ELECTRONICS &
Wireless world

December 1984 85p

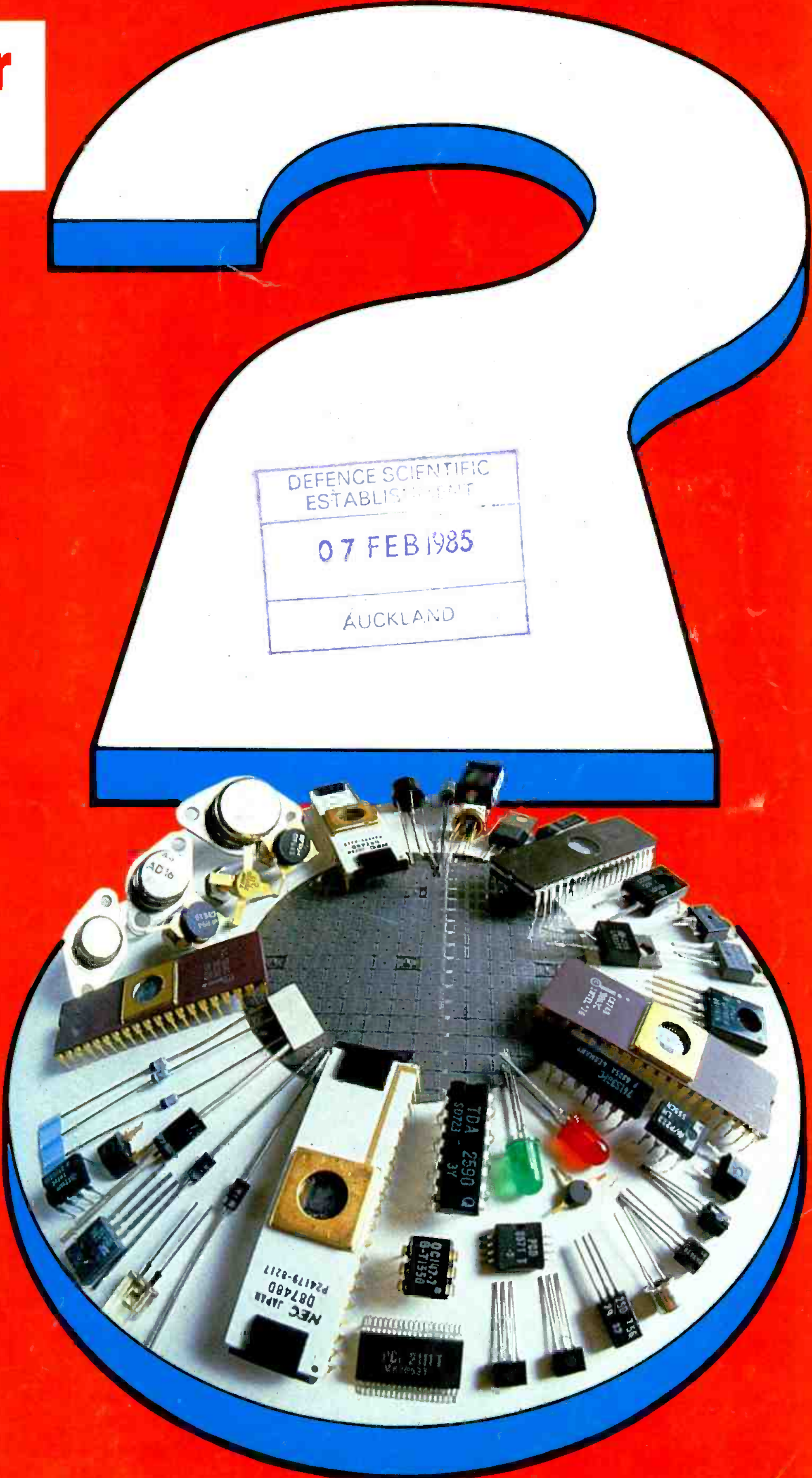
Semiconductor buyer's guide

BBC micro Mimicontroller

XY plotter update

Mobile radio

Digital feedback



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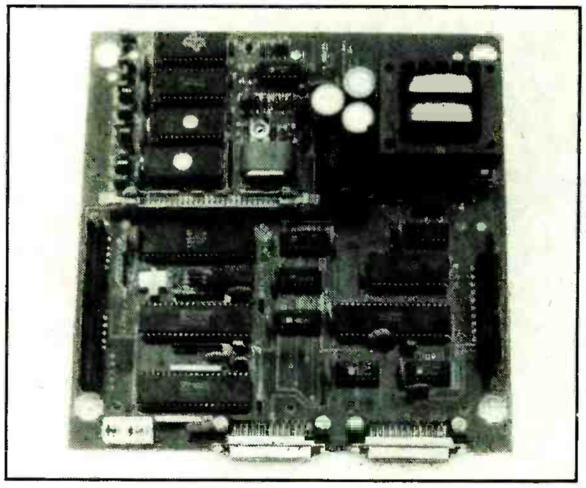

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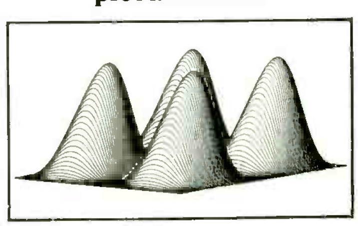
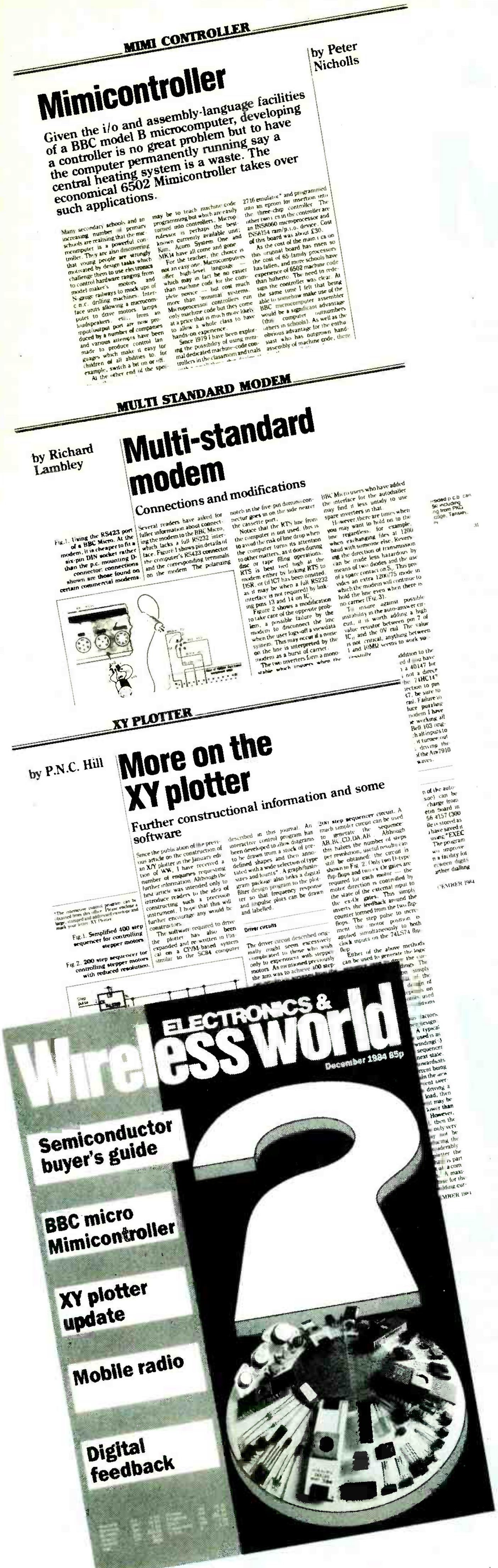
December 1984 — Volume 90 number 1586

FEATURES

REGULARS





Front cover is a Richard Newport design, illustrating this month's survey of semiconductor availability.

NEXT MONTH

Single-board computers are the subject of our latest market scan, in which Martin Eccles gives a brief outline of what they are and their applications. A table of specifications for currently available units is included.

John Linsley Hood presents his views on fully symmetrical audio amplifiers, with practical circuits for a moving-coil head amplifier and a gain block.

Compact discs are becoming well-established and John Watkinson gives a short overview of the making of discs and the method of playing them.

Safa Omran's design for a video camera/computer interface stores eight pixels at a time, reducing the time for storing a picture by a factor of eight.

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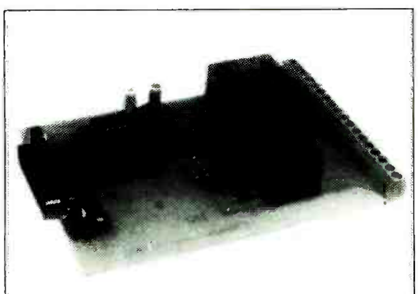

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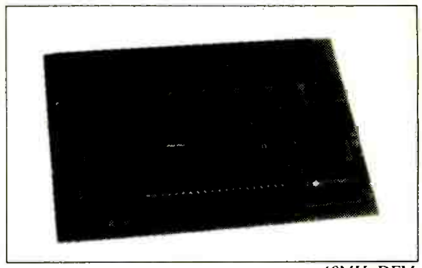

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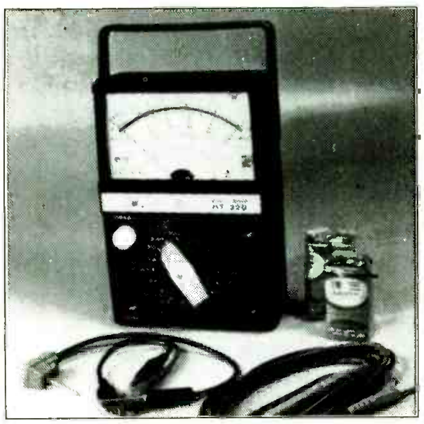

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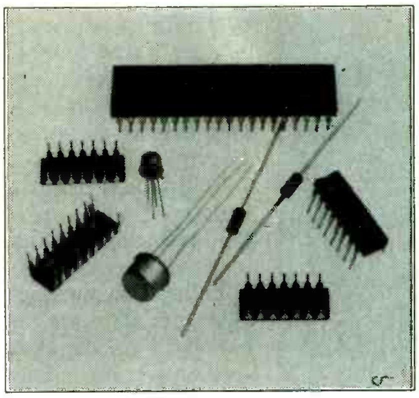

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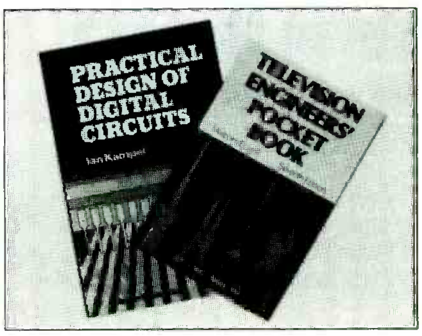

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CIRCLE 16 FOR FURTHER DETAILS.

GOTO Sweden

The new computer for Swedish schools described in these pages last month must have whetted quite a few appetities (ours included), pointing the way as it undoubtedly does towards the next-generation educational computer over here.

The fetchingly-named Compis is a 16-bit job with 128K of memory plus a separate graphics processor giving a 1280 by 800 pixel display, with word-processing and communications facilities thrown in, all for a price of around £1,000. Set beside that, the BBC Micro, for all its qualities, begins to look a little old fashioned.

One interesting feature of the new machine is the decision by its makers to adopt a version of Comal-80 as the standard language in preference to Basic. Comal is an interpreting language which provides a bridge between Basic and the highly structured compiling language Pascal.

Basic has long been the subject of criticism by programming purists on the ground that it puts no premium on tidy thought. And a quick glance at the contributions from readers in some of the home computing magazines provides a good deal of support for that argument: everywhere you see listings festooned with Goto statements and peppered with peeks and pokes. Short of laboriously tracing each program through line by line, it's impossible to discover what is going on.

With one or two honourable exceptions, the Basic on most home computers is indeed pretty awful. And it seems to be the untidiest features of the language that the average schoolboy learns first. Walk into your local computer store, and like as not you'll find a group of 12-year-olds working on a program which says

```
10 PRINT "KEVIN IS A WALLY"

20 GOTO 10
```

Only one home computer has been offered in Britain with a standard language other than Basic: the late lamented Jupiter Ace, which came with Forth.

In its several versions, Forth is probably the next most popular language after Basic. But how useful is it to the average keyboard hacker? It's fine for what it's good at — real-time hardware control and whatnot — but as a general-purpose medium for duties such as drawing pictures and processing text strings, it's nothing like as convenient as Basic.

So now that computer studies have taken the place of the classics as a discipline for the brain, it will be interesting to see what benefits Scandinavia obtains from switching to Comal. For when the eventual replacement for the BBC Micro comes along, perhaps we shall want to do the same.

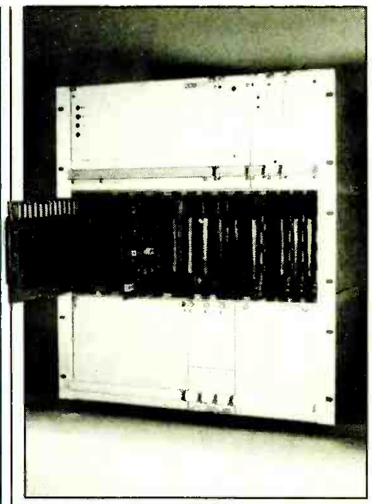
Robots in the lab

Those interested in using small robots in laboratories are invited to join the Laboratory Robotics Club. The Club has been formed by representatives from the Laboratory of the Government Chemist and from other industrial and academic laboratories.

At the Laboratory of the Government Chemist, the Automation and Instrument Development Group is developing an automated work station based on a small robot arm. This will be capable of such operations as weighing, homogenizing, dispensing and transfer of liquids, centrifuging, filtering, stirring and heating.

The laboratory has commissioned the construction of a prototype arm designed specifically for use in such activities. The club will provide: dissemination of information via newsletter, meetings and a technical information service; access to consultancy services; opportunities to collaborate in research and development projects; and sponsorship of the development and manufacture of specialized instrumentation. Further Details from D.G. Porter, Laboratory of the Government Chemist, Cornwall House, Stamford Street, London SE1 9NQ.

BBC design



A digital PAL decoder designed by the BBC was one of a number of new developments shown at a series of open days staged recently by the Corporation's designs department.

Unlike a conventional colour tv decoder, which uses bandpass and notch filters to separate the colour information from the luminance signal, the digital decoder uses comb filtering. By making use of the spectral separation between the brightness information and the colour sidebands, comb filtering makes it possible to retain high frequencies which would otherwise have to be thrown away to prevent unacceptable patterning. The result is a sharp picture almost free of the usual twinkling dots on colour boundaries.

Good quality PAL encoding and decoding is of importance in broadcasting, for until the day when the 'islands' of digital processing within the broadcasting chain finally coalesce into an all-digital whole, a signal may have to be decoded and recorded many times before it reaches the public. And any defects in the process will be compounded.

The new unit uses 8-bit conversion, with 12-bit internal processing to avoid rounding errors. The comb filter which separates chrominance from luminance operates in both the horizontal (line-by-line) and temporal dimensions. The results are very impressive, even on very demanding test signals such as the 'zone plate' pattern of concentric rings and the BBC's new SLUG test signal. SLUG, which stands for saturation and line-up generator (and this equipment was on display too), produces a lurid multi-coloured chequerboard designed to reveal maladjustments of phase and saturation in colour monitors.

BBC engineers pointed out that the digital decoding process adopted in their new decoder is not the same as that used in the new digital television sets from ITT: in those, decoding is by the conventional method, although in the digital domain.

Also in the television field was a range of new u.h.f. receivers. BBC engineers have found that most commercially produced receivers perform little better than domestic television sets. For one thing, they adopt (for reasons of cost) the intercarrier sound technique, which necessitates sacrifice of the higher vision frequencies to avoid sound-on vision interference.

