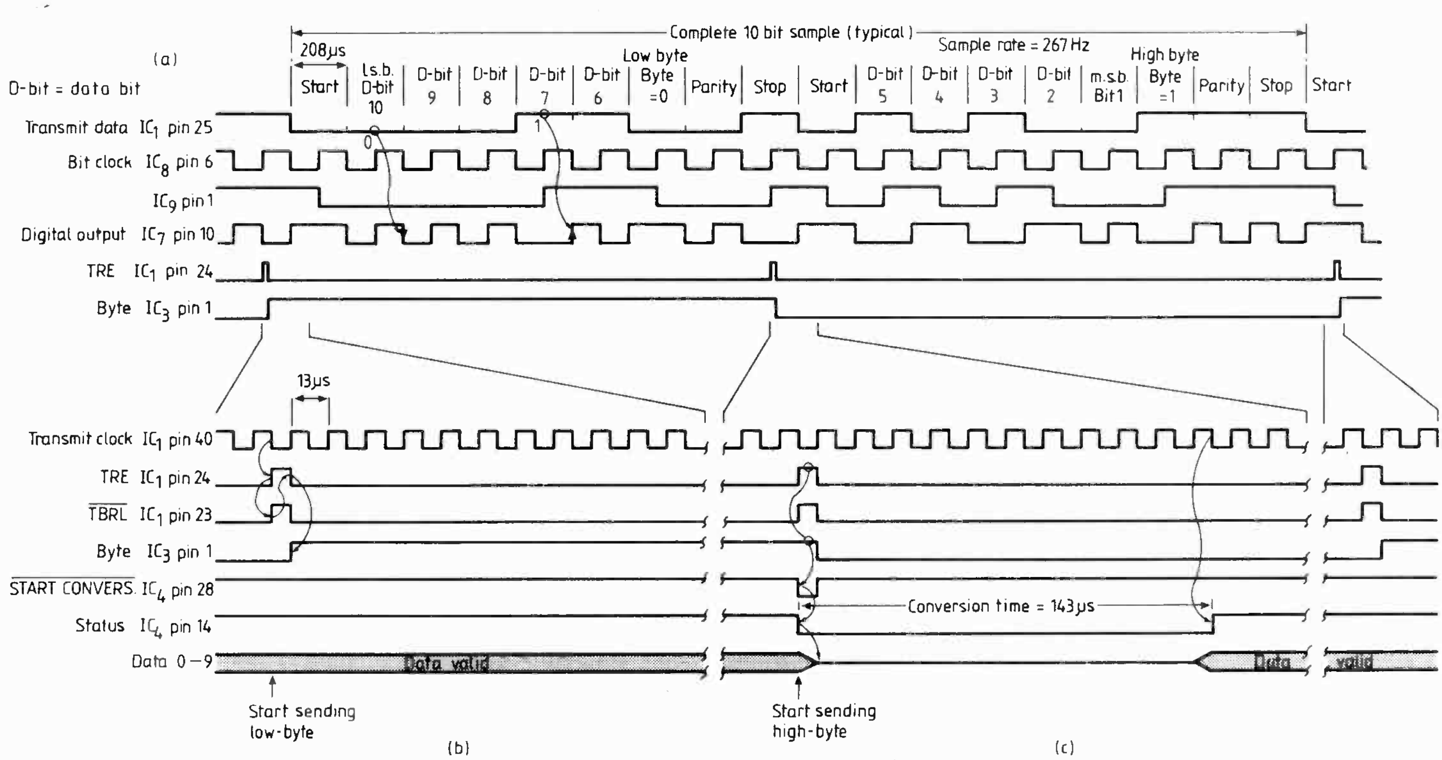


Fig. 1. Record section. Analogue signals are converted into a 10bit digital word and fed to the uart in sections.

Fig. 2. Record timing. In this system, a logical one is encoded as a rising edge and a logical zero as a falling edge.



A problem may arise here. START CONVERTION going low initializes the ZN432E sar so data present at uart inputs TBR_{1-5} will change. The maximum hold time requirement for the uart is 90ns so the delay from TBRL high through IC_{2b} IC_4 and IC_5 must be greater than this.

However since typical propagation delay of IC_5 is 160ns and the typical uart data hold time is 40ns, problems should not normally arise. If this does cause a problem then delay the start-conversion pulse from TRE.

The converter takes 11 clock cycles or 143μs at 4800 baud to make a conversion. When the uart has finished transmitting the first character TRE goes high (Fig. 2c). Output of 'Byte' is low at this stage gating the lower five bits of the sample into the uart. Signal $\overline{TBRL}$ loads the transmitter-buffer register and the TRE $\overline{(TBRL)}$ rising edge transfers this data into the transmit register and starts transmitting it. 'Byte' low output inhibits the start-conversion pulse and is also transmitted as bit six.

The falling edge of TRE toggles the 'Byte' bistable device high, Fig. 2b, and the five most-significant data bits are loaded into the uart by $\overline{TBRL}$ being low with bit 6 high. When the uart i.c. has finished transmitting the lower five data bits and associated bits, TRE again goes high on a clock falling edge. The five most-significant data bits and 'Byte' are loaded into the transmit register ready for transmission.

Being high, 'Byte' output gates a start-conversion pulse to the a-to-d converter, Fig. 2c, which begins taking a new sample while the upper five bits are transmitted. The sequence thus repeats itself and is self-driven.

Serial output data from the uart, IC_1 pin 25, is encoded into a biphase form by IC_{9a}, IC_{8a} and IC_{7c} (Fig. 1) as shown in Fig. 2a. In this system a one data bit is encoded as a rising edge and a zero as a falling edge of the digital output to the recorder[3].

Output level is around 50mV. Inspection of the output waveform shows that the highest frequency present is equal to the baud rate used e.g. at 4800 baud the maximum is 4800Hz.

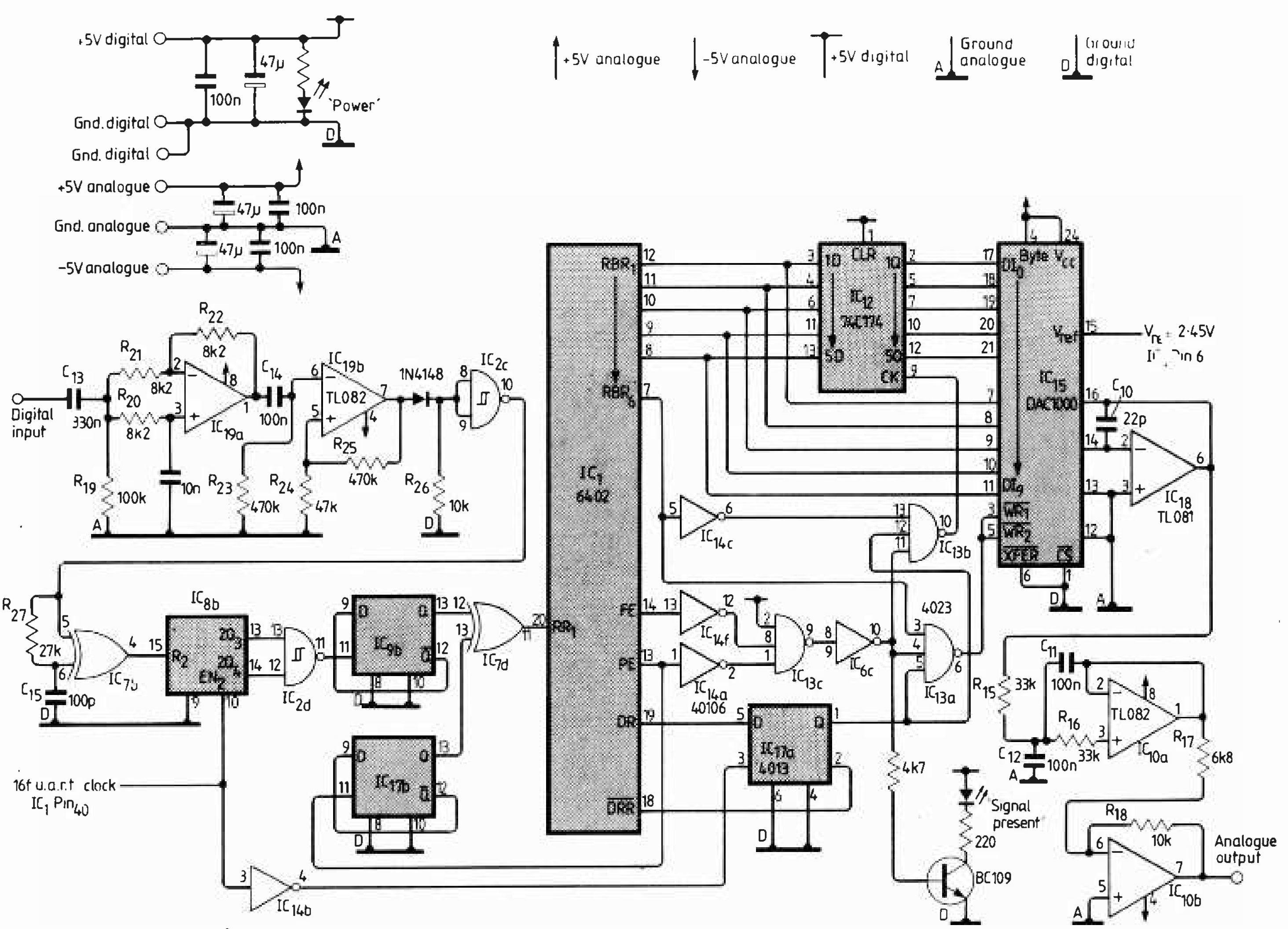
High level replay signal from the recorder would normally suffer from a phase distortion caused by the recording process itself[4] and appears usually as shown in Fig.4a.