The BBC's own receivers are necessarily much more complex. At the top of the range is a synthesized receiver designed to provide a programme feed for television relay stations. This features an interdigital filter tuned to the wanted channel at its front end, an image-cancelling mixer, an exalted-carrier detector and some specially manufactured surface acoustic wave filters to ensure a good amplitude and group-delay response. In the mixer, the signal is fed in quadrature to a pair of schottky diode ring mixers, the output of which is combined so as to cancel the unwanted image. Provision has been made for a digital stereo sound output.

For less demanding applications another u.h.f. receiver is available: this comes in synthesized or voltage tuned versions with local or remote tuning and it too features a low-distortion demodulator and special s.a.w.fs.

The BBC has for some years been using a digital sound-in-syncs technique for distributing tv sound: besides saving the cost of separate music lines this ensures that the sound cannot get lost in transit. But now the technique has been taken a step further to provide stereo sound. The system uses a sampling rate of approximately 32kHz (twice line frequency) with 14

s on show

bits per sample. The data stream is transmitted during the line sync. pulse and burst of four-level pulses. Before transmission to the public this signal would, of course, be stripped off.

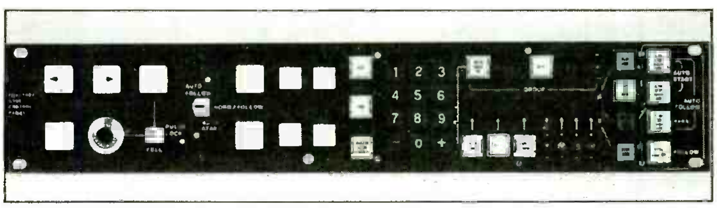
One development aimed at making life easier for television production staff is a new time-code converter. To help in identifying edit points, an 80-bit time signal is distributed around the studios and is recorded by the v.t.r. on an audio track. But when the producer goes way with a cassette of the day's takes, this signal is usually left behind, since most domestic v.c.rs have only one sound channel. The new equipment inserts the time code into the vision signal on a suitable line in the vertical interval. The data can then later be extracted and displayed, even at slow-motion or in stop-frame. Having chosen his edit points off-line, the user can store the codes on a floppy disc from which they can be recovered back at the studio.

maintenace staff have a small telemetry receiver fitted with a dot-matrix text display.

The same system is being used for safety monitoring of men working alone on isolated sites. The engineer has to push a button every so-often — and if he forgets, the rescue team is dispatched!

With the introduction of 24-hour broadcasting on Radio 2 it has become more difficult for the engineers to ensure good transmission quality, since there is now no time at which they can test the equipment. However, they believe they have now obtained a tacit agreement from the programme controllers for an occasional half-minute of engineering tests. These would no doubt have to be carried out during the small hours of the morning, since there is as yet no way of disguising a frequency sweep as programme material.

But Designs Department have now constructed some equipment for making short tests of this sort, based (like several other items on display) on a BBC Microcomputer. This low-cost system scans the network for a signal to start the test, which consists of a



BBC Television and the domestic radio services now have a very large number of transmitting stations dotted about the country, and the great majority of these now are unattended. Maintenance of the networks is carried out by a small number of crews operating from regional centres; and these crews need immediate warning of any mishaps at the transmiitter sites.

Such warnings are sent by automatic reporting equipment which dials up the local monitoring centre and sends a code number corresponding to the fault. To alert the crews, this information can now be broadcast as a data signal on one of the v.h.f. radio networks. The code number is converted into Ascii text and sent as a low-rate d.p.s.k. signal on a 76kHz subcarrier. For a read-out device,

frequency run and a 15s period of silence for noise measurements. Afterwards it displays the results.

For distributing radio programs a new radio link operating in the 1487-1492MHz band was shown. The BBC has been allocated four of the ten 500kHz channels in this band and is using the 'tamed f.m.' technique developed by Philips to squeeze in a 676kbit/s digital stereo signal. This system, like one or two other exhibits, has now been licensed to a commercial manufacturer.

Developments in studio equipment, both in radio and television, have been proceeding rapidly with the growth of digital processing and the evolution of new EBU interfacing standards. But analogue equipment, which still comprises the bulk of the broadcasting chain, has not been forgotten.

Acorn means business

Acorn Computer, manufacturers of the BBC and Electron micros are about to launch a series of business computers. There will be eight models in the series. At the lower end is a word-and-data processor with a specification similar to that of a BBC micro with the View and Viewsheet programs and a built-in disc drive, capacity 640Kbyte. The 'flagship' of the series will be the ABC 300. Software compatible with the IBM PC, It offers a desk-top manager with icons. For those unfamilar with the terminology, the screen is arranged like the surface of desk so that in order to write a memo, instead of reaching for a memo pad, you point an arrow on the screen to the picture (or icon) of a memo pad. The program then invites you to write, i.e. type the memo. The model 300 uses the Intel 80286 16-bit processor, and the Digital Research Concurrent operating system supports applications written for PC DOS, MS DOS and CP/M 86, ensuring that there will be a wide range of software already available. The system can also perform several tasks at the same time and is suitable for the development of integrated, multi-function software packages. The computer has twin floppy drives and a monochrome monitor, while model 310 adds a 10MByte hard disc and colour. All the ABC models can be networked through the Econet system and can have built-in modems. Prices are yet to be announced.

Voices in the computer

Electronic mail is all very well but each user needs to have a computer to operate it. Now BT Merlin have come up with a system very similar to electronic mail but using digitized recorded speech. It can be used from any remote telephone, almost anywhere in the world. Messages can be made available to all who contact the base station or may be given passwords so that only those for whom they are intended can receive them. Messages can also be coded so that they are not made available before a specified time. So it is possible for a sales director, for example, to record a message which will be delivered to selected sales staff at 10a.m. next Tuesday. The p.c.m. digitized speech is recorded onto a Winchester disc which has sufficient capacity for a large number of messages and further disc drives can be added to increase the capacity. Our impression was that the messages were perfectly clear and much better than any synthetic speech which we suppose could be an alternative. One minor problem is that the system requires a dedicated minicomputer and this makes the system quite expensive, though claimed by Merlin to be very 'cost-effective'. The entire package is devised and manufactured by Ferranti.

Space station Columbus

Discussions are currently taking place for the possible extension of the European Spacelab project into some form of orbiting space station. One project, called Columbus, was originally proposed by Germany and Italy. A preparatory programme has been initiated by the European Space Agency. Columbus is being thought of as three modules: a manned pressurized module which would provide a working environment for scientists; a payload carrier or space platform to act as a base for unmanned experiments; and a resource module which would provide power and propulsion for the whole system. Details and even which ESA member states will participate have yet to be settled.

Meanwhile the American at NASA are forging ahead with similar plans but on a very grand scale. The same three-part system is envisaged but with possibly several manned modules and unmanned platforms. Assembled in spce, the Nasa space station could expand to accommodate a crew of 18 by the year 2010. NASA is also investigating the part that robotics could play in the running of the station. The platforms would be re-useable carriers for experiments, sensors etc. NASA has invited participation from other space agencies including ESA and it is possible that Columbus could be developed as a European contribution to the NASA station. Other possibilities for collaboration are also being looked at. The potential practical use for such space stations falls into four categories: those which take advantage of the microgravity and vacuum environment for experimental or commercial purposes; the use of the station as a permanent statellite; the testing of technologies for later use in space; and the servicing of satellites. Microgravity research has already indicated that it is possible to produce highly pure pharmaceutical chemicals by electrophoresis. Metallurgy and electronics are though to be other areas where high-value products could benefit from processing in space.

RFI and computers

The British Standard Institution have published a new standard, BS 6527 covering a *Specification for limits and measurements of spurious signals generated by data processing and electronic office equipment*. Such equipment can cause interference bourne through the mains cables or direct radiation causing interference to radio reception.

The new standard is the first to specify limits for the levels of these spurious signals in order to reduce to an acceptable level the probability of the incidence of radio interference from sources in both domestic and commercial areas. Measurement of limits is at mains terminals in the frequency range 150kHz to 30MHz and of field strength from 30 to 1000MHz.

The limits and methods of measuring them are based on work currently in progress within the International Committee on Radio Interference (CISPR).

This Standard will help to overcome the anomoly of British computer manufacturer making equipment without any protection suitable for the domestic market and then having to substantially alter the designs in order to comply with the standards in other countries, for example the FCC regulations in the United States. At present there is no agreed international standard specifying the limits of permitted r.f. interference caused by computer in either the domestic or commercial area, but as such equipment becomes more widespread, the standard will meet a current and increasing need.

Copies are available from the BSI Sales Department, Linford Wood, Milton Keynes MK14 6LE, price £10.20.

TV news from anywhere

No sooner had we got used to the idea of e.n.g. (electronic news gathering), then GEC-McMichael come up with another idea, s.n.g. or satellite news gathering. This consists of a small, portable satellite earth terminal which may be flown in a light aircraft to anywhere in the world and transmit news back via any handy communicationd satellite which can receive the up-link frequency of 14 to 14.5 GHz. The s.n.g. terminal can also receive narrow-band signals for audio and so can be given instructions by the home broadcasting station. The whole system is powered by a 12V battery or local mains, if available.

The compactness of the system has been achieved by the design of an elliptical antenna which combines small size with high efficiency and a radiation pattern meeting the 2-degree satellite-spacing requirement. The dish measures one metre high by two metres wide with an offset feed, all held in a universal frame enabling the dish to be aimed at the satellite. The transmitted 14GHz signal is boosted by a fet amplifier to 4.8W, carried to conical horn feed of the antenna by a wave-guide. Another contribution to the small size of the unit is the use of a coder similar to those used in teleconferencing which only transmits the changing information in a tv picture and thus allows a much narrower bandwidth. This can give a blurred image to any fast-moving part of the picture but it is though that this is acceptable in situations where the events would normally be inaccessible.

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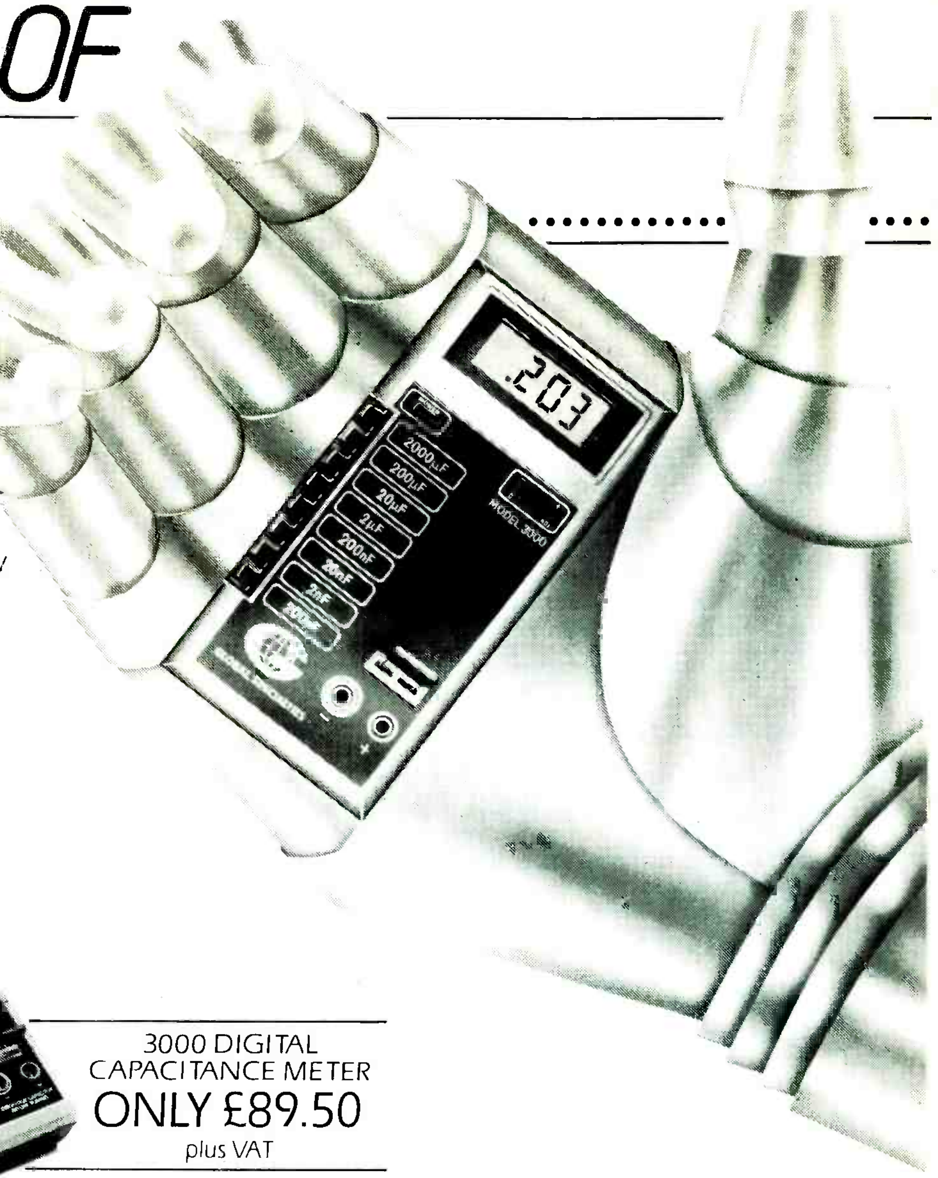

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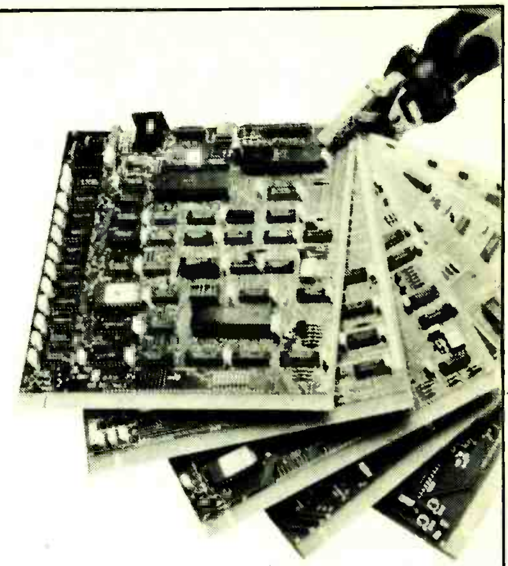

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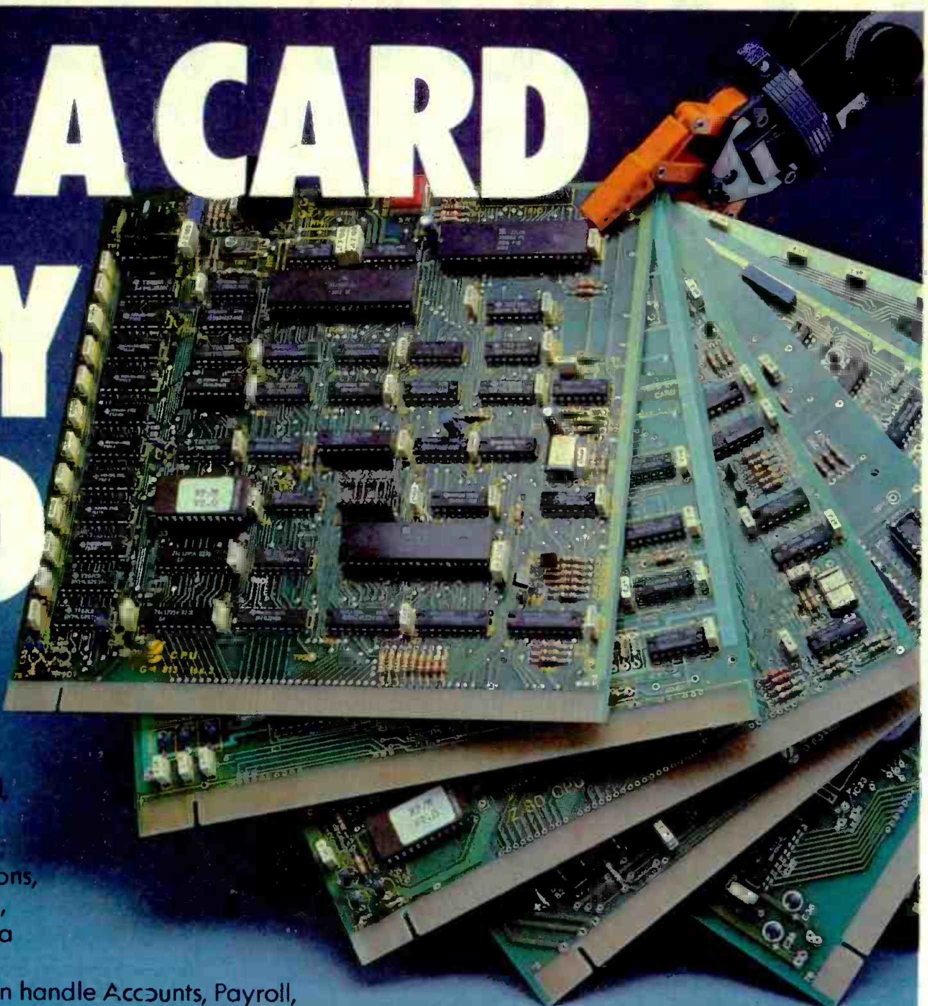

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BC148	0.12
BC149	0.13
BC157	0.13
BC158	0.13
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BC167	0.11
BC170	0.11
BC171	0.11
BC172	0.11

BC173	0.11
BC177	0.28
BC178	0.28
BC179	0.28
BC182	0.11
BC183	0.11
BC184	0.11
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BC213	0.11
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BC338	0.12
BCY30	1.25
BCY31	1.50
BCY32	1.50
BCY33	1.10
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BCY39	3.40
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BD238	0.54
BDX10	0.91
BDX32	2.00
BDY20	1.50
BDY60	2.75
BF115	0.35
BF152	0.16
BF153	0.16
BF154	0.17
BF159	0.17
BF160	0.17
BF167	0.24
BF173	0.30
BF177	0.35
BF178	0.35
BF179	0.35
BF180	0.28
BF181	0.28
BF182	0.30
BF183	0.28
BF184	0.28
BF185	0.30
BF194	0.14
BF195	0.12
BF196	0.13
BF197	0.14
BF200	0.40
BF224	0.25
BF244	35p

BF257	0.27
BF258	0.27
BF259	0.28
BF336	0.34
BF337	0.33
BF338	0.36
BFS21	4.00
BFS28	2.25
BFS61	0.20
BFS98	0.20
BFW10	0.97
BFW11	0.96
BFX84	0.30
BFX85	0.30
BFX87	0.30
BFX88	0.30
BFY50	0.25
BFY51	0.25
BFY52	0.25
BFY64	0.30
BFY90	0.95
BSX19	0.27
BSX20	0.27
BSX21	0.29
BT106	1.20
BTY79/400R	2.00
BU205	1.30
BU206	1.50
BU208	2.00
BY100	0.40
BY126	0.13
BY127	0.14
BZX61 Series	0.17
BZY88 Series	0.10
CRS1/40	0.60
CRS3/40	0.75
CRS3/60	0.90
GEX66	3.00

GEX541	5.00
GJ3M	1.50
GM0378A	1.75
KS100A	0.45
MJE340	0.60
MJE370	0.73
MJE371	0.71
MJE520	0.47
MJE521	0.73
MJE2955	1.30
MJE3055	1.10
MPF102	0.35
MPF103	0.35
MPF104	0.35
MPF105	0.35
MPSA06	0.26
MPSA56	0.28
MPSU01	0.53
MPSU06	0.65
MPSU56	0.69
NE555	0.45
NKT401	3.50
NKT403	2.50
NKT404	2.20
OA5	1.20
OA7	0.60
OA10	0.55
OA47	0.12
OA70	0.25
OA79	0.12
OA81	0.17
OA85	0.17
OA90	0.08
OA91	0.08
OA95	0.08
OA200	0.15
OA202	0.15
OA211	1.50
OAZ200	1.50
OAZ201	1.50
OAZ206	1.50

OAZ207	1.50
OC16	2.50
OC20	2.50
OC22	2.50
OC23	4.00
OC24	3.00
OC25	1.00
OC26	1.50
OC28	2.00
OC29	2.00
OC35	1.50
OC36	1.50
OC41	0.90
OC42	0.90
OC43	1.50
OC44	0.85
OC45	0.65
OC71	0.55
OC72	1.00
OC73	1.00
OC74	0.70
OC75	0.65
OC76	1.00
OC77	1.00
OC81	0.65
OC81Z	1.20
OC82	0.90
OC83	1.00
OC84	0.80
OC122	2.75
OC123	2.00
OC139	3.00
OC140	4.00
OC141	4.25
OC170	4.50
OC171	4.50
OC200	1.50
OC201	2.50
OC202	2.75
OC203	3.00
OC204	3.00

OC205	2.75
OC206	2.75
OC207	2.50
OCP71	2.00
ORP12	1.00
R2008B	2.00
R2009	2.25
R2010B	2.00
TIC44	0.27
TIC226D	1.20
TIL209	0.16
TIP29A	0.43
TIP30A	0.45
TIP31A	0.33
TIP32A	0.36
TIP33A	0.54
TIP34A	0.67
TIP41A	0.44
TIP42A	0.42
TIP2955	0.70
TIP3055	0.56
TIS43	0.43
ZS140	0.25
ZS170	0.21
ZS178	0.54
ZS271	0.23
ZS278	0.57
ZTX107	0.12
ZTX108	0.12
ZTX109	0.12
ZTX300	0.13
ZTX301	0.14
ZTX302	0.18
ZTX303	0.18
ZTX304	0.20
ZTX311	0.13
ZTX314	0.25
ZTX500	0.14
ZTX501	0.14
ZTX502	0.18
ZTX503	0.19

ZTX504	0.21
ZTX531	0.24
ZTX550	0.25
1N914	0.05
1N916	0.09
1N4001	0.06
1N4002	0.06
1N4003	0.06
1N4004	0.07
1N4005	0.09
1N4006	0.11
1N4007	0.12
1N4009	0.07
1N4148	0.04
1N5400	0.13
1N5401	0.13
1S44	0.04
1S920	0.08
1S921	0.09
2G301	1.00
2G302	1.00
2G306	1.00
2N404	1.30
2N696	0.32
2N697	0.32
2N698	0.32
2N705	1.25
2N706	0.25
2N708	0.25
2N930	0.25
2N1131	0.30
2N1132	0.30
2N1302	1.20
2N1303	0.80
2N1304	1.20
2N1305	1.00
2N1306	1.50
2N1307	1.10
2N1308	1.75
2N1309	1.20
2N1613	0.32

2N1671	5.00
2N1893	0.32
2N2147	4.00
2N2148	3.75
2N2218	0.32
2N2219	0.32
2N2220	0.20
2N2221	0.20
2N2222	0.20
2N2223	4.25
2N2368	0.25
2N2369A	0.25
2N2484	0.25
2N2646	0.50
2N2904	0.32
2N2905	0.32
2N2906	0.21
2N2907	0.21
2N2924	0.26
2N2925	0.22
2N2926	0.15
2N3053	0.26
2N3054	0.55
2N3055	0.65
2N3440	0.70
2N3441	0.85
2N3442	1.25
2N3614	2.20
2N3702	0.11
2N3703	0.11
2N3704	0.11
2N3705	0.11
2N3706	0.11
2N3707	0.11
2N3708	0.10
2N3709	0.11
2N3710	0.10
2N3711	0.10
2N3771	1.40
2N3772	1.60
2N3773	1.80

2N3819	0.30
2N3820	0.39
2N3823	0.60
2N3866	1.00
2N3904	0.17
2N3905	0.17
2N3906	0.17
2N4058	0.20
2N4059	0.20
2N4060	0.16
2N4061	0.16
2N4062	0.16
2N4124	0.16
2N4126	0.16
2N4286	0.15
2N4288	0.18
2N4289	0.18
2N4400	0.11
2N4401	0.11
2N4402	0.11
2N5457	0.32
2N5458	0.32
2N5459	0.32
2S017	10.00
2S019	12.00
2S026	25.00
2S103	1.50
2S302	3.50
2S303	1.50
2S322	3.50
2S324	3.50
2S701	3.50
2S745A	0.95
2S746A	0.95

CV Devices
Large stocks
Prices on application

VALVES

A1834	9.00
A2087	13.50
A2134	17.50
A2293	16.00
A2426	27.50
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	151.00
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	45.00
E80CC	8.81
E80CF	11.27
E80F	14.19
E80L	13.73
E81CC	8.00
E81L	13.27
E810F	35.48
E82CC	8.10
E83CC	8.40
E86C	8.25
E88C	8.25
E88CC	8.42
E90CC	9.47
E90F	9.90
E91H	6.25
E92CC	8.75
E99F	9.10

E130L	18.50
E180CC	10.50
E180F	10.20
E182CC	13.25
E186F	11.50
E188CC	8.91
E280F	22.51
E283CC	12.00
E288CC	17.50
EA52	125.00
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	410.00
ECC33	4.50
ECC35	4.50
ECC40	4.50
ECC81	1.75
ECC82	1.75
ECC83	1.75
ECC84	1.75
ECC85	1.75
ECC86	2.50
ECC88	2.10
ECC89	2.00
ECC91	8.93
ECC189	2.10
ECC807	1.75
ECC808	3.00
ECF80	1.55
ECF82	1.50
ECF86	2.50
ECH35	3.00
ECH42	3.50
ECH81	3.00
ECH83	2.50
ECH84	2.50
ECL80	1.50
ECL81	1.75
ECL82	1.50
ECL83	3.00
ECL84	1.50
ECL85	1.50
ECL86	1.75
EF37A	5.00
EF39	2.75
EF40	5.00
EF41	3.50
EF42	4.50
EF50	2.50
EF54	5.00
EF55	3.50
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
EL34MUI	4.00
EL36	2.50
EL41	2.80
EL42	2.50
EL81	5.25
EL83	6.00
EL84	2.25
EL86	2.75
EL90	2.25
EL91	9.69
EL95	2.00
EL156	30.00
EL360	8.50
EL500/504	3.00
EL509	7.00
EL821	13.00
EL822	13.97
EM34	5.00
EM80	2.50
EM81	2.50
EM84	2.00
EM85	2.75
EM87	2.50
EN32	17.46
EN91	6.50
EN92	6.96
EY51	2.75
EY81	2.50
EY83	2.50
EY84	9.24
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	2.00
FW4-500	3.50
FW4-800	3.50
G1.371K	35.00
G551K	12.00
G180.2M	17.50
G240.2D	12.00
G400.1K	17.50
GN4	9.00
GN4A	9.00
GS16	16.00
GT1C	15.00
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	3.00
GZ37	4.75
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	8.58
M8091	10.43
M8096	6.80
M8097	8.10
M8098	8.15
M8099	8.00
M8100	9.52
M8136	10.23
M8137	10.23
M8140	6.00
M8141	6.50
M8142	8.75
M8144	7.50
M8149	6.50
M8161	9.35
M8162	10.40
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
MD2901	115.00
MU14	2.50
MX119	55.00
MX123	72.00
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
PCL84	2.00
PCL85	2.50
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	2.50
PL509	6.00
PL519	6.00
PL801	1.50
PL802	6.00
PY33	2.50
PY81	1.50
PY82	1.50
PY83	2.50
PY88	2.00
PY500A	4.00
PY800	1.50
PY801	1.50
QF451	82.50
QQV02-6	31.80
QQV03-10	23.50
QQV03-20A	48.38
QQV06-40A	75.00
QQV07-50	69.74
QQZ06-40A	75.00
QU37	12.50
QV03-12	6.80
QV04-7	3.50
QV08-100	171.20

QY3-65	63.24
QY3-125	68.64
QY4-250	70.14
QY4-400	76.20
QY5-500	190.00
QY5-3000A	450.00
QZ06-20	32.70
R10	6.00
R17	3.00
R18	3.00
R19	9.24
R20	2.50
RG3-250	32.68
RG3-250A	32.68
RG3-1250	59.50
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
TT15	50.00
TT21	30.00
TT22	37.50
TT100	60.00
TY2-125	65.00
TY4-400	80.00
TY4-500	105.00
TY5-500	214.00
TY6-800	210.00
TY6-5000A	490.00
TY6-5000B	395.00
TY6-5000W	425.00
TY7-6000A	525.00
TY7-6000W	525.00
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
UCF80	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	55.00
XG2-6400	141.90
XG5-500	26.60
XG2-6400	162.00
XR1-1600A	53.75
XR1-3200	81.97
XR1-3200A	
XR1-6400	165.00
YD1120	395.00
YD1240	490.00
Z759	25.00
ZM1000	8.00
ZM1001	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	175.00
2J70A	383.00
2J70B	336.00
2K25	125.00
3-400Z	85.00
3-500Z	85.00
3A5	3.00
3B24	11.00
3B28	15.35
3B29	20.05
3B240M	17.50
3B241M	17.50
3C23	25.00
3C45	24.50
3CX100A5	47.00
3E29	45.00
3S4	2.00
3V4	1.75
465A	60.00
4-125A	60.00

4-250A	80.00
4-400A	87.00
4B32	20.00
4C35	78.00
4CX250B	45.00
4CX350A	80.00
4X150A	60.00
4X150D	56.00
5B254M	35.00
5B255M	35.00
5C22	160.00
5J180E	1650.00
5R4GY	3.50
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	2.25
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
6EB8	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
6K4N	2.50
6K6GT	2.75
6K7	3.00
6K8	3.00
6KD6	7.00
6L6G	3.00
6L6GA	3.00
6L6GC	3.50
6L6GT	3.00
6L7	2.50
6N2P	2.50
6N3P	2.50
6N7	3.00
6P25	4.00
6Q7	3.75
6R7	3.25
6SA7	3.00
6SC7	2.75
6SF7	2.50
6SH7	3.00
6SJ7	3.25
6SK7	3.50
6SK7GT	3.00
6SN7GT	3.00
6SQ7	3.40
6SR7	4.00
6SS7	2.75
6U5G	3.50
6U8A	2.25
6V6GT	2.25
6X4	2.00
6X5GT	1.75
7B7	2.50
7C5	4.00
7C6	2.50
7H7	4.00
7R7	4.25
7S7	3.50
7Y4	2.25
7Z4	2.00
11E3	55.00
12AH8	5.00
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30C18	2.00
30F5	1.60
30FL1/2	1.38
30FL12	1.80
30FL14	2.00
30L1	1.50
30L15	2.00
30L17	2.00
30P4	2.50
30P19	2.50
30PL1	3.00
30PL14	1.80
30PL15	1.80
35W4	1.00
50C5	1.50
75B1	6.05
75C1	4.50
85A1	7.50
85A2	6.45
90AG	12.96
90AV	12.96
90C1	6.00
90CG	14.54
90CV	15.45
92AG	20.00
92AV	20.00
95A1	8.45
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5879	5.00
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5965	3.50
6005	2.25
6021	4.50
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6059	6.00
6061	6.00
6063	3.75
6064	8.58
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7416	0.32
7417	0.32
7420	0.18
7422	0.20