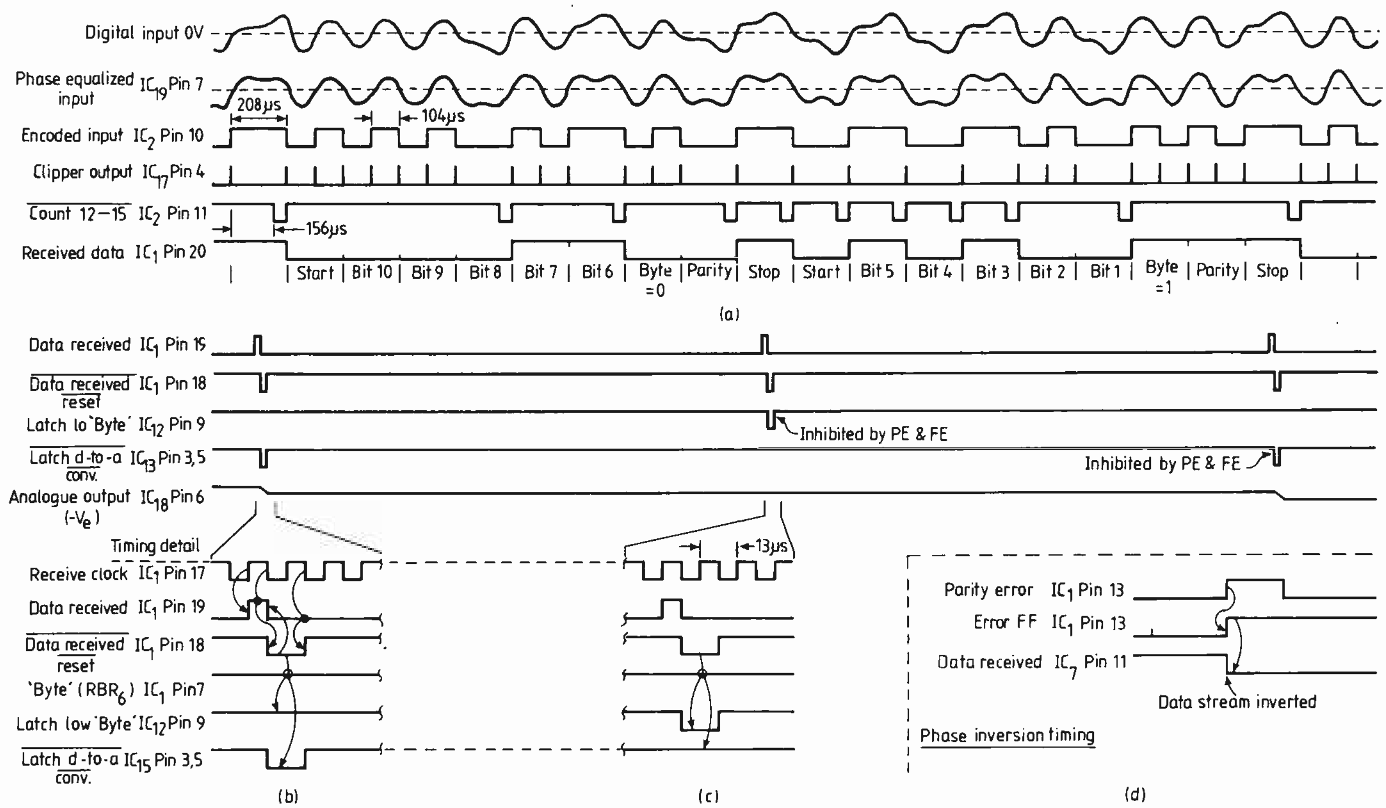
This signal is applied to a phase-equalizing circuit comprising IC_{19a} and associated components (Fig.3) to compensate for this distortion. It is then amplified, IC_{19b} and squared, IC_{2c}, to obtain a t.t.l.-level signal that is close to the original recorded signal.

The biphase decoding circuit comprises IC_{7b}, IC_{8b}, IC_{2d}, and IC_{7b}. Clipping circuit IC_{7b} produces a narrow pulse for each transition of the encoded digital signal. Counter IC_{8b}, driven by the 16× uart clock, counts to 12 or greater unless reset by clipper output pulses. If the counter goes to 12 or greater IC_{2d} output goes low then high causing bistable device IC_{9b} to toggle.

Output of IC_{9b} as can be seen from the timing waveforms is decoded serial data. It is however possible that bistable device IC_{9b} may be in the wrong state initially in which case the decoded data will be inverted. This produces a parity error and/or a frame error signal from the uart which cause bistable device IC_{17b} to toggle. Output Q of this bistable device drives exclusive-or gate IC_{7d} pin 13 which gates decoder output to the uart serial input; the net effect is to invert the data stream seen by the uart. The circuit then rapidly synch-

Fig. 3. Replay section. High-level replay signal would normally suffer from phase distortion but here it is applied to a phase-equalizing circuit.





ronises itself to incoming data, Fig. 4d.

Assuming then that a correct stream of data is being received the problem is to reconstruct the 10bit analogue samples. When a full character has been received, data-received flag DR, IC_1 pin 19, goes high in the middle of the stop bit on the clock rising edge, Fig. 4c.

Data-received bistable device IC_{17a} is driven by the inverted clock so the next clock falling edge transfers DR to its outputs. Signal Q of IC_{7a} is used to reset DR via $\overline{DRR}$ to prepare for the next character and the next clock falling edge transfers DR low to IC_{17a} output which is thus a pulse one clock period wide.

If the received character contained the lower five bits of the sample then bit 6, IC_1 pin 7, is low so bistable-device output is gated via IC_{13b} to register IC_{12} which stores the data.

The next received character will contain the five higher bits of data and bit 6 will be high so the data received pulse is gated via IC_{13a} to the output d-to-a converter, IC_{15}, Fig. 4b. The five lower bits from IC_{12} and the five upper bits from the uart are thus clocked into the DAC1000 output register and the analogue output attains the latest value.

The output d-to-a converter obtains its reference voltage from the ZN432E a-to-d converter so ensuring good tracking between the two devices. However the output, IC_{18} pin 6, will be inverted so after filtering (IC_{10a}) to remove quantizing noise it is inverted (IC_{10b}). If no signal is being received or the replayed data is incorrect for some reason then parity or frame-error signals inhibit output-latch pulses and cause the 'signal present' lamp to go out.

The circuit described here was built and tested to determine the validity of the design concept and has been used to good effect for recording e.c.g. signals. Certain features which contribute to the absolute overall accuracy of the system are not included such as converter offset and gain adjustment potentiometers. Note however the use of separate analogue and digital power supplies and grounds.

Dynamic sampling accuracy can be improved by using a sample-and-hold circuit such as the LF398, which may be connected as shown in Fig. 5. The circuit as shown without a s/h device will have a dynamic sample error of 2% on a 50Hz full scale sinewave input[5].

Thomas Loughlin graduated from Queen's University Belfast with a B.S.c. (Hons) Electrical and Electronic Engineering in 1979. Now he is a Senior Medical Physics Technician at the Regional Medical Cardiology Centre in Belfast developing equipment for use in cardiology, including computer hardware and software. Prior to that he worked as an analogue and digital designer and as a systems engineer on computer control systems. Thomas' current project involves displaying physiological signals using very high resolution graphics.

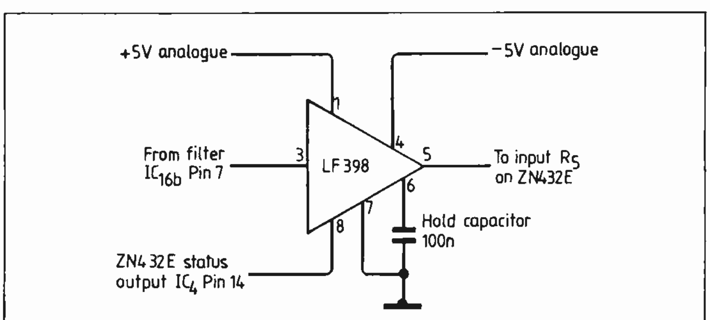


Fig. 4. Replay timing. Synchronization of the circuit with incoming data occurs rapidly.

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1 Loughlin T., Analogue recording using digital technique, *Wireless World*, Feb. 1983 pp 74/75.

2 Ferranti Semiconductors, ZN432E 10 Bit Successive Approximation Monolithic A/D Convertor Data Sheet, 1982.

3 Koanantakool, T., 4800 Baud Cassette Interface, *New Electronics*, Vol 12, No 21, October 30 1979, p. 36.

4 Smith, P. Zorkoczy, P. I., Data Recording on Audio Cassette, *Wireless World*, February 1982, pp 50-52, 62.

5 Clayton, G. B., Data Convertors, Macmillan Press, London. 1982, pp 45-46.

Fig. 5. Dynamic sampling accuracy can be improved by including a sample-and-hold amplifier such as this one.

THE ALL-ELECTRONICS/ECIF SHOW

At Olympia, in Hammersmith, London, the British Electronics Week has come round again. Occupying even more space, with a greater number of exhibitors, the show has become a major event in the electrical/electronic calendar. From the 29th April to the first of May, Olympia will be full to overflowing with exhibitors.