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

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

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

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

74175	1.02
74176	1.16
74178	1.36
74179	1.36
74180	1.20
74190	1.90
74191	1.90
74192	1.90
74193	1.90
74194	1.25
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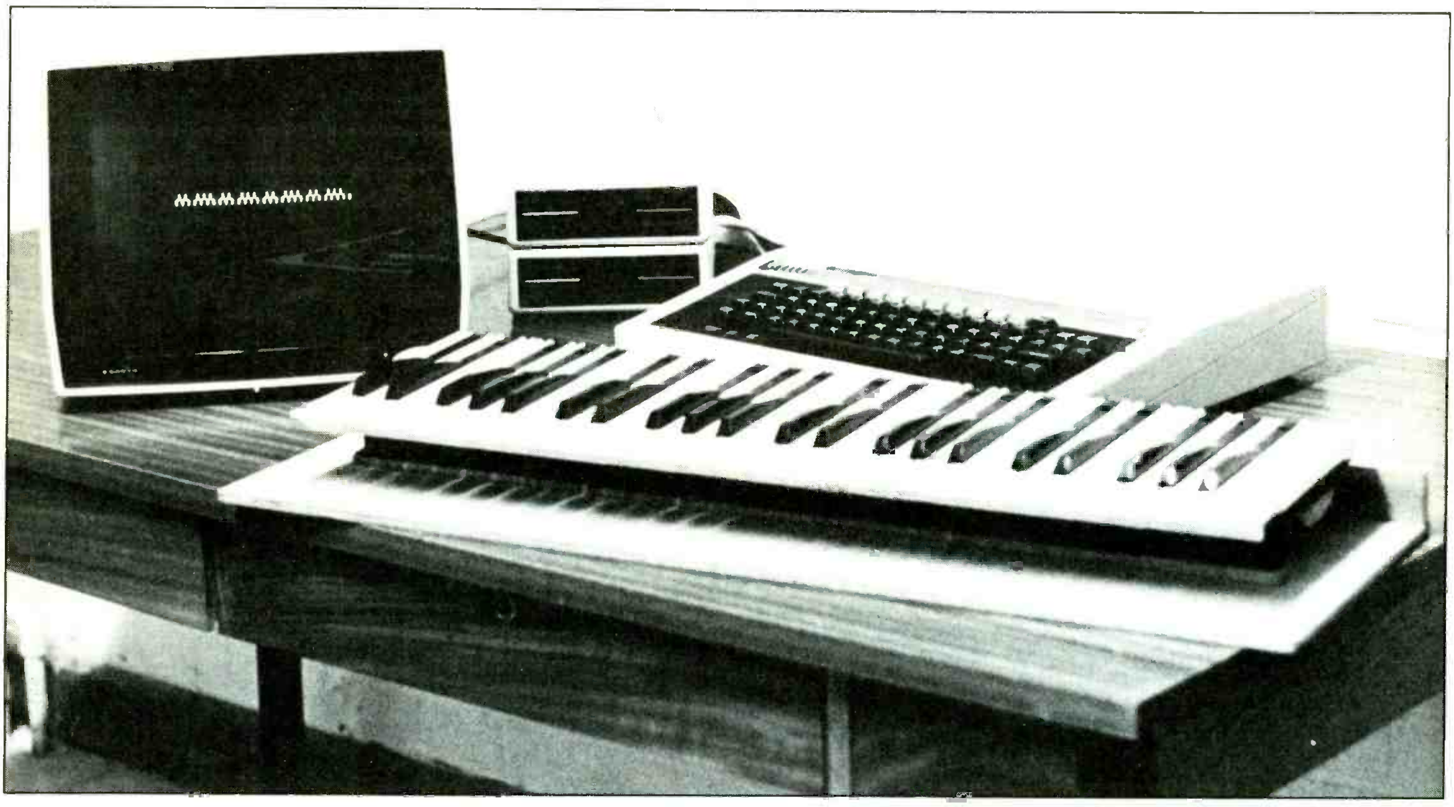

Music keys for the BBC microcomputer

by R.M. Adelson

Two programs — one for playing music using the BBC computer sound generator — supplement this discussion of software for the economical polyphonic keyboard interface. Hardware was presented in the July issue.

As described in the July issue, the keyboard communicates with the computer by sending an interrupt through the handshake line CB_1 on the user port. This initiates a routine which reads the keyboard in bit-mapped form into eight memory locations, in accordance with the flow diagram given previously. Details are given in List 1. This is a keyboard-read utility which can be used on its own to check functioning of the keyboard hardware, or as part of a more elaborate program (e.g. List 2) designed to exploit the interface more fully.

The main part of List 1 is written in assembly language which is both the natural way to deal with interrupts and is efficient in memory usage and speed. The default setting of HIMEM in MODE 7 is 7C00 (hexadecimal). Line 440 sets aside 256 bytes for the assembled code. The interrupt routine is in two sections, the first (lines 520 to 750) being assembled at HIMEM, the second (lines 760 to 1060) at HIMEM+30. A short initialising procedure which configures the versatile interface adaptor, v.i.a., and tells the computer where to find the interrupt-servicing routine is assembled at HIMEM+70. The variable FLAG1 (line 470) is used as a message to the display routine (lines 1270 to 1320) that an interrupt has been received and serviced and that there is therefore something new to display. Data read in from the keyboard is stored in eight bytes starting at M% (line 450). These eight bytes are initially set to zero by lines 480 to 500. By referring all these variables to HIMEM, the assembled code is easily relocated should, for example, the user wish to use a different MODE (illustrated in List 2).

I assume that the reader has some familiarity with the BBC assembler and the IRQ vector system. The subroutine SETUP (lines 1070 to 1210) which is

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called at line 1250, sets the registers of the 6522 v.i.a. (B) (which is memory-mapped from FE60 to FE6F) as follows

-data-direction register B (FE62) all inputs
-auxiliary-control register (FE6B) to give single-shot interrupts from timer 1
-peripheral-control register (FE6C) to give interrupts on positive-going edges of CB_1 and set CB_2 high
-the interrupt-flag register (FE6D) cleared
-interrupt-enable register (FE6E) has CB_1 and timer 1 interrupts enabled.

This routine also stores the location (HIMEM) of the user interrupt service vector (IRQ2V) in locations 206/7 (note that the coding assumes that the low byte of HIMEM is 00).

On receipt of an interrupt request on CB_1, the code at HIMEM is entered (line 520). This stores the 6502 A, X and Y registers on the stack and disrupts further interrupts on CB_1 (lines 590 — 600). Timer 1 coun-

List 1. **Basic with assembly-language program for the BBC microcomputer music keyboard interface stores key information in bit-mapped form in eight bytes at HIMEM.**

List 2. **This program for the BBC microcomputer uses key information from List 1 to play the computer's internal sound generator and display a map of the keyboard status.**

List 1

```
430 MODE7
440 HIMEM=&7B00
450 M%=HIMEM+&98
460 SETUP=HIMEM+&70
470 FLAG1=HIMEM+&6A:?FLAG1=1
480 FOR I%=0 TO 4 STEP 4
490   M%!I%=0
500   NEXT
510 FOR I%=0 TO 2 STEP 2
520   P%=HIMEM
530   [OPT I%
540   PHA
550   TXA
560   PHA
570   TYA
580   PHA
590   LDA #&10
600   STA &FE6E
610   LDA #&20
620   STA &FE64
630   LDA #&4E
640   STA &FE65
650   LDA #&30
660   STA &206
670   LDA #&10
680   STA &FE6D
690   PLA
700   TAY
710   PLA
720   TAX
730   PLA
740   RTI
750   ]
760   P%=HIMEM+&30
770   [OPT I%
780   PHA
790   TXA
800   PHA
810   TYA
820   PHA
830   LDX #0
840   .AGAIN LDA &FE60
850   STA M%,X
860   INX
870   LDA #&D0
880   STA &FE6C
890   LDA #&F0
900   STA &FE6C
910   CPX #8
920   BMI AGAIN
930   LDA #&90
940   STA &FE6E
950   LDA #0
960   STA &206
970   STA FLAG1
980   LDA #&50
990   STA &FE6D
1000  PLA
1010  TAY
1020  PLA
1030  TAX
1040  PLA
1050  RTI
1060  ]
1070  P%=SETUP
1080  [OPT I%
1090  LDA #0
1100  STA &FE62
1110  STA &FE6B
1120  STA &206
1130  LDA #&F0
1140  STA &FE6C
1150  LDA #&7F
1160  STA &FE6D
1170  LDA #&D0
1180  STA &FE6E
1190  LDA #HIMEM DIV256
1200  STA &207
1210  RTS
1220  ]
1230  NEXT I%
1240 @%=2
1250 CALL SETUP
1260 CLS:PRINT:PRINT:PRINT:PRINT
1270 REPEAT:UNTIL?FLAG1=0
1280 FOR I%=0 TO 7
1290   PRINT~M%?I%;" ";
1300   NEXT
1310 ?FLAG1=1:PRINT
1320 GOTO1270
```

List 2

```
100 MODE7
110 *FX9,10
120 *FX10,10
130 INPUT"VOLUME 0-15 (ppp-ff)"V%
140 IF(V%>15ORV%<0)GOTO130
150 MODE5
160 HIMEM=&5500
170 FLAG3=HIMEM+&6C
180 VOL%=HIMEM+&69:COU=HIMEM+&68
190 DISPLAY=HIMEM+&A0
200 TIBLE%=HIMEM+&200:TUBLE%=HIMEM+&280
210 ?VOL%=15-V%
220 VDU23;8202;0;0;0;
230 VDU19,2,8,0,0,0:VDU19,1,0,0,0,0
240 DIMA%(11)
250 FORI%=0TO11:READA%(I%):NEXT
260 DATA&88,&22,&22,&88,&88,&22,&22,&88,&88,&22,
&88,&88,&6C30,&6B08,&6AF0,&6C50,&6C38,&6B10,&6AF8,
&6C58,&6C40,&6B18,&6C48,&6C60
270 A=LN(1760):B=LN(2)/12
280 FORK%=0TO5
290 FORJ%=0TO1
300 READ PAX%
310 FORI%=0TO3:FORPAT%=0TO7
320 PAX%?PAT%=A%(2*K%+J%):NEXT
330 I1%=4*I%+2*J%+16*K%
340 ?(TIBLE%+I1%)=PAX%MOD256:?(TIBLE%+I1%+1)
=PAX% DIV256
350 PAX%=PAX%+&38
360 X=125000/(EXP(A+(K%+6*J%+12*I%-45)*B))
370 I1%=INT(X+.5)
380 TUBLE%?(4*I%+2*J%+16*K%)=I1%MOD16
390 TUBLE%?(4*I%+2*J%+16*K%+1)=I1%DIV16:NEXT,,
400 ?(TIBLE%+&60)=&10:?(TIBLE%+&61)=&6D
410 FOR PAT%=0TO7:?(PAT%+&6D10)=&88:NEXT
420 X=125000/(EXP(A+3*B))
430 I1%=INT(X+.5)
440 TUBLE%?&60=I1%MOD16:TUBLE%?&61=I1%DIV16
445 REM Lines 450 to 1220 inclusive
446 REM are the corresponding lines of List 1
1230 P%=DISPLAY
1240 [ OPTI%
1250 LDA #&15
1260 LDX #7
1270 JSR &FFF4
1280 DEX
1290 JSR &FFF4
1300 DEX
1310 JSR &FFF4
1320 LDA #3
1330 STA FLAG3
1340 LDA #&FF:STA &FE43
1350 LDA #0
1360 STA COU
1370 INC FLAG1
1380 .STI SEI
1390 LDX COU
1400 CPX #6
1410 BEQ LASTA
1420 LDA M%+1,X
1430 LDY #0
1440 .SHIFT ASL A
1450 PHA:STY &70
1460 BCC RST
1470 JSR SET
1480 JMP OVER
1490 .RST JSR RESET
1500 .OVER PLA:LDY &70
1510 INY:INY
1520 CPY #&10
1530 BEQ CLEI
1540 JMP SHIFT
1550 .CLEI CLI
1560 LDA FLAG1
1570 BEQ DISPLAY
1580 INC COU
1590 JMP STI
1600 .LASTA NOP:JMP LAST
1610 .SET TXA
1620 ASLA:ASLA:ASLA:ASLA
1630 CLC
1640 ADC &70
1650 TAX
1660 LDA FLAG3
1670 BEQ FLASHA
1680 JSR PLAY
1690 JMP FLASH
1700 .PLAY CMP #3
1710 BNE CH2
1720 LDA TUBLE%,X
1730 ORA #&80
1740 STA &FE4F
1750 JSR SEND
1760 LDA TUBLE%+1,X
1770 STA &FE4F
1780 JSR SEND
1790 LDA #&90
1800 ORA VOL%
1810 STA &FE4F
1820 JSR SEND
1830 JMP NECH
1840 .CH2 CMP #2
1850 BNE CH1
1860 LDA TUBLE%,X
1870 ORA #&A0
1880 STA &FE4F
1890 JSR SEND
1900 LDA TUBLE%+1,X
1910 STA &FE4F
1920 JSR SEND
1930 LDA #&B0
1940 ORA VOL%
1950 STA &FE4F
1960 JSR SEND
1970 JMP NECH
1980 .CH1 LDA TUBLE%,X
1990 ORA #&C0
2000 STA &FE4F
2010 JSR SEND
2020 LDA TUBLE%+1,X
2030 STA &FE4F
2040 JSR SEND
2050 LDA #&D0
2060 ORA VOL%
2070 STA &FE4F
2080 JSR SEND
2090 .NECH DEC FLAG3
2100 RTS
2110 .FLASHA NOP:JMP FLASH
2120 .SEND LDA #0
2130 STA &FE40
2140 LDY #&A
2150 .ROU DEY
2160 BNE ROU
2170 LDA #8
2180 STA &FE40
2190 RTS
2200 .FLASH LDA TIBLE%,X
2210 STA &71
2220 LDA TIBLE%+1,X
2230 STA &72
2240 LDY #8
2250 .COY DEY
2260 LDA #&F0
2270 AND (&71),Y
2280 STA (&71),Y
2290 TYA
2300 BNE COY
2310 LDX COU
2320 RTS
2330 .RESET TXA
2340 ASLA:ASLA:ASLA:ASLA
2350 CLC
2360 ADC &70
2370 TAX
2380 LDA TIBLE%,X
2390 STA &71
2400 LDA TIBLE%+1,X
2410 STA &72
2420 LDY #8
2430 .COY1 DEY
2440 LDA #&F
2450 ORA (&71),Y
2460 STA (&71),Y
2470 TYA
2480 BNE COY1
2490 LDX COU
2500 RTS
2510 .LAST LDA #&FF
2520 CMP M%+7
2530 BEQ FL
2540 LDA #&88
2550 JMP DOWN
2560 .FL LDA FLAG3
2570 BEQ FLA
2580 LDX #&60
2590 JSR PLAY
2600 .FLA LDA #&80
2610 .DOWN LDY#7
2620 .ROUND STA &6D10,Y
2630 DEY
2640 BPL ROUND
2650 CLI:RTS:]
2660 NEXTI%
2670 CALL SETUP
2680 REPEAT:UNTIL?FLAG1=0
2690 IF?M%<>&FF PRINT"SYNC
ERROR":END
2700 CALL DISPLAY
2710 GOTO 2680
```

ters are then loaded to give a time-out after 20ms (lines 610 to 640). These latter two actions give a 20ms delay for residual switch-bounce to die out and to allow for slight differences in the closing times of switches if more than one note is altered at a time. This amount of delay seems to be about right, but it is easily altered (up to about 65ms without any significant change in the coding) by changing the bytes loaded at lines 610 and 630, noting that 4E20 is the equivalent of 20ms (decimal).

The low byte of IRQ2V is altered to point to HIMEM+30 (lines 650-660) and the CB_1 interrupt flag cleared (lines 670-680) before the A, X and Y registers are restored from the stack and the return-from-interrupt is performed. Thus interrupts are re-enabled during the 20ms delay to allow the computer to go about its housekeeping duties.