The week actually consists of four exhibitions; The All-Electronics/ECIF Show, Circuit Technology, Electronic Product Design, and Fibre Optics. A fifth section has been announced for inclusion in the Week in 1987; Power Sources and Supplies. We had planned to provide a map of the stands and a list of exhbitors, but this would have taken up too much of our space; it is better left to the catalogue, available at the Show; instead we have concentrated on presenting some recent announcements of new products by exhbitors. Some companies are very chary of releasing details of products to be launched at the Show; so we will report on such releases after the event.

Your correspondents will have the unenviable task of attempting to visit every stand in this mammoth circus. For those unwilling or too busy to spend too much time there, we would recommend that you get a catalogue and then find a spot to sit down and read the sections that interest you. This will save a lot of time. Also at the entrance to the Show there are stations that can provide computer print-outs of the positions of the stands that have the products that may interest you.

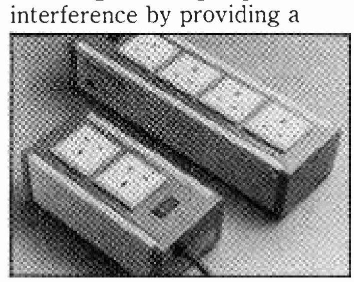
Olympia has its own underground station, served during exhibitions by a shuttle train from Earls Court, which is the exhibition hall for the Fibre Optics section.

Alternative to tantalum

Subminiature electrolytic capacitors with radial leads are suggested as a low-cost alternative to tantalum beads. The Waycom WSQ series has a capacitance range of 0.1 to 100μF with rated voltages from 6.3 to 63V. The aluminium capacitors are cased in aluminium with welded internal connections. High-grade paper separators for long-term reliablity. BA Electronics Ltd, Hitchin Road, Arlesley, Beds SG15 6SG. **EWW 212 on reply card. Stand No. 482.**

Mains filter

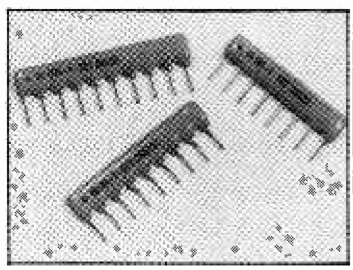
Compufilter has been designed to remove noise, r.f.i., and voltage transients from mains lines used with microcomputers and allied peripherals. Each model comprises a series of filters designed to eliminate both incoming and outgoing interference by providing a



high level of attenuation. A two-stage filter protects against incoming asymmetry and includes a transient suppressor. Each socket is protected against asymmetry and is isolated from the others. There is a choice of output socket types. Each output is limited to 3A. Cetronic Power Products Ltd, Hodeston Road, Stanstead Abbotts, Ware, Herts SG12 8EJ. **EWW 209 on reply card. Stand no. 561.**

Function generator

Among the products to be displayed by Global Specialities is the Sovereign 8200 series of synthesized 20MHz function generators. Fully programmable through the GPIB interface, the generators provide sine, square and triangle waves and pulses with variable amplitude, symmetry and offset over a 2mHz to 20MHZ frequency range. The company are also showing d.c. power supplies, surface-mounting breadboards using plastic leaded chip carriers, a low-cost universal counter-timer and a wide range of rack systems and test-and-measurement instruments. Global specialities corporation (UK) Ltd, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ. **EWW 207 on reply card. Stand no. 260.**



SIL resistors

High volume production and improved manufacturing techniques have allowed Allen-Bradley to extend the range of its 700 series of cermet resitor networks in single in-line (SIL) packages. The resistors are available in 4 to 14-pin packages with resistances from 22Ω to 2.7MΩ. They are connected internally to a common bus (style A), as individual resistors (style B) or as digital line terminators (style E). All are fully tested. Allen-Bradley Electronics, Ennia House, High Street, Edenbridge, Kent TN8 5LY. **EWW 216 on reply card. Stand No. 106.**

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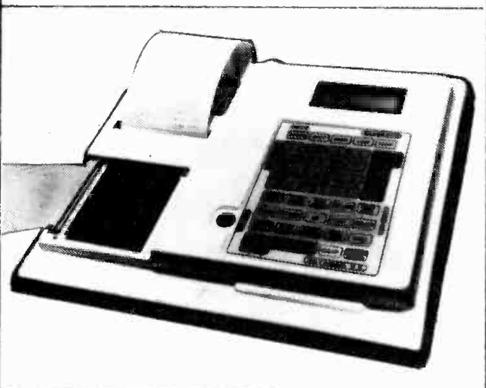
showing ROM, RAM, I/O
and EMPTY ADDRESSING SPACE



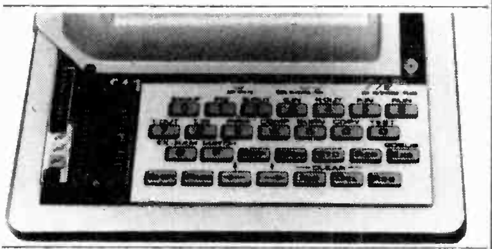
LOGS all tests and responses
on PRINTER and ALPHA LCD
Non-volatile memory
retains test sequences
CHECKSUMS, RAMTESTS,
READS/WRITES MEMORY & I/O
Reports location of SHORTS
on ADDRESS and DATA busses
Prints out memory contents
in ASCII, HEX or SOURCE CODE

You cannot expect to mend microprocessor products with a meter and a scope. How many repairs would pay for your SuperDOC?

SuperDOC.. £395

EPROM EDITOR

Displays HEX on standard TV
with text-editing facilities
inserts and deletes
shifts and copies
bytes and blocks of code
EMULATES EPROM in circuit
using romulator lead supplied



Uploads and downloads
using serial and parallel
routines - RS232, Centronics

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Useful for development
particularly for piggy-back
single-chip micros

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Z80 TUTOR

Designed for Schools Council
to teach Z80 machine code
MENTA uses TV for display
shows STACK & PROGRAM in HEX

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direct keyboard ASSEMBLER
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Used to write & debug
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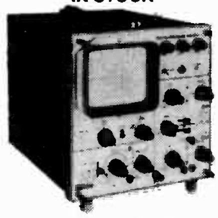
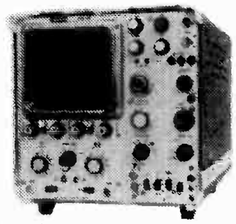


Portable Battery or Mains Oscilloscope. SE Laboratories 111 Oscilloscope — Solid State — General purpose — Bandwidth DC to 18/20MC/S at 20MV/CM — Dual Channel — Rise time 19NS — Calibrated Sweep — Calibrator — Display 10CMS×8CMS — Power AC — 95 Volts to 100-190 Volts to 260 or 24 Volt DC battery — Size. 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 at 5MV/CM — Dual Channel — High brightness display (8×10cm) Full delayed time base with 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 front containing polarized viewer and camera adaptor plate — probe (1) — Mains lead. Tested in Fair condition 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 dust cover — operation instructions — circuit — in fair used condition.** Racal Synthesisers **(Decade frequency generators)** 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 Convertor **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 field telephone sets.** Type F — L and J — Large quantity in stock £6 to £15 depending on type and quantity P.O.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.

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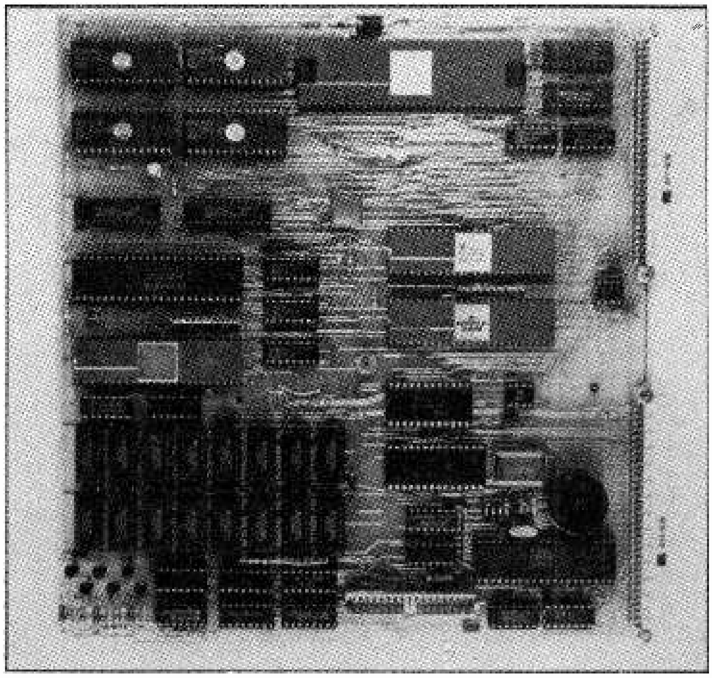
CIRCLE 20 FOR FURTHER DETAILS.

British rival for Amiga



The new Amiga computer from Commodore with its exceptionally fast graphics created a good deal of interest at the recent *Which Computer?* show. But now comes a British rival to the Amiga, the Microbox 3, which on paper outpaces it.

Microbox 3 is a colour graphics computer designed around the 68000 (or 68010) processor running at 8MHz and Motorola's Raster Memory System chip set. It offers 40 different screen modes, with resolution ranging up to 640 by 500 pixels, plus features such as a 4096-colour palette, eight re-usable sprites and a virutal screen of up to 512K in size with smooth horizontal or vertical scrolling. The video standard is 625-line PAL or NTSC and the output can be genlocked to an external video source.