When timer 1 times out, code at HIMEM+30 is entered (line 760). Again, the registers are saved, and port B of the v.i.a. is read and stored in the l.s.b. of M%. CB_2 is then brought low (lines 870-880) and high again (lines 890-900) thus clocking IC_{10} in the interface. Lines 840 and 920 are looped eight times in all, the bytes being read into consecutive memory locations by the offset X (lines 850-860). CB_1 interrupts are enabled again (lines 930-940); IRQ2V is restored to its previous value (lines 950-960); FLAG1 is reset to zero as a signal to the display routine that the keyboard has been read again; the interrupt flags are cleared and the interrupt routine terminated. The Basic display routine at lines 1270 to 1320 simply loops in line 1270 until advised by FLAG1 that its attention is required. It then prints the values of the eight-bytes from M% in two-digit (line 1240) hexadecimal fields.

To test the interface, run this program and press the bottom note on the keyboard. This should cause the line

FF 80 00 00 00 FE

to be displayed (bytes 0-7). Byte zero should always be FF as explained in the July issue. If the FF appears elsewhere (or not at all) then the interface is out of synchronization and the reasons for this need to be explored. Circuit IC_{10} not resetting to zero on switch-on is a possibility, as is spurious pick-up of electrical noise. However, since sorting out some teething troubles with the prototype, synchronization problems have been rare. Some suggestions for dealing with any that do arise are given later.

Assuming all is well at this point, releasing the key should produce

FF 00 00 00 00 FE

Pressing the lowest C# should produce

FF 08 00 00 00 FE

and so on. Notice that the lowest six notes (C to F) are taken to bit seven of bytes one to six respectively, the next six notes (F# to B) are taken to bit six of these bytes, etc. This is to avoid a large number of p.c.b. wire crossings. Thus byte one contains the bits for the four F#s interleaved with those of the first four Cs, byte two contains the Gs interleaved with the C#s, etc. Top C (the 49th note) is taken to bit zero of byte seven, so playing top C should produce

FF 00 00 00 FF

Playing several notes at once should, of course, affect all the relevant bits and thus will be reflected in the values of the bytes displayed. The system responds quickly despite the 20ms delay it is easy to obtain multiple readings when playing chords unless one very carefully presses the notes evenly. In practice this is not likely to be of consequence since such spurious responses can be rejected by software if necessary. To terminate this program press ESCAPE.

List 1 is all that is necessary to read data from the keyboard into the computer, which can then be used as desired. As an illustration, the program in List 2 uses the data to play the computer's three-channel sound generator. It also displays a representation of the keyboard on the screen. The

Circuit boards for this project will be available from Lancaster ITEC for around £10. Please send an s.a.e. to the ITEC at St Leonard's House, St Leonardsgate, Lancaster, Lancashire, LA1 1NN for further information.

Computers and Music at Lancaster

The University's Music Department is interested in all aspects of computers as a musician's aid but not so much with synthesizers. Our main current interest is in the potential of the computer as a teaching aid for music theory and aural training, right through from beginners to university/college level. The biggest problem until now has been the lack of a satisfactory means of student feedback to the computer, the typewriter keyboard being unsuitable for this, except at a rudimentary level.

We have now successfully designed two economical accessories which go a long way toward solving the music-input problem — the four-octave music keyboard and a 'rhythm box'. Keyboard software packages for the BBC microcomputer currently under development include

o Keyboard familiarity, in which the computer displays a note on the stave and the pupil has to identify the note on the keyboard.

o Major and minor thirds, in which the computer plays a major or minor third at random and displays the lower note on the stave. The pupil has to identify major or minor and play the pair of notes on the keyboard after which the computer displays its version. A score of successes is kept.

o Interval recognition plays and displays a random note from anywhere on the keyboard then selects and plays another random note from the same octave but doesn't display it. The pupil has to recognize the interval and play the second note. Again a score is kept.

o Triad recognition plays a tonic triad in close position (any key, root position or an inversion). The computer displays the key name but not whether it is major or minor and the pupil has to play the correct chord on the keyboard. Both the computer's and the pupil's versions are then displayed.

Further teaching software envisaged includes recognition of cadences, musical dictation and transposition.

We also have software for playing musical phrases into the computer through the keyboard and replaying them at different speeds. These phrases can be stored on disc or tape which offers the possibility for pupils learning, say, the violin to have an accompaniment which is gradually speeded up as the pupil's proficiency increases.

The 'rhythm box' allows rhythm information to be accurately fed into the computer by tapping on the box with a pencil. Its main purpose is to use the computer to give feedback on the type of rhythm exercises normally carried out by hand clapping. It also has some interesting recreational (and perhaps compositional) possibilities. For example, a tune can be played into the computer through the keyboard and its rhythm altered by tapping out a new rhythm on the box.

Our next hardware project is to enhance the computer's sound capability. Direct musical input to the computer from voice or musical instrument is also a possibility. In the more distant future we envisage small computers being used for music transcription, editing, printing, etc. The centre has expertise in music, computing, engineering and other disciplines and is well placed to make real contributions in this field.

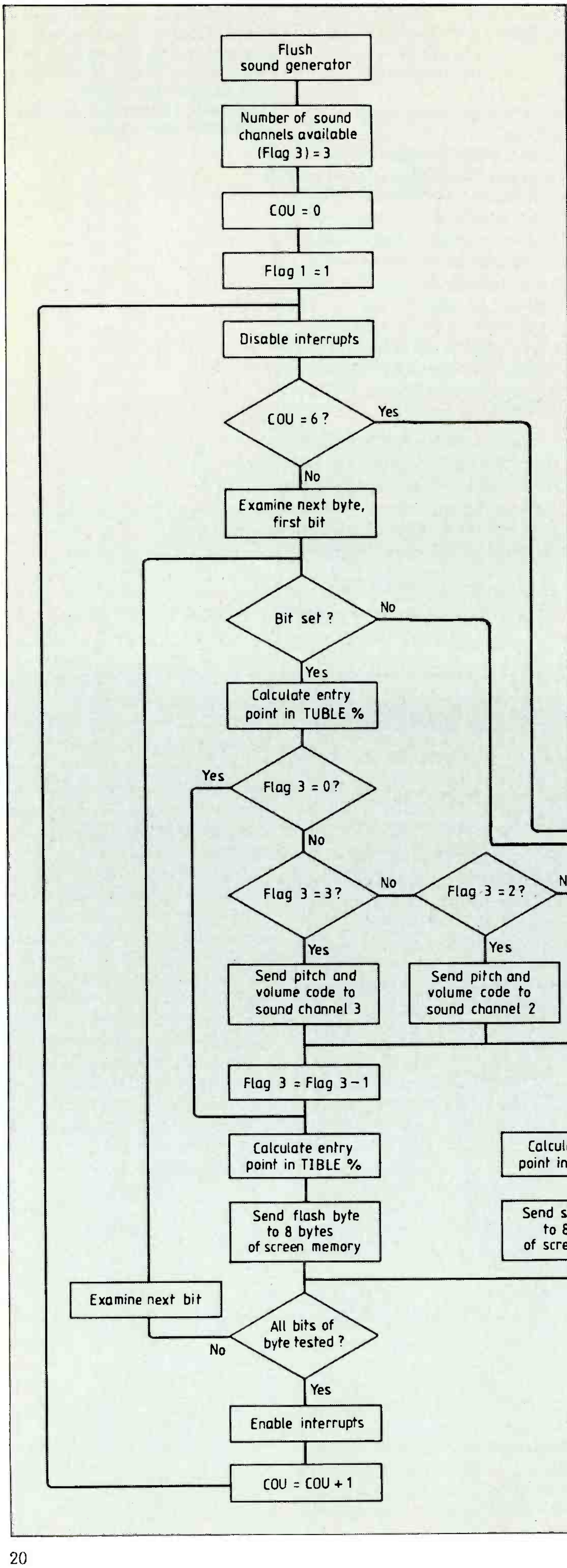
representations of those keys that are pressed change colour if a colour monitor is in use, or flash if the monitor is monochrome. The listing given is for a monochrome monitor. Note that lines 450 to 1220 have been omitted from the printed listing, as they are identical to the corresponding lines of List 1.

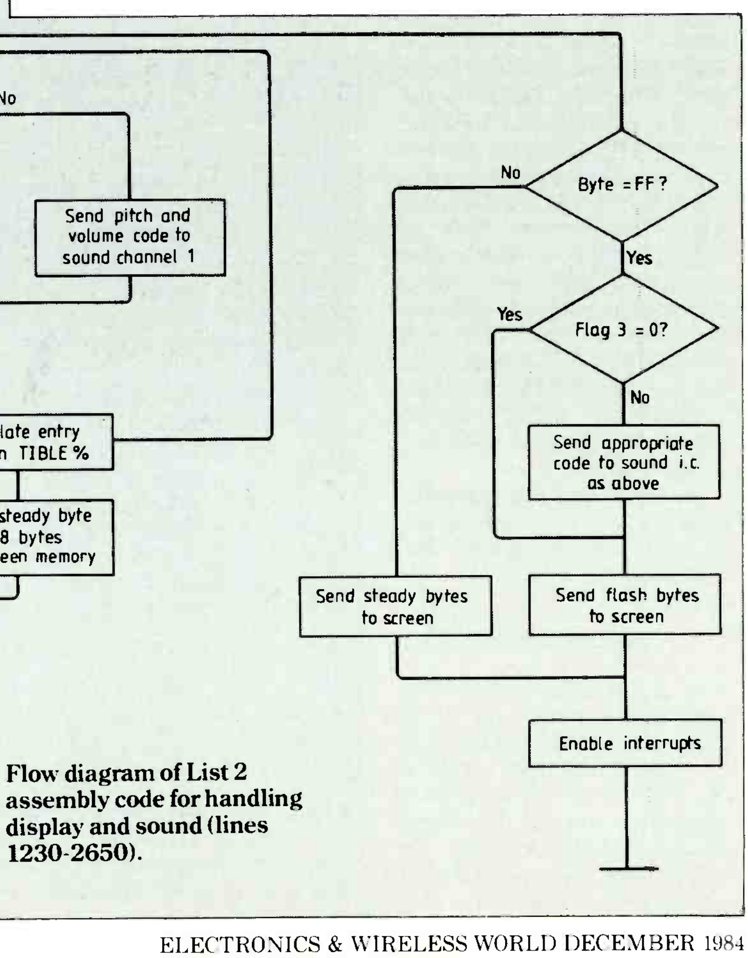
Code from lines 1230 to 2650 is an assembly-language program which controls the visual and sound display described above. In effect it replaces the display routine at the end of List 1. An earlier version of this, written in Basic, was much too slow at handling the display, taking about 1.25s to update it each time. No doubt it could have been speeded up but since about two orders of magnitude would have been required it was abandoned in favour of the assembly version.

The first part of the program sets the flash rate to a more suitable value than the default and asks for the volume level required. Perhaps 'ppp' is something of a misnomer since entering a value of zero would turn the sound generator right off producing glorious silence. Mode five (four-colour) is used and HIMEM set to allow 300 bytes for the assembler code, various flags etc. and two look-up tables (TIBLE% and TUBLE%). The former of these is concerned with the visual display, the latter with bytes sent to the sound i.c. Although the BBC Basic SOUND instruction can be accessed from machine code through OSWORD, I decided against this because the program was required to work as fast as possible and tests with SOUND showed that the parameters recommended in the User Guide for setting the pitches produced sounds which were very nearly half a semitone sharp. Since this program effectively turns the computer into a microsynthesiser which users might wish to play with other instruments I felt it expedient to recalculate the appropriate values to get as close as possible to an equal-tempered scale based on the standard A of 440Hz (the sound system in the BBC microcomputer leaves much to be desired both in terms of the noise it makes and the accuracy with which it can be tuned, however that is another story).

To convert the program for use with a colour monitor either remove the first part of line 230, or change the number eight in this instruction in accordance with the table given on page 224 of the User Guide. This instruction cur-

Continued on Page 34





Flow diagram of List 2 assembly code for handling display and sound (lines 1230-2650).

by T. Segaran.

Multiplexing Liquid Crystal Displays

A short description of the 'black art' of driving l.c.ds.

Although l.c.ds are finding their uses in various products, driving them seems to be a bit of a black art. Many users tend to connect the appropriate driver chips and the displays together, without fully appreciating the intricacies of multiplexing the driver. Below is presented an explanation of various levels of multiplexing.

It is best to start by drawing an analogy with driving leds, which need a direct current to light them. Multiplexing leds is therefore a relatively simple matter — Fig. 1 shows a suitable arrangement. The segment lines (8) and the digit-enable lines define the particular segments that need to be lit up. As long as each digit is addressed about 50 times per second, no flicker will be visible to the human eye.

L.c.ds, however, can be damaged by prolonged direct voltages and have slower response times than leds. Because of this, the multiplexing scheme for l.c.ds is rather more complex. When no multiplexing is needed (because few digits are being driven, say 4) the arrangement shown in Fig. 2(a) is adopted. Each segment of each digit has a unique line running to it from the driver. The backplanes of all the digits are commoned and are also connected to the driver. Hence, a four-digit display will have 32 segment connections and a common connection, which carries square wave of equal mark: space ratio, as in Fig. 2(b). All segments that need to be lit have a waveform which is 180 deg. out of phase with the common, as at (c), while those that do not have a waveform in phase with the common. Figure 2(d) shows the resulting polarizing waveforms across the segments that are selected. The non-selected segments have no net voltage across them.

When two-way multiplexing is needed, the scheme in Fig. 3(a) is adopted. There is a connection from the driver to a pair of segments and there are two backplane connections to each digit.

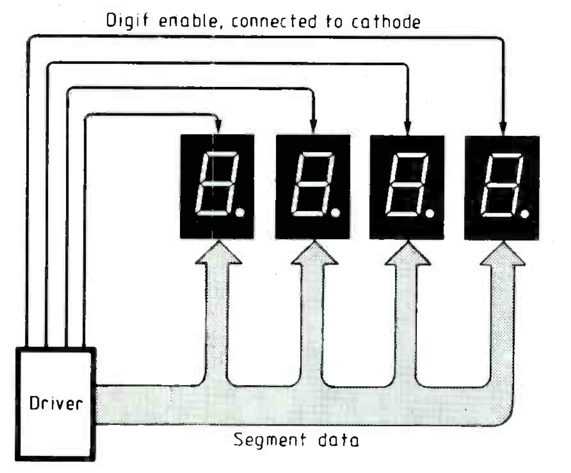


Fig. 1. **Use of d.c. enables simple method of multiplexing leds.**

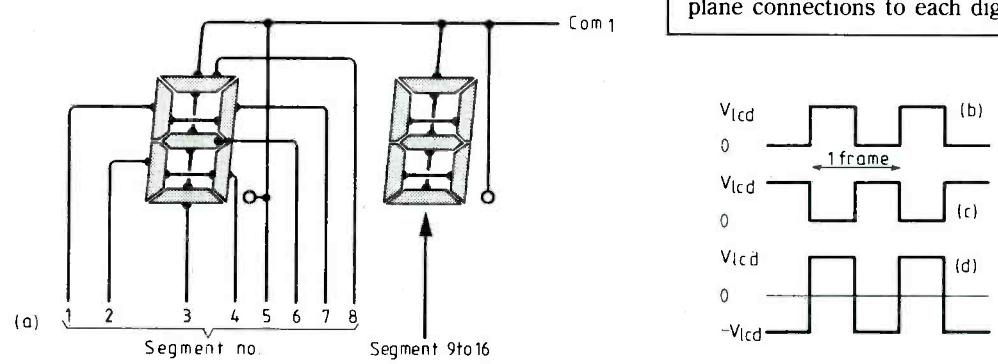


Fig. 2. **Without multiplexing, l.c.d. drive simply requires a line for each segment and a common lead, which carries a 1:1 square wave, as in (b). Segment drives are either in phase or antiphase with common line waveform.**

Thus, for example, in an 8 digit display there would be 32 segment lines and 2 common lines. Notice that the common 2 waveform shown at (b) lags behind the common 1 waveform by 90 degrees. When segment 'a' needs to be lit up and segment 'b' must be off, then the waveform shown at (c), is impressed on the segment 1 line. The first half of the waveform is 180 deg. out of phase with common one thus lighting up segment 'a' and the latter half of the waveform is in phase with common two, thus switching off segment 'b'. A similar waveform at (d) on segment 2 lights up segment 'e' and keeps segment 'd' switched off. Thus, although one reduces the number of lines by a factor of two, an additional complexity of a special waveform with three voltage levels is needed, to implement two-way multiplexing.

Three-way multiplexing is not commonly used, but four-way multiplexing can be discussed. In this scheme, shown in Fig. 4(a) each segment line from the driver is connected to four segments in each digit. There are four common connections (backplanes) to each digit, each common line connecting to two segments in each digit. Each waveform on the common lines in (b) is 45 degrees out of phase with the previous one. If all four segments connected to the segment 1 line (a, d, e and f) need to be lit, then the waveform shown at (c), is output on that line. Note that this waveform is 180 degrees out of phase with each of the peaks in the common waveforms, resulting in a large polarizing voltage across the four segments, as at (d). If segments 'b' and 'c' must be lit, while 'g' and 'h' are off, then the waveform shown in Fig. 4(d) is applied to the segment 2 line, resulting in the appropriate polarizing voltage. Figure 4(f) shows the voltage across a non-selected segment. Four-way multiplexing, although reducing the interconnection between the driver and l.c.d. considerably, requires still more complex drive circuitry and four voltage levels. Another disadvantage is that the difference in voltage applied to a selected segment compared to that applied to a non-selected segment is less than in other cases. Table 1 summarizes the drive volts.

Multiplex drive of alphanumeric and graphics l.c.ds follows the same principle used in driving

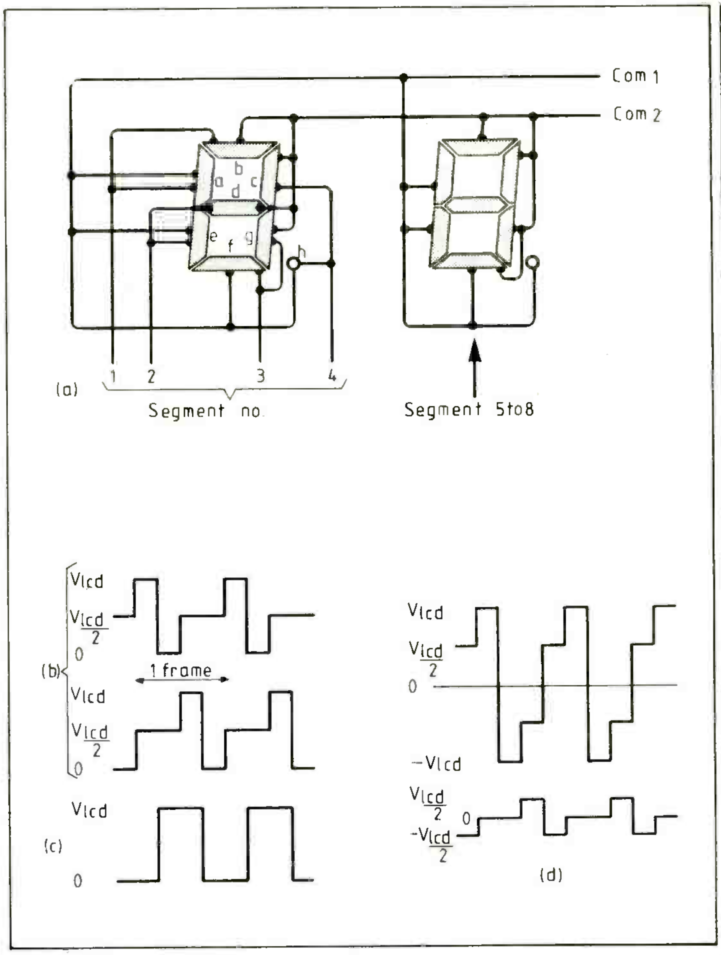
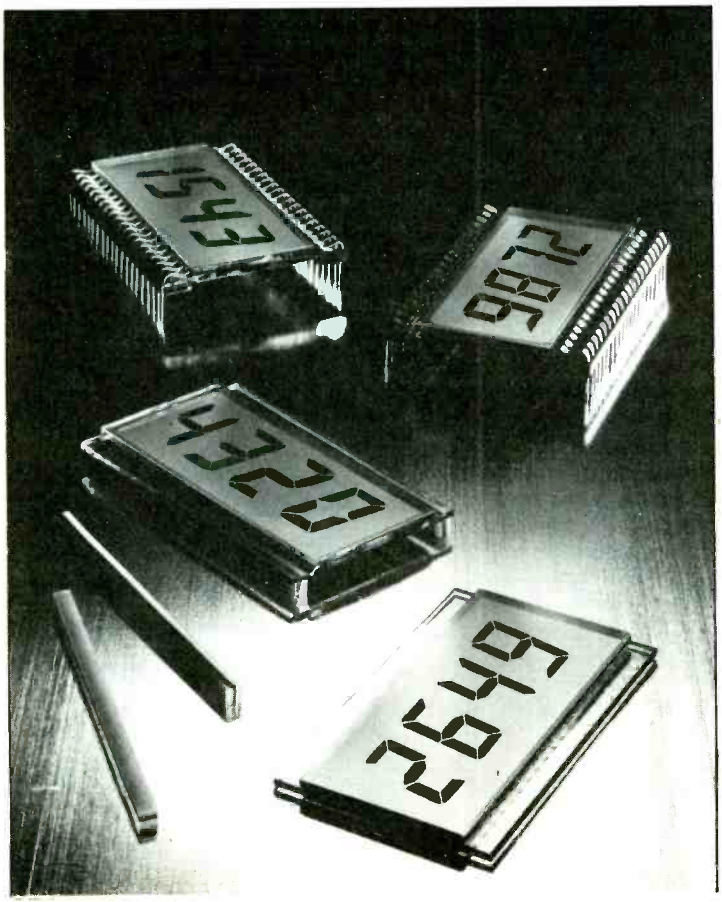


Fig. 3. **Two-way multiplexing requires two common lines.**



Group of 4-digit Lucid l.c.ds from EE Valve Company

Table 1.

	Static	2-way	4-way
Voltage levels required	2 0, V_{lcd}	3 0, $V_{lcd}/2$	4 0, $V_{lcd}/3$, $2V_{lcd}/3$, V_{lcd}
Selected segment	V_{lcd}	$\frac{3}{4}V_{lcd}$	$V_{lcd}/2$
Non-selected segment voltage (r.m.s.)	0	$V_{lcd}/4$	$V_{lcd}/3$

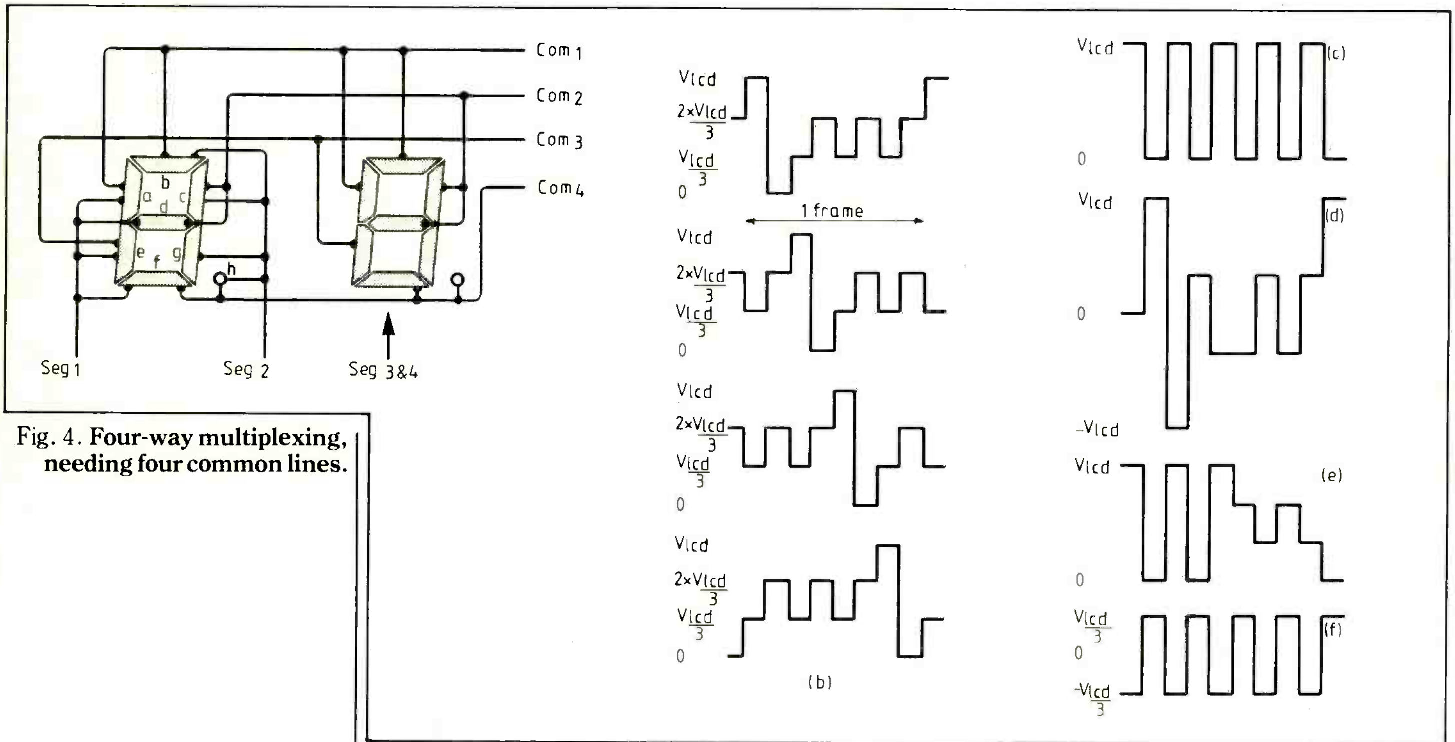


Fig. 4. **Four-way multiplexing, needing four common lines.**

numeric displays. The number of common lines used can get as high as 8, 16 or 32: the limiting factors are how closely the thresholds on the displays can be determind and how well the reference voltages for the steps can be defined. For example, when 16 common lines are used, the voltage across a selected segment is 1/4 $V_{l.c.d}$ and the voltage across a non-selected segment is 11/80 $V_{l.c.d.}$ The threshold for an l.c.d. segment must be between these two levels and the tolerance on the reference levels must be an order of magnitude better than those levels, i.e. about 0.1%.

by Roy Hodges, MIEE

SPEED OF LIGHT

Light may, or may not travel at constant speed in vacuo, but it must do when it meets matter.

The human mind possesses a strong urge to seek after the truth; but is it perhaps a feeling of pseudo-religious fervour which allows us to accept theories and phenomena which are not easily comprehensible or are even paradoxical? One rather perplexing concept falling within this category is the constancy of the speed of light notwithstanding any velocity the light source may have relative to that of the observer.

When my own study of elementary physics brought this seemingly illogical concept into focus, I recall being rather more intrigued than bewildered. And when this concept was linked to relativistic notions and dramatized by the story of a frail old man being greeted by his very young twin brother on his return from a trip round Andromeda, I became fascinated by the possible credibility of such mystical ideas. The last thing I wanted was anyone to destroy this illusion — and in any case, all the loose ends appeared to be well taken care of by the Special Theory of Relativity. I therefore became very sceptical about articles I read which dared to suggest that some aspects of the theory were perhaps a little suspect. I voiced, rather than seriously considered the point that if the theory were not as stated there appeared to be no other satisfactory explanation of the peculiar way which light seemed to behave. Certainly all experiments appeared to show that the speed of light is constant. And it also appeared logical that the speed of light should be constant everywhere in the universe.

Although I accepted the usefulness of considering the photon in some circumstances, the model I built up in my mind to visualize and explain, say, the propagation of radio waves, was a very electromagnetic one. It seemed so natural that the magnetic field created by the accelerating electrons in an antenna, should combine with the electric field across various parts of it to send forth an electromagnetic wave. Despite these views, however, I was very uneasy about the classical concept of electromagnetic propagation. It was not until I took courage and seriously questioned my electromagnetic model that some rationality dawned.

Although it is often convenient to reason in terms of electromagnetic fields, the important part that matter plays in their propagation can easily be overlooked and forgotten. This, of course, is not the case when one considers the quantum model and that photons actually emanate from within the atomic structure as a whole. Well, the stuff that light is made of either does emanate from within an atom or it doesn't. If it doesn't then the present most popular electromagnetic theory may suffice, though continue to be confused by the existence of photons. But if it does emanate from within an atom, one must at least try to satisfy the concept of duality by modelling the photon on say a toroidal package of electric and magnetic fields in quadrature. If, however, this makes one nervous, better forget duality and concentrate only on photons.

Whatever forces exist within an atom, there is one inviolate law which states that the initial velocity of photons propagated from an atom is constant, i.e. our accepted value of approximately 3×10^8 m/s. It is, of course, fairly well understood that atoms can absorb and generate radiation at very specific frequencies. And, due possibly to the various transition times of photons within an atom's sphere of influence, it is also a fact that the speed of light in air is markedly different from that in, say, water. It is adequately demonstrated, therefore, that all photons are profoundly affected by atoms irrespective of any signature frequencies or densities, when, during their flight through the universe, they enter the space governed by these particles. There may even be room for argument that such photons leaving an atom's influence are not the same ones which entered it. Whether or not this is the case, photons which leave the field of an atom, must surely be subject to the same law which governs photons actually generated by the atoms.

If this postulate can be accepted — and it doesn't exactly violate any existing laws, it becomes quite evident that the speed of light measured by a stationary observer must always be constant, because the relatively dense air through which the photons have been travelling is also more or less stationary with respect to the observer. In fact, every encounter between a photon and an atom, ensures the maintenance of this constant velocity.

Consider now what happens to light emitted by a body moving towards the Earth at say 0.2 of the speed of light. Depending on one's 'faith' (and let's face it, most students, if not mature people, will believe what they are told if the argument is made to look plausible enough), light will either leave the moving source at 1.2 times our accepted value (with respect to Earth) or at exactly our accepted value with all the Lorentz modifications to the source in order to balance the books. The latter value, of course, lands us right in the middle of our present jungle of controversy — espcially with respect to the supposed time dilation. As there are many persuasive and intelligent people of great experience who cannot digest this principle, is it not logical, despite all the rhetoric against their arguments, to conceive that this same principle is not proven beyond all shadow of doubt. If we can tolerate the suggestion that there is just a tiny shred of logic in this view, let us ignore (for a few minutes) the Lorentz complications and consider what happens if we assume that the light from our moving object commences its travel towards Earth at 1.2 times our accepted value.

First choose to imagine that a perfect vacuum exists between the moving body and the outer reaches of the Earth's atmosphere. With no atomic encounters on their journey, the ejected photons would be entering the atmosphere at the same enhanced speed. However, on their very first encounter with an atom of its gas, the velocity of a photon entering the particle will be immediately reduced to the velocity of light with respect to that atom, i.e. our accepted value. To maintain the frequency (increased in this case by what might be confused with the Doppler effect), this lower but normal velocity would produce light of a shorter wavelength and of course, blue shift. This also implies that the light would be of greater energy to compensate for the reduced velocity of the photons.