The board carries 512K of D-RAM plus 128K of system rom and has room for 64K of user rom. An 8M-byte plug-in expansion board with a floating-point co-processor is promised. Also on the way is a Transputer co-processor.

There is a twin 800K floppy disc interface built in and a choice of four operating systems — CP/M68K (GEM), OS-9/68K, Tripos and SMS-2, which should enable the machine to run most software designed for the Amiga or the Atari 520ST. In addition there is an SCSI bus interface for a 20M-byte hard disc.

Other details include a real-time clocks, a stereo sound generator, a dual RS232 port, parallel printer port, mouse interface and a built-in emprom programmer.

The board alone, is available at £650; boxed versions of the computer with built-in disc-drives will be ready later. Applications suggested by the makers include image processing, engineering work, video games and Kanji word-processing. Micro Concepts, 2 St Stephen's Road, Cheltenham, Gloucestershire GL51 5AA. **EWW 220 on Reply Card.**

FFT on the BBC

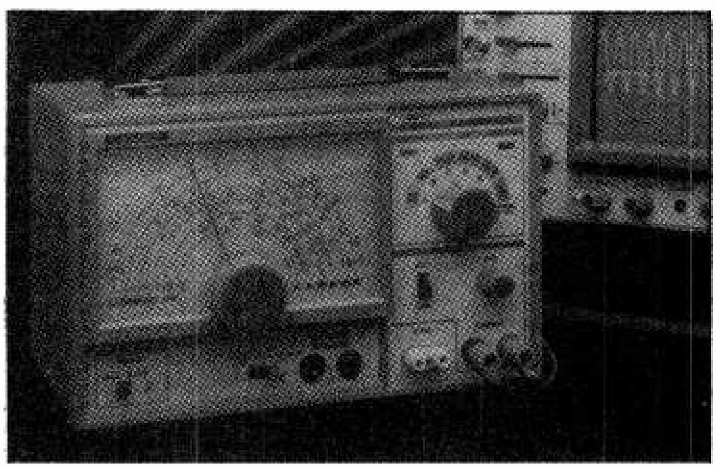
A second-processor board will allow the BBC Micro (or many other computers) to perform fast Fourier transformations *very* rapidly; 1024 complex points in less than 50ms using 16-bit two's complement arithmetic. Magnitude scaling is included to maintain a high dynamic range. Computing power is provided by the TMS 32010 digital signal processor from Texas Instruments with 4K of program memory and 64K of 16-bit memory with 100ns access time. The instruction set is optimized for singal processing. For example a 16 by 16 to 32-bit multiply takes only 200ns and 32-bit accumulates can be pipelined with the loading of the next operand.

A hardware interface enables the transfer of data and programs between the BBC and the TMS at about 2Kword/s. Operation is controlled by software running on the BBC. It takes assembled program data from discs, sends them to the TMS for processing and displays the results either graphically or as a table of numbers.

A compatible a-to-d board is available to allow processing of incoming data in real time, sampling at frequencies up to 500kHz for 8-bit resolution.

The processor board, interface and software to perform FFTs and design matching filters is all bundled together to provide a development system for the TMS processor in a variety of real-time digital signal processing applications such as spectral analysis, finite and infinite impulse response filters. It make a useful teaching aid for students of digital signal processing. Practical applications include the possibility of recording sound in real time digitally with a resolution comparable with that on compact discs; real time encryption is also possible.

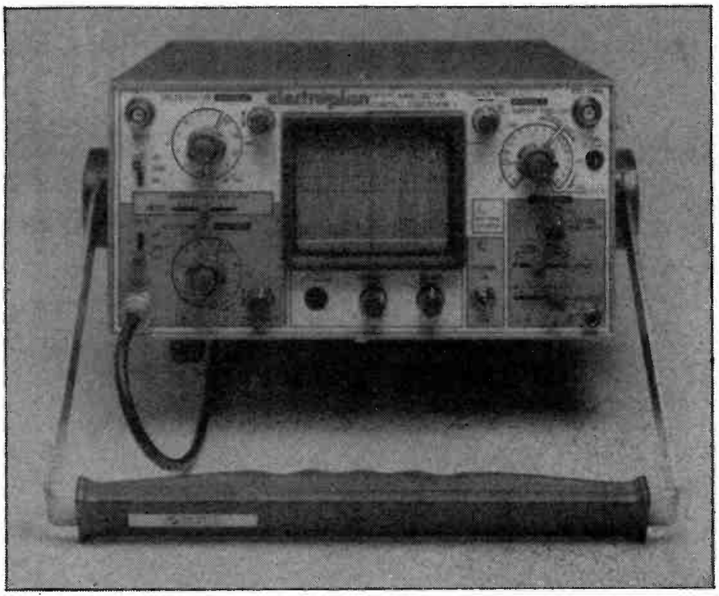
The hardware can be used with other computers since it only requires two i/o ports on the host. Enquiries about adapting the interface to work on any host computer bus would be welcomed by Graham Sutherland and James Ervine, 71 Linden Gardens, London W2 4HJ. **EWW 211 on reply card.**



Signal generators

Two new signal generators cover the frequency spectrum from 10Hz to 450MHz in overlapping ranges. The audio frequency model has an accuracy of +3%, generating sine waves up to 1MHz and square waves up to 100kHz with a rise-time of 200ns. Output voltage is variable from 0 to 4V, flat to within 1.5dB with an output impedance of 600Ω.

The r.f. model covers six bands from 100kHz to 150MHz on fundamentals extending to 450MHz on harmonics, with a continuously variable output of 0 to 0.1V. r.m.s. Modulation is by an internal 1kHz tone or can be supplied externally. The provision of an external crystal socket makes it easy to use for spot frequency calibration. Available through MS Components Ltd, Zephyr House, Waring Street, London SE27 9LH. **EWW 213 on reply card.** MS are part of the Steatite Group who are also showing a range of r.f.i. protection and shielding products; capacitor and resistors; semi-conductors, cells and batteries and many other products. **Stand No. 219.**



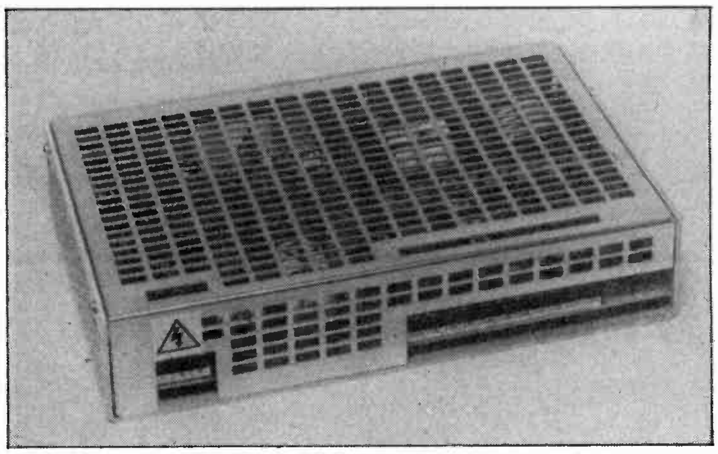
Battery-powered oscilloscope

The new T0315 oscilloscope from Electroplan is a dual-trace 15MHz instrument weighing only 4.5Kg. The low weight and small dimensions make it suitable for field service and for application where a.c. power may not be available. It has sensitivity ranges from 2mV to 10V/division in 12 ranges, automatic selection of chopped or alternate mode, and tv line or frame display. It can operate from batteries or a.c. mains with internal re-chargeable batteries offering up to two hours of continuous operation. Electroplan Ltd, PO Box 19, Orchard Road, Royston, Herts SG8 5HH. **EWW 217 on reply card. Stand No. 132.**

Compact switch-mode power

Peak current may be drawn from all outputs in this 350W switched-mode power supply. The F350 is a compact, open frame supply that can provide 5V at 50A, −5V at 5A, −12V at 5A and +24V at 5A. Power-failure indication is included and pulse overload capability is available on all outputs. 'Power trading' between the outputs is used. Meeting a number of IEC, BS, VDE and TG standards the supply is intended for use on computer systems with disc drives, printers and other electromechanical devices that demand high peak power.

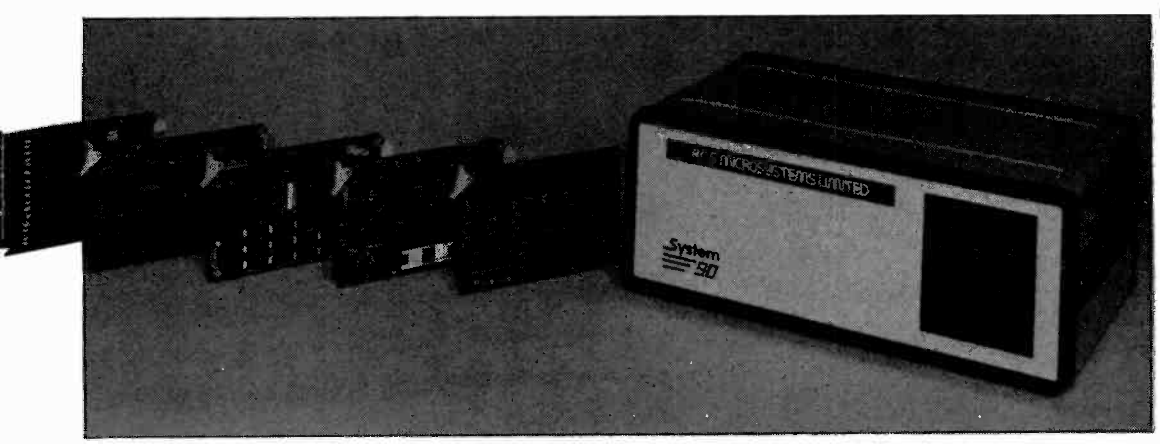
Powerline are displaying a wide range of other products including the Vicor VI100 d.c.-d.c. converter that switches at zero volts. It is claimed to produce half the heat of a conventional switched-mode regulator and to have a minimum efficiency of 80% — typically 90%. Powerline Electronics Ltd, 9 Nimrod Way, Eglar Road, Reading, Berks RG2 0EB. **EWW 211 on reply card. Stand No. 118.**



Modular measurement systems

The introduction of a family of Eurocard computer products comes from Measurement Systems. Modular 96 supports the Unix-like OS-9 operating system, giving multi-user, multi-tasking capability. OS-9 can be contained in a rom and can be used in turnkey systems, with or without discs. The family includes a wide selection of rom, ram and i/o functions including disc, parallel, serial, isolated parallel, GPIB, analogue and graphics interfaces.

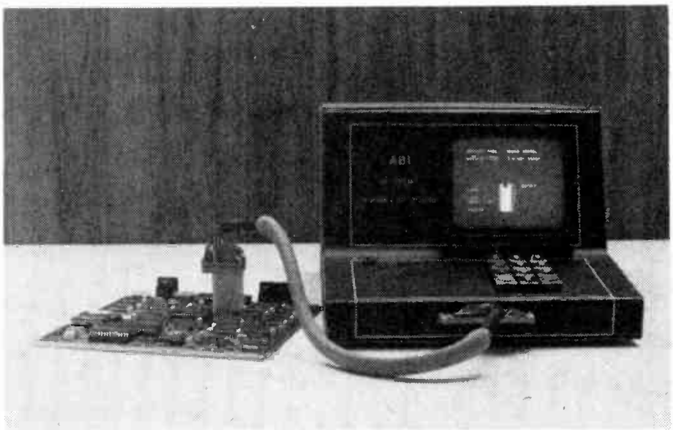
A key feature is that all the modules in the range are provided with OS-9 software at no extra cost. Support includes comprehensive documentation, regular training courses and on-site consultancy to ensure rapid system development. Available through R.C.S. Microsystems Ltd, 141 Uxbridge Road, Hampton Hill, Middlesex TW12 1BL. **EWW 218 on reply card. Stand No. 527.**



Surface-mount connectors

In order to obtain the best benefits from surface-mounted p.c.b.s, it is necessary that all the components used should mount on the surface. Erni, in West Germany have come up with two-part connectors specifically developed for surface mounting. They conform to DIN 41612 and allow the use of conventional p.c.b. size, spacing and racking. The materials used are suitable for vapour-phase and reflow soldering. Fixing holes are supplied and the makers recommended screwing or rivetting the body to the p.c.b. Available through Radiatron Components Ltd, Crown Road, Twickenham, Middlesex. **EWW 214 on reply card. Stand No. 375.**

ANOTHER BRIGHT IDEA from A.B.I.



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SmartWatch

SPECIAL OFFER from ELECTRONICS & Wireless World

A battery-backed real-time clock/calendar with 64Kbit non-volatile ram for under £35.

This real-time clock/calendar from Dallas Semiconductor includes a battery-backed c-mos ram capable of holding data for 10 years.

SmartWatch keeps track of:
Hundredths of seconds — seconds — minutes — hours — day — date — month — year in any computer or controller application.

Looking like a 28-pin socket, SmartWatch fits into a computer's 8K-by-8bit memory socket* — without any hardware modifications on most computers.

For memory read/write operations, no software modifications are required either.

Normally the computer sees SmartWatch as a standard memory i.c. but when a special code is sent to the socket, internal address decoding triggers the clock/calendar function, allowing time and date information to be read and written.

This means that both clock and memory occupy the same computer address range and no external decoding is required.

Only a small software routine is needed to trigger the clock function and read and write time/date information.

Built into the socket are the real-time clock, a lithium battery, address decoding and power-down switching.

Because of their extremely low power consumption, the 6264-type static memory i.c. and clock/calendar remain powered for 10 years using the same battery.

**JEDEC pinout*

Send to:— E&WW SmartWatch Offer,
M.S. Components, Zephyr House, Waring St., West Norwood London, S.E.27 9LH.
Offer applies to U.K. only. Please allow 28 days for delivery. Price includes data sheet.

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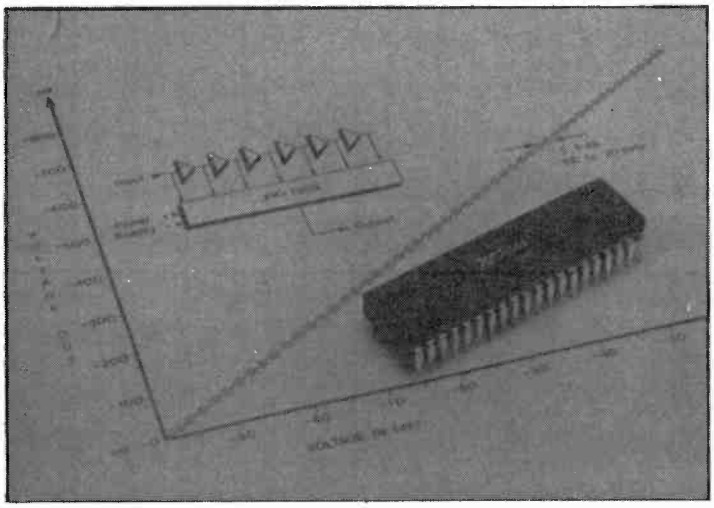
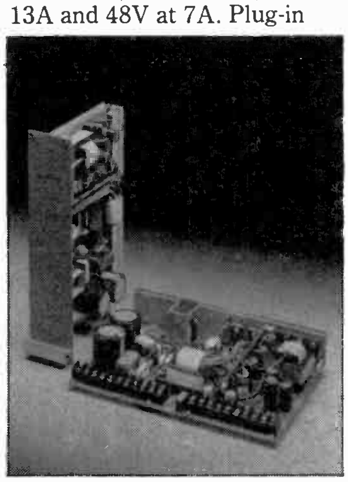


Logarithmic video amp

Among the products to be displayed by Exar is the XR-7000 a log video amplifier i.c. with a wide bandwidth, suitable for many applications from audio to radar and including test instruments, video and audio systems, smoke tectors, ultrasonic detectors, medical instrumentation and so on. The single-chip device has seven logarithmic stages which may be cascaded for increased dynamic range. Total bandwidth is 30MHz. Also included are most of the parts for a precision signal processing system; so there is an internal band-gap reference, a differential summing amplifier, an on-chip temperature sensor and power supply regulators. Exar Corporation, Zilos House, Moorbridge Road, Maidenhead, Berks. **EWW 205 on reply card. Stand No. 389.**

Power supplies

Advance Power Supplies have extended several of their ranges. The d.c. driven Powerflex range now includes a PD500 which has a nominal input of 48V, but which will operate between inputs of 40.5 and 63V, believed to be the widest input operating voltage swing in the world. Outputs are available in four versions: 5V at 60A, 12V at 30A, 24V at 13A and 48V at 7A. Plug-in p.c.bs offer auxiliary outpurs of 5, 12, 15, 18, 24 and 48V. 'Power trading' between outputs is a standard feature.

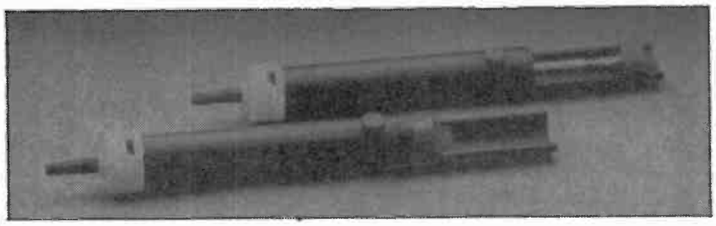


The Powermag A1500 is a 5V, 300A switchmode power supply working from 110V or 220V a.c. inputs. These are nominal and the supply will operate from almost any a.c. supply and input frequency. Its largest dimension is 280mm.