But a perfect vacuum, of course, does not exist and matter appears to be present in the order of several atoms per cubic centimetre of interstellar space. If one considers that only a single atom exists per cubic centimetre, then to a first approximation, the mean free path of the gas would be in the region of 10^{10}km. Therefore, a photon travelling through space, would, on average, encounter an atom approximately every 10^{10}km. Even by astronomical standards, this is a fair distance — about the same as the diameter of our solar system — but is eaten up in about nine hours by the travelling photon. However, if we then consider just the nearest star, whose distance is more conveniently measured in light years, a mean free path of 10^{10}km is quite insignificant. This means that light would hardly have left a star before its velocity is changed to that prevailing for the interstellar gas. Moreover, it means that the velocity of its emitted light may have changed thousands of times before it reaches Earth. Another interesting thought is that any two photons leaving the souce at the same time are each likely to encounter their first interstellar atom in anything from a few minutes to a few days after departure. For this reason there would be no defined frontal system. It is true that after several thousand possible changes in velocity, nearby photons should keep roughly abreast; however, there is bound to be some random grouping giving the effect of — well how does the nursery rhyme go? twinkle, twinkle....?

Even if any of the famous experiments to determine the speed of light could have been carried out in deepest space, the results would have been just the same as they are on Earth. Photons may well arrive to within one atomic diameter of the apparatus at a velocity substantially different to the speed of light on Earth but the velocity would be immediately changed relative to that of the apparatus on encountering the first material interface.

Any satisfactory measurement of the speed of light in a near vacuum, would, of course, be rather difficult. One possible way would be to pass the light emitted from a star through a segmented glass disk rotating at high speed and noting whether the light passing through the glass overtakes or falls behind the light which travels directly. For accurate results, the disk would have to be an inconvenient distance from the measuring device — perhaps on the next Moon visit we may know. There would, however, be no way of actually measuring the initial velocity of, say, light emitted from stars with a pronounced red or blue shift due to the levelling out process mentioned above.

I am not saying that Lorentz contractions and quirks of time are just fantasy — interpretation of some phenomena suggest they are quite real. However, do we really need them to explain away a universal constancy of light which may not exist. Could not the tail, in fact, be wagging the dog?

The author
After his college studies were interrupted in 1943 by wartime circumstances, Roy Hodges commenced a career in Broadcasting Engineering by joining the B.B.C. at their Brookman's Park transmitting station. Being only 15 years old at the time, he naturally felt himself a little at the deep end; however, he later transferred to the television service and after 10 years with the Corporation, he joined the Ghana Broadcasting Service and spent 8 years as Engineer in Charge of various departments.

For the next 2 years he was a student at the Brighton College of Technology studying electrical and electronic engineering and within the following year obtained Corporate membership of the IEE. Since then, he has worked extensively in Africa and the Far East with various international organisations in the fields of broadcasting, electronics, product management and education.

Optical power

That strange genius Nikola Tesla used to believe that communication by radio waas simple: the real problem was to transmit *power*. In practice it was not until the 1960s that it was shown possible to keep a model helicopter flying by beaming up microwave power from the ground. Even today it is doubtful whether any practical use is made of power transmission — though at IBC82 it was suggested that DBS sound radio transmitters on 26 MHz could be so powered in what seemed largely an engineering pipe-dream.

Now the idea has spread to optical fibres with their extremely low potential attenuation but with thin fibres limited in power-transmission capability. Japanese engineers have reported (*Electronic Letters*, September 27, 1984, pp811-2) transmitting 39 watts over 420cm of 1000μm-diameter fibre and believe that with this diameter fibre the limit would be about 80 watts. Using a CO_2 laser with a wavelength of about 5.3μm the transmissions loss is about 0.3dB/m.

It is suggested that the ability to transmit 40 watts "enables us to use this fibre for some practical applications" but the writers do not expand on these.

Meanwhile, the international rivalry to transmit high-speed data over long lengths of optical fibre, using coherent systems, continues. At a recent Open Day at British Telecom Research, Martlesham, the claim was made that the adoption of superheterodyne principles for reception combined with the ability to obtain a narrow-band coherent output from semiconductor lasers has enabled BT to establish a world record by transmitting a 140Mbit/s (the BT notes gave 140kbit/s but I am assured this was in error) along 200km of fibre without intermediate regeneration. A long external-cavity laser being studied at Martlesham has a linewidth of only 10kHz and can be tuned over a 13,000 GHz range, so opening the way for frequency multiplexing a series of independent transmissions over a single fibre.

However, on the "anything you can do I can do better" principle, I note that Japanese engineers have reported (*Electronic Letters*, September 13, 1984) on optical link of 216-km with a total attenuation of 46.3dB at 1.55μm, using 107 splices.

Interscan or TRSB?

A distinctly aggrieved piece by Philip Watson in *Electronics Australia* (July 1984) complains that the microwave instrument landing system,, generally known as TRSB (time reference scanning beam), chosen in 1978 by the International Civil Aviation Organization and now in production, although of CSIRO origin, is seldom credited to Australia. As the Interscan system it was first field tested at Melbourne.

According to Philip Watson, the system should rank as one of Australia's most significant scientific achievements, adopted as a world standard in preference to competing designs from the UK, continental Europe and the USA. Yet, he adds, "it is both surprising and disturbing to find that Australia's role in this development has been completely ignored overseas."

Interscan TRSB operates on 5 GHz with a range of about 37km and, among its advantages over still-current v.h.f., ILS can handle several aircraft at the same time. The system, as a world standard and including developmdents introduced in the USA, is not subject to basic patent restrictions but the Aussies are clearly sore that its origins and the early work at CSIRO are being overlooked

Farewell 405

During the first week of January, 1985 405-llne television (System A) will finally disappear into history — where for the vast majority of viewers it has been for the past decade.

Announced as a British television standard (competing with Baird's 240-line sequential system) during 1935, it has narrowly failed to make 50 years. The long-lasting Blumlein waveform, with positive modulation (excellent apart from susceptibility to ignition interference) and a.m. sound might have been a 243-line system if the EMI team had not tried the effect of changing one divide-by-three multivibrator into a divide-by-five (243×5/3=405). The system which gave Britain a significant lead in world television will be remembered with affection by all who were not unduly worried by the often audible 10.125Hz line-whistle. In association with 4.5 in image orthicon tube cameras it gave really excellent black-and-white pictures — and even the visible line-structure could have been alleviated if the public had taken kindly to spot-wobble techniques.

It was interesting to learn at IBC84 that there is a revival of interest in the USA in synchronized spot-wobble as an aid to high-definition television — a technique oyiginated by Alan Blumlein but which Leslie Jesty strove to introduce for so many years. It was fitting that he was in the audience at IBC84, though describing himself as "an unemployed engineer".

IBC84 provided further evidence of the very impressive results that are possible with the 1125-line (60 Hz) NHK and the proposed 1249-line (80 Hz) BBC systems. The pictures on Sony's excellent 6ft winde projection system could not be faulted, though both standards require over 20 MHz of video bandwidth and may never be possible in Europe for terrestrial or 12 GHz satellite broadcasting, although suitable for electronic cinematography and closed-circuit working.

Single-tube colour cameras are still finding it difficult to compete with three tubes. For display, the principle of the single-gun beam-indexing tube has been around for a very long time. On several occasions it has been hailed as the coming thing in brighter colour displays. One of the few such tubes actually in production is a 1in tube made by Hitachi for camera viewfinders. Sony Corporation, however, has recently announced a new beam-index projection tube with a 5.25 inch faceplate and ethylene glycol-water cooling, claimed to have a peak brightness of about 1600 lumen, roughly seven times more than with good shadow-mask tubes. The tube is being put into a home video projection unit, with built-in v.c.r. and cable tv tuner, marketed in the USA at about $3000.

Sony are also to provide a giant mosaic-type display (160 ft diagonal) for Expo 85 near Tokyo, visible at distances up to 1 km. This uses light sources having fluorescent-type cells with three electron flood sources, one for each primary colour, with a common cathode to provide a 40m wide by 25m high screen with a 400 by 378 array.

Amateur Radio

New IARU "locator"

From January 1985, a new IARU locator system will come into use with the UK and possibly throughout the world. It will enable v.h.f. and u.h.f. operators to pass, in a single six-character coded group, information on the location of their stations to within a couple of kilometres. It replaces a European-only "squares" locator system and was originally devised by John Morris, G4ANB as the "Maidenhead" system.

In the new system the world is divided first into 324 "fields" each covering 20° of longitude and 10° of latitude. Each field is labelled by two letters between "A" and "R", the first letter indicating the longitude starting from 180° West; the second, latitude starting from 90° South. Thus most of the UK west of the Greenwhich meridian is in the field "10", but the Channel Isles, Isles of Scilly and Lizard Point, Cornwall are in field "IN", most of the Shetlands in "IP", and those parts of England east of Greenwich in "JO".

Each field is then divided into 100 "squares" arranged as a 10 by 10 grid, each covering 1° of latitude and 2° of longitude, each designated by a digit "0" to "9", the first indicating longitude, starting from the west, and the second the latitude starting from the south. Finally each square is divided into a 24 by 24 grid of sub-squares, each covering 5 minutes of longitude and 2.5 minutes of latitude, labelled by two letters, each in the range A to X starting from the Southwest corner. Thus the location of Edinburgh Castle using the new system is 1085JW. There is however no truth in the rumour that anyone working out their locator group correctly at the first attempt will be excused from taking the Radio Amateur's Examination.

Costly h.f.?

Exchange rates and inflation continue to push up the cost of imported top-of-the-range amateur radio transceivers, leading to a revival of interest in "economy" designs and home construction, though a flexible, full-specification design is not a matter to be tackled lightly, on the kitchen table.

As an example of rising prices, one notes that the basic Yaesu FT-ONE h.f. transceiver is currently being offered at about £1570 compared with £1450 in October 1983 and £1295 in October 1982. The absence of UK production or assembly makes the imported equipment very vulnerable to changes in exchange rates. Japanese domination of the world market for such equipment is challenged only by a few American firms with, for example, the innovative Drake firm now increasingly concentrating on "professional" markets, and with some of the remaining American firms relying on assembly in the Far East.

Nevertheless, it still remains possible for newcomers, who do not aim too high initially, to assemble a complete h.f. transmitting station for less than £100 by using secondhand equipment and aerial based on wire suspended from trees or houses rather than aluminium tubing arrays mounted on towers.

At the other extreme one notes aerial tuning units, for which many of us still use just an odd coil and capacitor, priced at around £350!

More use now appears to be made by both newcomers and long-established amateur h.f. stations of the lower h.f. bands, including 1.8, 3.5 and 7 MHz, reflecting the recent rapid decline in sun-spot activity, including a period in September of almost a fortnight during which no spots were visible on the face of the Sun. We now face a period of two or three years of sunspot minimum, with the consequent lowering of the maximum usable frequencies, difficulty of working across the day/night barrier, and the virtual fade out of the 14 MHz and higher bands at night.

It will be interesting to see if the IARU Region 1 recommendation of no s.s.b. on 10.1 MHz remains unchallenged for long, with numbers of amateurs in Region 3 (Asia, Oceania) already operating phone in this narrow band. Currently in Europe, c.w. activity on 10.1 MHz is at only a moderate level.

Back to batteries

It has long been a truism that for portable operation it is relatively simple to convert electric power into r.f.: the difficult part is finding an economic source of the basic electric power. With most modern amateur transceivers designed for operation from 12-14 volts d.c. as mobile units, many amateurs are finding that the home construction of reliable regulated mains power supply units, fully protected against delivering an over-voltage output, and capable of supplying peak outputs for s.s.b. operation of over 30A, is by no means as simple as it may appear at first sight. Low-cost, series-pass transistors, such as the 2N3155, although nominally rated at 10A, often prove to have "worst case" ratings of around 5A, and their failure, invariably a short-circuit, can typically put a damaging 18-20 volts into an expensive transceiver. "Crowbar" protection can similarly present unanticipated design problems, even though nominally fail-safe.

There is thus a growing belief that the simplest, most reliable and usually most economical solution for base operation of 12V transceivers is the use of a float-charged car battery. The introduction of fully-sealed "maintenance-free" lead-acid batteries help to overcome the former fear of causing domestic damage to carpets etc. due to acid spillage. Standard car-battery chargers can be used with 4A or 8A rating.

The conventional lead-acid battery still tends to survive only a limited number of charge/discharge cycles without the plates buckling, shedding active material (which can short-circuit the cell) or suffering from sulphation. New Zealand amateurs, in particular, seem prepared to tackle the problem of regenerating cells by such techniques as washing out the shed material, or by using Glauber's salt solutions to counter sulphation, in a manner originally described in 1912 and also in *Wireless World* in 1941!

Here and there

By October the sequence of G4Z Class A licences was almost exhausted and GO callsigns may begin to be issued late in 1984 or early 1985.

The Channel 4 play "CQ" took pains to provide an authentic portrayal of amateur radio operating. No so *TV Times* which must have upset some amateurs by saying that "peppered throughout the entertaining script is the freaky language of Citizens' Band radio"!

Pierre Lorain, F2WL's definitive book on the weapons, radios and techniques of SOE published in France in 1972 has been published in the USA and UK in an English-text adaptation by David Kahn as "Secret Warfare" (UK, Orbis Publishing Ltd., 185pp £7.00 hard covers). It includes clear drawings of about 15 different suitcase and pocket transmitter-receivers used for clandestine communications, 1941-45.

While the recent excellent BBC documentary series on SOE included sequences with John Brown, G3EUR showing the use of radio equipment, it seemed odd that a later episode gave the impression that Captain Hudson, the first SOE man with the Yugoslav Resistance, sent out his own radio messages. In face he was accompanied by H.W. King, who now lives near Oban, as radio operator, burdened down by a heavy Mark 3 transmitter supplied to SOE by Intelligence.

Australian amateurs will benefit — but possibly not for many years — from the decision of the Department of Communication to phase out some of the anomalies in Australian television frequency allocations. Channel 5A, adjacent to the 144 MHz band, will disappear, along with television usage of three channels in the v.h.f. boardcast band (Band 2) which 20 years ago was made available to Australian television but are now required for the expansion of v.h.f./f.m. radio. But it may be years before these decisions can be implementated.

PAT HAWKER, G3VA

In brief

The September "Commentary" noted the Government's proposed transfer of the 22 high-power broadcast transmitters belonging to the Foreign & Commonwealth Office's Communications and Broadcast Department to the BBC. Four months after this became known, no final decision has been made, with various committees examining the proposals which are bitterly opposed by many of the engineering staff. Though FCO still seems to hope to push these changes through, they are cagey about suggesting any possible timetable.

New battery technology is claimed as a key factor in the new Peugot Electric 205 car with a claimed operating range of between 100 and 140 miles at average speeds of 45 and 27mph and to speed of 60mph. The 12 nickel-iron 6 volt batteries have cells not completely separated, and each can be filled from a single opening; they provide about twice the energy of standard cells of similar size with 1500 recharge cycles possible. Battery recharging however takes 10 hours and the cost of the batteries is very high, reflecting the use of expensive materials.

Phone-in radio programmes can be dangerous work in the USA. Alan Berg, a controversial host on KOA Denver was shot dead last summer, after having been threatened several times — by no means the first American broadcaster to be gunned down apparently by angry listeners.