To complete the additions to the Advance range there are the Powerite A200 series of five-output, 200W openframe power supplies. They use 100kHz EEIS to allow the use of small tansformers and be 'highly efficient and reliable'. The supplies operate from a.c. mains and offer a main output of +5V at 40A, with auxiliary outputs of −5V, 5A, +12V, 5A, — 12V, 5A and +24V, 8A. Advance Power Supplies Ltd, Raynham Road, Bishop's Stortford, Herts CM23 5PF. **EWW 255 on reply card. Stand no. 251.**

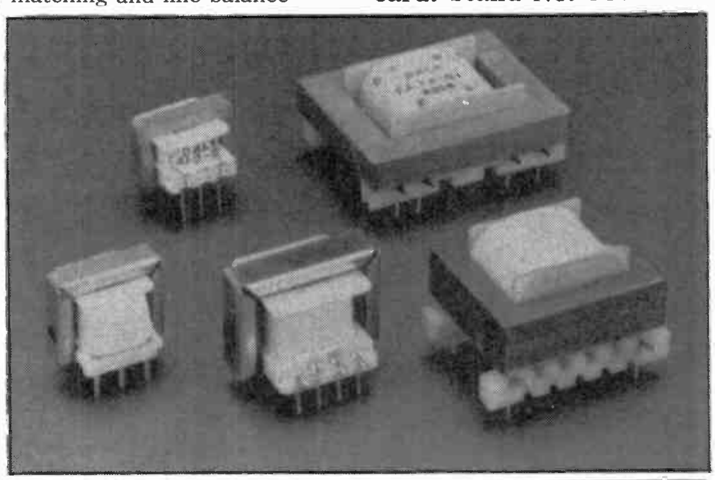
Desolderer free from static

A new addition to OK Industries' 'Anti-static' range of products is this desoldering pump, the DP3, which conforms to standards of electrostatic-free materials. It has a conductive tip that is easy to clean and change. Presently available at a special offer of £3.16 inclusive — 40% off the list price. OK Industries UK Ltd, Dutton Lane, Eastleigh, Hants SO5 4SL. **EWW 210 on reply card. Stand No. 250.**



Telecomms transformers

An expansion of its range of audio transformers for telephone coupling applications, is the TA series from Dale-ACI. All the new models are desgined to meet FCC part 68 requirements. A wide range of sizes, mounting configurations and circuits are available to provide line isolation, four-wire to two-wire hybrid termination, impedance matching and line balance functions over a frequency range of 300 to 3500Hz for data and voice applications. Modifications to the impedance, frequency response or other electrical characteristics are available to meet specific design needs. Dale-ACI Components Ltd, River Park Industrial Estate, Berkhamstead, Herts HP4 1HL. **EWW 215 on reply card. Stand No. 99.**



High-frequency power sensor

Marconi Instruments has added a high-frequency, 50Ω power sensor to its range of detectors for use with its digital and analogue power meters. The new sensor, 6913, extends the upper limit of the overall sensor frequency range to 26.56Hz and a 50dB power range from +20 to −30dBm. Applications for measurement in microwave, radar and satellite communications. Marconi Instruments Ltd, Longacres, St Albans, Herts AL4 0JN. **EWW 206 on reply card. Stand no. 357.**

Low-cost data logger

A comprehensive range of industrial and scientific data capture tasks can be performed by the Vela data logger from Data Harvest. At its heart is a 6802 processor, 8-bit d-to-a and a-to-d conveters, rom software and 4K of battery-backed c-mos ram. Sockets are available internally for additional applications roms. There are four analogue inputs plus an additional pulse input for counting, timing and triggering. Internal pulses for timing and triggering are also provided. Various transducers and sensors can be connected directly to the inputs, or through amplifiers and signal-conditioning units which are available as optional extras and themselves plug directly to the inputs. The instrument can be mains or battery powered and the recorded data is retained in memory for later downloading. Vela's programs are selected by simple push-button instructions, selected the front panel. These include transient recording, data collection, timing, pulse counting and waveform generation. Channel number and required parameters are all selected through the membrane keyboard and shown on the led display at the top of the panel. After an event is captured it can be stepped through with the recorded values being displayed on the leds. All of the four channels can be used simultaneously.

The instrument can also output its data to an analogue oscilloscope or a microcomputer. Both can display the recorded waveform and it is possible to step through he sequence to get spot values at the cursor. This has the added advantage of turning the laboratory oscilloscope or micro into a digital storage oscilloscope. The micro has the addition advantage of being able to store the recorded events as waveforms or as tables of data, make comparisons and perform such analyses as FFT and statistics. The data can also be output to a printer to obtain a graph of the waveform or a table of the data. Graphical output can also be obtained on a pen plotter and as the data is all recorded, there is not disadvantage in the slow speed of the plotter. Vela may be connected to a BBC micro, an Apple II and many other computers.

Applications are very numerous as the instrument has been designed to be as versatile as possible. If it is possible to use a sensor it is possible for Vela to record the output. Some examples are structural stress analysis using accelerometers and pressure sensors. Analysis of gases, recording the vibrations in machinery and then analysing potential failure, using FFT etc. Data Harvest believes that its instrument will become a standard piece of lab equipment alongside the multimeter and the oscilloscope. They also believe that at the low price of £375 there is no rival for use in industry or higher education. The instrument is also being marketed under their own name by a well-known component distributor and is featured as a new product in the latest edition of their catalogue. Data Harvest Ltd, 28 Lake Street, Leighton Buzzard, Beds LU7 8RX. **EWW 222 on reply card.**

Fans on show

Papst needs two stands — one each in the All Electronic and Electronic Production Design shows — to display all their air-moving products. New are a range of 25mm rugged a.c. fans and 120mm electronically commutated d.c. models. Also on display is an "intelligent" cooling system that can automatically control d.c. fans to suit varying requirements of ambient temperature and operating load. Papst Motors Ltd, East Portway, Andover, Hants SP10 3RT. **EWW 208 on reply card. Stands no. 101 and 1031.**

Assembler + emulator = instant development

Developing object-code software for a target system presents problems. However one solution is to use an eprom emulator. Such a device is the Portal emulator one port of which plugs into the development system and the other to the target. Portal has the advantage of being developed by Andy Green, who also wrote the Meta assembler — and of being cheap. When a program is assembled by Meta, in the machine code of the target system, the object code is immediately available on the target and may be run instantly. Meta can translate a program into machine code for all the popular 8-bit processors (68000 is under development). This means that the Meta/Portal combination can be used on a wide variety of target processors and is not dedicated to one specific system. Up top four Portals can be chained together and addressed individually and can be used in sockets for a 2716 up to a 27512 i.e. 64Kbyte. Two may be used together, one each for the high and low data strobes of a 68000 system. The system runs from the user port on a BBC micro with no hardware modification. Meta is on two roms. Crash Barrier. Freepost Flitwick, Bedford MK45 1YP. **EWW 219 on reply card.**

01-208 1177 TECHNOMATIC LTD 01-208 1177

BBC Computer & Econet Referral Centre

AMB15	BBC MASTER Foundation computer 128K	£435 (a)
AMB12	BBC MASTER Econet computer 128K (only ANFS)	£348 (a)
A MC06	Turbo (65C – 02) Expansion Module	£107 (b)
ADF13	Rom Catridge £13 (b) ADF10 Econet Module	£43 (c)
ADJ22	Ref. Manual Part I..£14.50 (c) ADJ23 Ref. Manual Part II	£14.50 (c)
ADJ24	Advanced Ref. Manual	£19.50 (c)

BBC Dust Cover **£450(d)** .... 1770 DFS Upgrade for Model B **£43.50(d)**
ADFS ROM (for B with 1770 DFS & B plus) .... 64K Upgrade Kit for B plus £35 (d)
ACORN Z80 2nd Processors **£329** (a) .... 6502 2nd Processor £162(b)
MULTIFORM Z80 2nd Processor .... £299 (b)
TORCH Z80 2nd Processor ZEP 100 .... £199 (a)
TZDP 240: ZEP 100 with Technomatic PD800P dual drive with built-in monitor stand **£469** (a)

META-ASSEMBLER. Both an editor and Macro-Assembler. Meta can assemble most 65xx, 68xx, 6804, 6805/6305, 6809, 8048, 8080/8085, Z80, 1802 and more. Please phone for comprehensive leaflet. **Meta-Assembler £126(c)**

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

PRINTERS & PLOTTERS

EPSON: LX-80 NLQ .... £195 (a) — Optional Tractor Feed .... £20 (c)

EPSON FX RANGE
FX85 (80 col) .... £315 (a) — FX105 (136 col) .... £449 (a)
EPSON JX80 4 colour printer .... £435 (a)

EPSON LQ Range:
LQ800 (80 col) .... £595 (a) — LQ1500 (136 col) 2K buffer .... £875 (a); 32K buffer .... £950 (a)

TAXAN:
KP810 (80 col) .... £160 (a) — KP910 (156 col) .... £339 (a)

DAISY WHEEL:
BROTHER HR15 .... £285 (a) — JUKI 6100 .... £289 (a)
CENTRONICS GLP (NLQ) Printer .... £109 (b) — Tractor feed .... £14 (d)
DOTPRINT + NLQ Rom for Epson .... £28 (d)
Epson HI-80 PLOTTER .... £325 (a) — Integrex Colour Printer .... £569 (a)

PRINTER ACCESSORIES

We hold a wide range of printer attachments (sheet feeders, tractor feeds etc) in stock. Serial, parallel, IEEE and other interfaces also available. Ribbons available for all above plotters. Pens with a variety of tips and colours also available. Please phone for details and prices.

Plain Fanfold Paper with extra fine perforation (Clean Edge):
2000 sheets 9.5" X 11" **£13(b)** 2000 sheets 14.5" X 11" **£18.50(b)**
Labels per 1000s: Single Row 3½" X 1 7/16" **£5.25(d)** Triple Row 2-7/16" X 1 7/16" **£5.00(d)**

MODEMS

MIRACLE WS 2000
The world standard BT approved modem covering all standard CCITT and BELL (outside UK only) standards upto 1200 baud. Allows communication with virtually any computer system in the world. Expandability to Auto Dial and Auto Answer with full software control enhance the considerable features already provided on the modem. Mains powered. WS 2000 **£102 (b)**, Data Cable **£7(d)**,

NEW WS-3000 RANGE — the new professional series. All are intelligent and 'Hayes' compatible, allowing simply 'English' commands to control its many features. All models feature Auto-Dial with 10 number memory, Auto-Answer, Speed buffering, printer port, data security option etc. All models are factory upgradeable.

WS3000 V2123 (V21 & V23 + Bell **£295 (a) WS3000 V22** (as above plus 1200 baud full duplex **£495 (a) WS3000 V22bis** (as above plus 2400 baud full duplex **£650 (b)**
BBC Data Cable for WS3000 **£6(d).** Data Cables for other micros available
The WS3000 range all have BT approval.

GEC DATACHAT 1223: An economically priced BABT approved modem complying with CCITT V23 standard capable of operating at 1200/75bps and 75/1200bps and 1200/1200bps pseudo full duplex. It is line powered does not require external power source. it is supplied with software suitable for connecting to PRESTEL, Micronet 800, Telecom Gold and a host of bulleting boards **£86(b)**

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/O routines. Can be used as an emulator, cassette interface.
Softy II .... **£195.00 (b)**
Adaptor for 2764/2564 .... **£25.00**

SPECIAL OFFER

2764-25 £2:00(d);
27128-25 £2:50(d);
6264 LP-15 £3:40(d);

ACORN IEEE INTERFACE £278(a)

INDUSTRIAL PROGRAMMER EP8000 £695 (a)

DISC DRIVES

PD800P (2 × 400K/2 × 640K 40/80T DS) with built in Monitor stand .... **£289(a)**
PD800 (2 × 400K/2 × 640K 40/80T DS) .... **£269(a)**
TS400 1 × 400K/1 × 640K 40/80T DS .... **£119(b)**
PS400 with psu 1 × 400K 40/80T DS .... **£139(b)**

3.5" Drives
1 × 400K/1 × 640K 80T DS
TS35 1 .... £115 (b) — **PS35** 1 with psu .... **£130(b)**
2 × 400K/1 × 640K 80T DS
TD352 .... £205(b) — **PD35** 2 with psu .... **£220(b)**

3M FLOPPY DISCS

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

5¼" DISCS				3½" DISCS	
40 T SS DD	£10:50(d)	40 T DS DD	£12:75 (d)	80 T SS DD	£18(d)
80 T SS DD	£14:75(d)	80 T DS DD	£16:00 (d)	80 T DS DD	£25(d)

FLOPPICLENE DRIVEHEAD CLEANING KIT

FLOPPICLENE Disc Head Cleaning Kit with 28 disposable cleaning discs ensures continued optimum performance of the drives. 5¼" **£14.50(d)** 3½" **£16.00(d)**

DRIVE ACCESSORIES

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 **£16**(c)

MONITORS

All 14" monitors now avilable in plastic or metal cases, please specify your requirement.
14" RGB 1431 STD Res **£179 (a); 1451** Med Res **£229 (a); 1441** Hi Res **£375 (a).**
14" RGB with PAL & Audio 1431 AP Std Res **£199 (a) 1451** AP Med Res **£275 (a)**
Swivel Base for Plastic 14" Microvitecs **£20** (c)
20" RGB with PAL & Audio 2030CS Std Res **£380** (a); **2040CS** Hi Res **£685** (a).

TAXAN 12" RGB

SUPERVISION III £330 (a)
MITSUBISHI 14" RGB Med RES IBM & BBC Compatible **£249** (a)

MONOCHROME MONITORS:

TAXAN KX1201G Hi Res 12" Etched Green Screen **£90** (a)
TAXAN KX1203A Hi Res 12" Etched Amber screen **£105** (a)
PHILIPS BM7502 12" Hi Res Green Screen **£75** (a)
PHILIPS BM7522 12" Hi Res Amber Screen **£79** (a)
BBC Leads RGB **£5(d)** Microvitec **£3.50m (d)** Monochrome **£3.50 (d)**

UVERASERS

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 **£69**, UV141 **£85, p&p £2.50.**

PRINTER BUFFER

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. **£199** (a).
BBC Cable Set £30.

Serial Test Cable

Serial Cable switchable at both ends allowing pin options to be re-routed or linked at either end — making it possible to produce almost any cable configuration on site.
Available as M/M or M/F **£24.75 (d)**

Serial Mini Patch Box

Allows an easy method to reconfigure pin functions without rewiring the cable assay. Jumpers can be used and reused. **£22 (d)**

Serial Mini Test

Monitors RS232C and CCITT V24 Transmissions, indicating status with dual colour LEDs on 7 most significant lines. Connects in Line. **£22.50 (d)**

CONNECTOR SYSTEMS

I.D. CONNECTORS

(Speedblock Type)

No of ways	Header Plug	Receptacle	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 £7.50; 28-pin £9.10; 40-pin £12:10

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	Plug	Skt
2 X 32 way St Pin	230p	275p
2 X 32 way Ang Pin	275p	320p
3 X 32 way St Pin	260p	300p
3 X 32 way Ang Pin	375p	400p
IDC Skt A + B	400p	
IDC Skt A + C	400p	

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

MISC CONNS

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

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

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	160p	200p
40 pin	200p	225p

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

TECHNOLINE VIEWDATA SYSTEM. TEL: 01-450 9764

Using 'Prestel' type protocols. For information and orders — 24 hour service, 7 days a week

74 SERIES

7400 0.30
7401 0.30
7402 0.30
7403 0.30
7404 0.36
7405 0.30
7406 0.40
7407 0.40
7408 0.30
7409 0.30
7410 0.30
7411 0.30
7412 0.30
7413 0.50
7414 0.70
7416 0.36
7417 0.40
7420 0.30
7421 0.60
7422 0.36
7423 0.36
7425 0.40
7426 0.40
7427 0.32
7428 0.43
7430 0.30
7432 0.36
7433 0.30
7437 0.30
7438 0.40
7439 0.40
7440 0.40
7441 0.90
7442A 0.70
7443A 1.00
7444 1.10
7445 1.00
7446A 1.00
7447A 1.00
7448 1.00
7450 0.36
7451 0.35
7453 0.38
7454 0.38
7460 0.55
7470 0.50
7472 0.45
7473 0.45
7474 0.50
7475 0.60
7476 0.45
7480 0.65
7481 1.80
7483A 1.05
7484A 1.25
7485 1.10
7486 0.42
7489 2.10
7490A 0.55
7491 0.70
7492A 0.70
7493A 0.55
7494 1.10
7495A 0.60
7496 0.80
7497 2.10
74100 1.90
74107 0.50
74109 0.75
74110 0.75
74111 0.55
74116 1.70
74118 1.10
74119 1.70
74120 1.00
74121 0.55
74122 0.70
74123 0.80
74125 0.65
74126 0.55
74128 0.55
74132 0.75
74136 0.70
74141 0.90
74142 2.50
74143 1.30
74144 2.70
74145 1.10
74147 1.70
74148 1.40
74150 1.75
74151A 0.70
74153 0.80
74154 1.40
74155 0.80
74156 0.90
74157 0.80
74159 1.75
74160 1.10
74161 0.80
74162 1.10
74163 1.10
74164 1.20
74165 1.10
74166 1.40
74167 4.00
74170 2.00
74172 4.20
74173 1.40
74174 1.10
74175 1.05
74176 1.00
74178 1.50
74179 1.50
74180 1.00
74181 3.40
74182 1.40
74184 1.80
74185A 1.60
74190 1.30
74191 1.30
74192 1.10
74193 1.15
74194 1.10
74195 0.80
74196 1.30
74197 1.10
74198 2.20
74199 2.20
74221 1.10
74251 1.00
74259 1.50
74265 0.80
74273 2.00
74276 1.40
74278 1.70
74279 0.90
74283 1.05
74742 3.20
74290 0.90
74293 0.90
74298 1.80
74351 2.00
74365A 0.80
74366A 0.80
74367A 0.80
74376 1.60
74390 1.10
74393 1.20
74490 1.40

74LS SERIES

74LS00 0.24
74LS01 0.24
74LS02 0.24
74LS03 0.24
74LS04 0.24
74LS05 0.24
74LS08 0.24
74LS09 0.24
74LS10 0.24
74LS11 0.24
74LS13 0.34
74LS14 0.50
74LS15 0.24
74LS20 0.24
74LS21 0.24
74LS22 0.24
74LS24 0.50
74LS26 0.26
74LS27 0.24
74LS28 0.24
74LS30 0.24
74LS32 0.24
74LS33 0.24
74LS37 0.24
74LS38 0.24
74LS40 0.24
74LS42 0.50
74LS43 1.50
74LS48 0.90
74LS49 1.00
74LS51 0.24
74LS54 0.24
74LS55 0.24
74LS73A 0.30
74LS74A 0.35
74LS75 0.45
74LS76A 0.36
74LS78 0.42
74LS83A 0.70
74LS85 0.75
74LS86 0.35
74LS90 0.48
74LS91 0.90
74LS92 0.35
74LS93 0.54
74LS95B 0.75
74LS96 0.90
74LS107 0.40
74LS109 0.40
74LS112 0.45
74LS113 0.45
74LS114 0.45
74LS122 0.70
74LS123 0.80
74LS125 0.50
74LS126 0.50
74LS132 0.65
74LS133 0.55
74LS136 0.45
74LS138 0.55
74LS139 0.55
74LS145 0.95
74LS147 1.75
74LS148 1.40
74LS151 0.65
74LS152 2.00
74LS153 0.65
74LS154 1.60
74LS155 0.65
74LS156 0.65
74LS157 0.50
74LS158 0.65
74LS160A 0.65
74LS161A 0.75
74LS162A 0.75
74LS163A 0.75
74LS164 0.75
74LS165A 1.10
74LS166A 1.50
74LS168 1.10
74LS169 1.00
74LS170 1.40
74LS173A 1.00
74LS174 0.75
74LS175 0.75
74LS181 2.00
74LS183 1.90
74LS190 0.75
74LS191 0.75
74LS192 0.80
74LS194A 0.75
74LS195A 0.75
74LS196 0.80
74LS197 0.80
74LS221 0.90
74LS240 0.80
74LS241 0.80
74LS242 0.90
74LS243 0.90
74LS244 0.80
74LS245 1.10
74LS247 1.10
74LS248 1.10
74LS249 1.10
74LS251 0.75
74LS253 0.75
74LS256 0.90
74LS2457A 0.70
74LS258A 0.70
74LS259 1.20
74LS260 0.75
74LS266 0.60
74LS273 1.25
74LS279 0.70
74LS280 1.90
74LS283 0.80
74LS290 0.80
74LS292 9.00
74LS293 0.80
74LS295 1.40
74LS297 9.00
74LS298 1.00
74LS299 2.20
74LS321 3.70
74LS322A 3.90
74LS323 3.00
74LS324 3.20
74LS348 2.00
74LS352 1.20
74LS353 1.20
74LS356 2.10
74LS363 1.80
74LS364 1.80
74LS365 0.50
74LS366 0.50
74LS367 0.52
74LS368 0.50
74LS373 0.90
74LS374 0.90
74LS375 0.75
74LS377 1.30
74LS378 0.95
74LS379 1.30
74LS381 4.50
74LS385 3.25
74LS390 0.60
74LS393 1.00
74LS395A 1.00
74LS399 1.40
74LS445 1.80
74LS465 1.20
74LS467 1.20
74LS490 1.50
74LS540 1.00
74LS541 1.00
74LS608 7.00
74LS610 19.00
74LS612 19.00
74LS624 3.50
74LS626 2.25
74LS628 2.25
74LS629 1.25
74LS640 2.00
74LS640-1 3.00
74LS641 1.50
74LS642 2.50
74LS642-1 3.00
74LS643 2.50
74LS643-1 3.00
74LS644 3.50
74LS645 2.00
74LS645-1 4.00
74LS668 0.90
74LS669 0.90
74LS670 1.70
74LS682 2.50
74LS683 3.00
74LS684 3.50
74LS687 3.50
74LS688 3.50
74LS783 21.00

74S SERIES

74S00 0.50
74S02 0.50
74S04 0.50
74S05 0.50
74S08 0.50
74S10 0.50
74S11 0.75
74S20 0.50
74S22 0.50
74S30 0.50
74S32 0.60
74S37 0.60
74S38 0.60
74S40 0.50
74S51 0.60
74S64 0.45
74S74 0.70
74S85 3.00
74S86 1.00
74S112 1.50
74S113 1.20
74S114 1.20
74S124 3.00
74S132 1.00
74S133 0.60
74S138 1.80
74S139 1.80
74S140 1.00
74S151 1.50
74S153 1.50
74S157 2.00
74S158 2.00
74S163 3.00
74S169 5.50
74S174 3.00
74S175 3.20
74S188 1.80
74S189 1.80
74S194 3.00
74S195 3.00
74S196 3.50
74S200 4.50
74S201 3.20
74S225 5.20
74S240 4.00
74S241 4.00
74S244 4.50
74S251 2.50
74S257 2.50
74S258 2.50
74S260 1.00
74S261 3.00
74S283 2.70
74S287 2.25
74S288 2.00
74S289 2.25
74S299 4.50
74S373 4.00
74S374 4.00
74S387 2.25

74C SERIES

74C00 0.70
74C04 0.50
74C08 0.70
74C10 0.70
74C14 0.50
74C20 0.70
74C32 1.00
74C42 1.50
74C48 1.50
74C73 1.00
74C74 1.20
74C76 1.00
74C83 2.00
74C85 2.25
74C86 0.50
74C90 1.90
74C93 1.50
74C95 1.60
74C107 1.00
74C150 5.00
74C151 2.00
74C157 2.50
74C160 1.80
74C161 1.80
74C162 1.80
74C163 1.80
74C173 1.00
74C174 1.50
74C175 1.50
74C193 1.50
74C194 1.50
74C195 1.50
74C221 2.50
74C244 2.00
74C245 2.25
74C373 2.25
74C374 2.25
74C902 1.20
74C911 9.00
74C912 4.50
74C922 6.00
74C923 6.50
74C925 6.50
74C926 7.50

74ALS SERIES

74ALS00 0.45
74ALS02 0.45
74ALS04 0.50
74ALS08 0.50
74ALS10 0.45
74ALS20 0.45
74ALS32 0.45
74ALS74 0.70
74ALS138 1.50
74ALS139 1.50
74ALS244 4.00
74ALS245 4.75
74ALS573 2.60
74ALS574 4.50
74ALS580 2.60

4000 SERIES

4000 0.20
4001 0.24
4002 0.25
4006 0.70
4007 0.25
4008 0.60
4009 0.45
4010 0.60
4011 0.24
4012 0.25
4013 0.36
4014 0.60
4015 0.70
4016 0.36
4017 0.55
4018 0.60
4019 0.60
4020 0.80
4021 0.60
4022 0.70
4023 0.30
4024 0.48
4025 0.24
4026 0.90
4027 0.40
4028 0.60
4029 0.75
4030 0.35
4031 1.25
4032 1.00
4033 1.25
4034 2.50
4035 0.70
4036 2.50
4037 1.10
4038 1.00
4040 0.60
4041 0.55
4042 0.50
4043 0.60
4044 0.60
4045 1.00
4046 0.60
4047 0.60
4048 0.55
4049 0.36
4050 0.35
4051 0.65
4052 0.60
4053 0.60
4054 0.80
4055 0.80
4056 0.85
4060 0.70
4063 0.85
4066 0.40
4067 2.30
4068 0.25
4069 0.24
4070 0.24
4071 0.24
4072 0.24
4073 0.24
4075 0.24
4076 0.65
4077 0.25
4078 0.25
4081 0.24
4082 0.25
4085 0.60
4086 0.75
4089 1.20
4093 0.35
4094 0.90
4095 0.95
4096 0.90
4097 2.70
4098 0.75
4099 0.99
4501 0.36
4502 0.55
4503 0.36
4504 0.95
4505 3.60
4506 0.90
4507 0.35
4508 1.20
4510 0.55
4511 0.55
4512 0.55
4513 1.50
4514 1.10
4515 1.10
4516 0.55
4517 2.20
4518 0.48
4519 0.32
4520 0.60
4521 1.15
4522 0.80
4526 0.70
4527 0.80
4528 0.65
4529 1.00
4531 0.75
4532 0.65
4534 3.80
4536 2.50
4538 0.75
4539 0.75
4541 0.90
4543 0.70
4551 1.00
4553 2.40
4555 0.36
4556 0.50
4557 2.40
4560 1.40
4566 1.40
4568 2.40
4569 1.70
4572 0.45
4583 0.90
4584 0.48
4585 0.60
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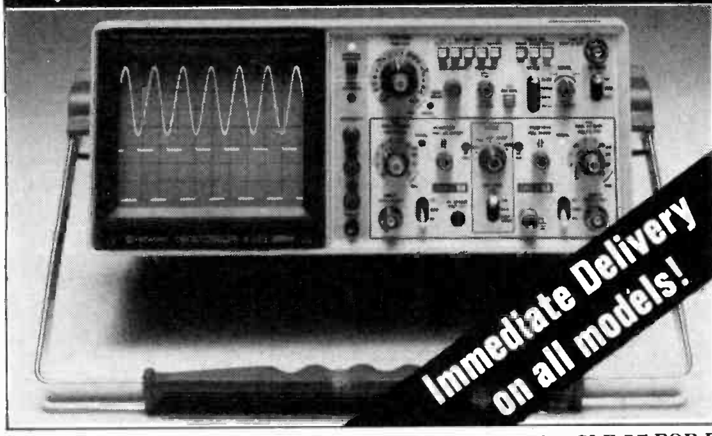

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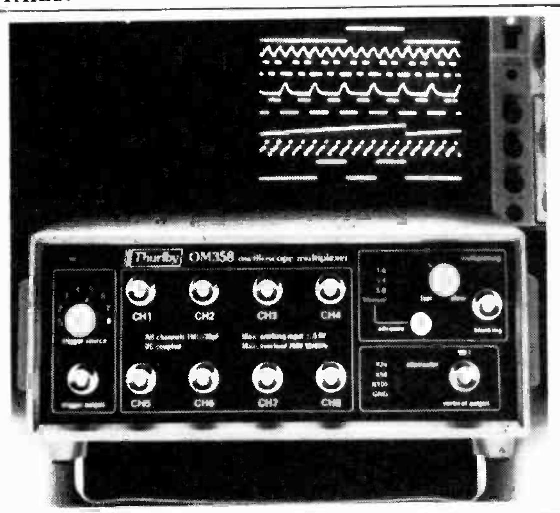

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(225)

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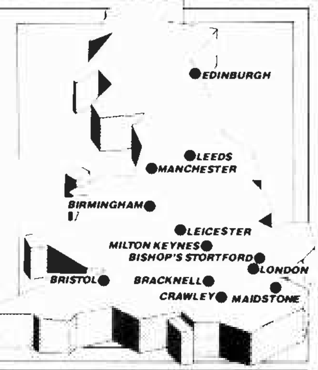

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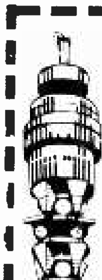

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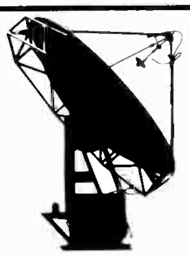

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