PAT HAWKER, G3VA

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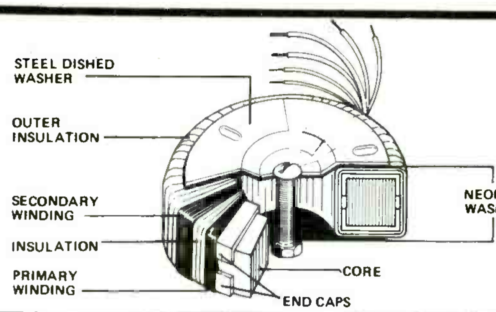

15 VA — 62 x 34mm, 0.35Kg, Regulation 19%

SERIES No	SECONDARY Volts	RMS Current
0x010	6+6	1.25
0x011	9+9	0.83
0x012	12+12	0.63
0x013	15+15	0.50
0x014	18+18	0.42
0x015	22+22	0.34
0x016	25+25	0.30
0x017	30+30	0.25

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30 VA — 70 x 30mm, 0.45Kg, Regulation 18%

SERIES No	SECONDARY Volts	RMS Current
1x010	6+6	2.50
1x011	9+9	1.66
1x012	12+12	1.25
1x013	15+15	1.00
1x014	18+18	0.83
1x015	22+22	0.68
1x016	25+25	0.60
1x017	30+30	0.50

50 VA — 80 x 35mm, 0.9Kg, Regulation 13%

SERIES No	SECONDARY Volts	RMS Current
2x010	6+6	4.16
2x011	9+9	2.77
2x012	12+12	2.08
2x013	15+15	1.66
2x014	18+18	1.38
2x015	22+22	1.13
2x016	25+25	1.00
2x017	30+30	0.83
2x028	110	0.45
2x029	220	0.22
2x030	240	0.20

80 VA — 90 x 30mm, 1Kg, Regulation 12%

SERIES No	SECONDARY Volts	RMS Current
3x010	6+6	6.64
3x011	9+9	4.44
3x012	12+12	3.33
3x013	15+15	2.66
3x014	18+18	2.22
3x015	22+22	1.81
3x016	25+25	1.60
3x017	30+30	1.33
3x028	110	0.72
3x029	220	0.36
3x030	240	0.33

120 VA — 90 x 40mm, 1.2Kg, Regulation 11%

SERIES No	SECONDARY Volts	RMS Current
4x010	6+6	10.00
4x011	9+9	6.66
4x012	12+12	5.00
4x013	15+15	4.00
4x014	18+18	3.33
4x015	22+22	2.72
4x016	25+25	2.40
4x017	30+30	2.00
4x018	35+35	1.71
4x028	110	1.09
4x029	220	0.54
4x030	240	0.50

160 VA — 110 x 40mm, 1.8Kg, Regulation 8%

SERIES No	SECONDARY Volts	RMS Current
5x011	9+9	8.89
5x012	12+12	6.66
5x013	15+15	5.33
5x014	18+18	4.44
5x015	22+22	3.63
5x016	25+25	3.20
5x017	30+30	2.66
5x018	35+35	2.28
5x026	40+40	2.00
5x028	110	1.45
5x029	220	0.72
5x030	240	0.66

225 VA — 110 x 45mm, 2.2Kg, Regulation 7%

SERIES No	SECONDARY Volts	RMS Current
6x012	12+12	9.38
6x013	15+15	7.50
6x014	18+18	6.25
6x015	22+22	5.11
6x016	25+25	4.50
6x017	30+30	3.75
6x018	35+35	3.21
6x026	40+40	2.81
6x025	45+45	2.50
6x033	50+50	2.25
6x028	110	2.04
6x029	220	1.02
6x030	240	0.93

300 VA — 110 x 50mm, 2.6Kg, Regulation 6%

SERIES No	SECONDARY Volts	RMS Current
7x013	15+15	10.00
7x014	18+18	8.33
7x015	22+22	6.82
7x016	25+25	6.00
7x017	30+30	5.00
7x018	35+35	4.28
7x026	40+40	3.75
7x025	45+45	3.33
7x033	50+50	3.00
7x028	110	2.72
7x029	220	1.36
7x030	240	1.25

500 VA — 140 x 60mm, 4Kg, Regulation 4%

SERIES No	SECONDARY Volts	RMS Current
8x016	25+25	10.00
8x017	30+30	8.33
8x018	35+35	7.14
8x026	40+40	6.25
8x025	45+45	5.55
8x033	50+50	5.00
8x042	55+55	4.54
8x028	110	4.54
8x029	220	2.27
8x030	240	2.08

625 VA — 140 x 75mm, 5Kg, Regulation 4%

SERIES No	SECONDARY Volts	RMS Current
9x017	30+30	10.41
9x018	35+35	8.92
9x026	40+40	7.81
9x025	45+45	6.94
9x033	50+50	6.25
9x042	55+55	5.68
9x028	110	5.68
9x029	220	2.84
9x030	240	2.60

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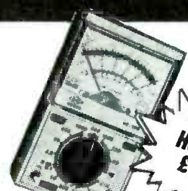

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Mimicontroller

by Peter Nicholls

Given the i/o and assembly-language facilities of a BBC model B microcomputer, developing a controller is no great problem but to have the computer permanently running say a central heating system is a waste. The economical 6502 Mimicontroller takes over such applications.

Many secondary schools and an increasing number of primary schools are realising that the microcomputer is a powerful controller. They are also discovering that young people are strongly motivated by design tasks which challenge them to use electronics to control hardware ranging from model-maker's motors and N-gauge railways to mock-ups of c.n.c. drilling machines. Interface units allowing a microcomputer to drive motors, lamps, loudspeakers, etc., from an input/output port are now produced by a number of companies and various attempts have been made to produce control languages which make it easy for children of all abilities to, for example, switch a bit on or off.

At the other end of the spectrum there are microprocessor systems whose primary function may be to teach machine-code programming but which are easily turned into controllers. Microprofessor is perhaps the best-known currently available unit; Kim, Acorn System One and MK14 have all come and gone.

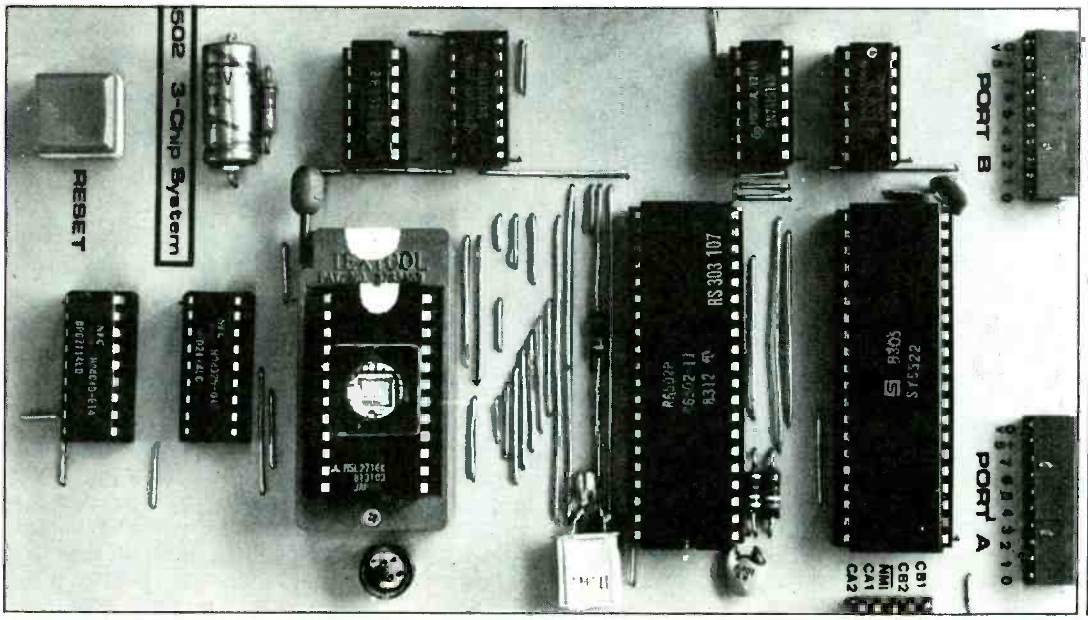
For the teacher, the choice is not an easy one. Microcomputers offer high-level language — which may in fact be no easier than machine code for the complete novice — but cost much more than 'minimal' systems. Microprocessor controllers run only machine code but they come at a price that is much more likely to allow a whole class to have hands-on experience.

Since 1979 I have been exploring the possibility of using minimal dedicated machine-code controllers in the classroom and trials with a small three-chip design at Belper High School in Derbyshire have proved successful. Briefly, code for the controller was developed on either the Sinclair Radionics' MK14 or a purpose-built 2716 emulator* and programmed into an eprom for insertion into the three-chip controller. The other two i.cs in the controller are an INS8060 microprocessor and INS8154 ram/p.i.o. device. Cost of this board was about £30.

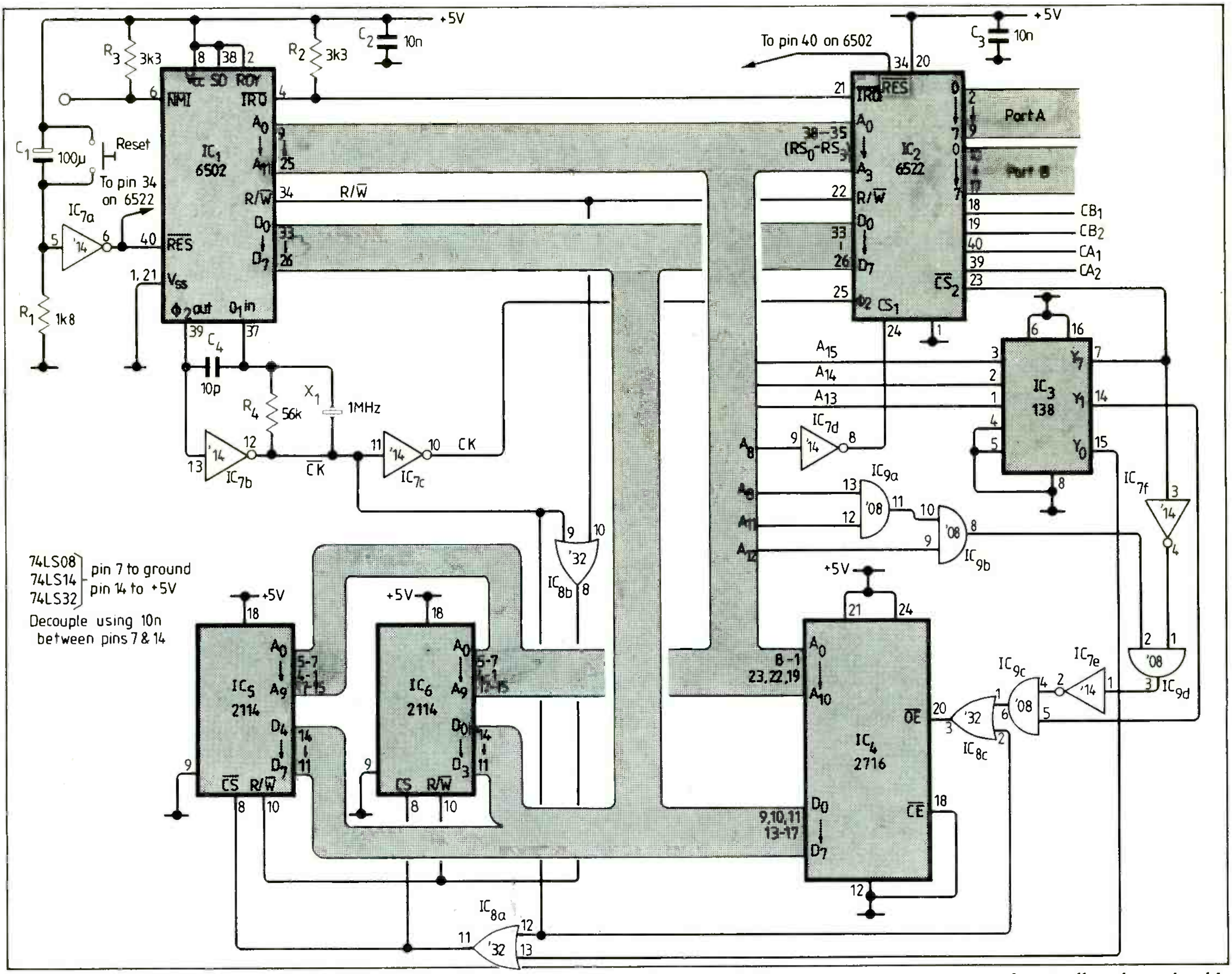
As the cost of the main i.cs on this original board has risen so the cost of 65-family processors has fallen, and more schools have experience of 6502 machine code than hitherto. The need to redesign the controller was clear. At the same time I felt that being able to somehow make use of the BBC microcomputer assembler would be a significant advantage (this computer outnumbers others in schools). As well as the obvious advantage for the enthusiast who has outgrown hand-assembly of machine code, there is the possibility of tempting teachers to have a go at machine

Peter Nicholls is East Midlands coordinator for Electronics and Control Technology with the Microelectronics Education Programme.

*The author's eprom emulator was described in the September, October and November 1982 issues of E&WW pages 83, 73 and 82 respectively.



An undrilled single-sided p.c.b. can be obained for £5.50 including postage and packing from PKG Electronics, Oak Lodge, Tansley, Matlock, Derbyshire.



Mimicontroller is designed to emulate BBC microcomputer i/o in control applications. Software is developed and tested using the computer's assembly-language and i/o facilities then transferred to a 2716 eprom for use in Mimicontroller. Ports A and B and control lines of the 6522 v.i.a., top left, act as those on the BBC microcomputer.

code control using a computer that they are already familiar with.

Using the assembler to help people write their first bytes of machine code bridges a conceptual gap which may otherwise be too large; thus Mimicontroller was developed.

The circuit

Simplicity of the controller can be seen in the circuit diagram — components, including zero-insertion-force socket for the eprom but excluding p.c.b., cost less than £20 which makes it attractive for school use. More relevant to most readers though is that Mimicontroller opens up the possibility of using the BBC microcomputer as a development tool for all sorts of applications from central-heating control upwards but without committing the computer to the actual job of controlling the application. Once the code has been developed, it is programmed into a 2716 eprom, using one of the several eprom programmers available for the computer, and transferred to Mimicontroller.

The crystal, IC_{7b}, R_4 and C_4 and part of the 6502 produce inverted clock signal C̄K̄ and IC_{7c} a non-inverted clock for the 6522 timers. The BBC microcomputer has a 2MHz clock whose frequency is halved through a complex system when certain memory devices are accessed. Because of this it is virtually impossible to design a simple controller that will mimic the computer in respect of software timing. Memory i.cs rated at 350ns are significantly cheaper than faster ones — a further reason for not attempting to clock the Mimicontroller above 1MHz.

The 6522 versatile interface adapter, v.i.a., has elaborate timing facilities, however, and Mimicontroller's 1MHz clock is the same as the microcomputer's 6522 clock. If software timing/delay loops are avoided and the v.i.a. used instead on both computer and controller, there should be no problems.

To prevent bus contention between the different memory devices, it is preferable to stobe memories with the CK clock. By feeding C̄K̄ into or gates $IC_{8a,c}$, the chip-select signals to $IC_{5,6\&4}$ respectively are only allowed low when CK is high, provided of course that $IC_{3/9c}$ have selected the device in question. In a similar way, IC_{8b} strobes read/write line R/W̄ using CK.

Gate IC_{7a}, C_1 and R_1 form the power-on reset circuit; 74LS14 Schmitt inverters are used solely to give a short rise time to the reset signal. Time constant of R_1, C_1 should not be shortened.

The rest of the circuit produces the address map. It would be possible to assemble code for any 6502 system using the BBC microcomputer, but it's a significant advantage to be able to test the software by running it on the computer, modifying it if necessary, before committing it to eprom for use with Mimicontroller. Relevant addresses within the microcomputer are

0070-008F page-zero ram (reserved for user)

0100-01FF 6502 stack

0200-27FF area chosen for program

FE60-FE6F 6522 v.i.a.

One other point to bear in mind is that the processor loads its reset vector and interrupt vectors from FFFA-FFFF in memory. Since the programmer needs to be able to store these vectors in the top six bytes of eprom, address-bus states FFFA-F must be decoded into the eprom area 27FA-F.

Three-to-eight-line decoder IC_8 and gate IC_{7d} select the 6522 for exactly half of the possible 16 byte blocks between E00x and FFFx. In this way the 6522 is selected for FE60-F but inhibited for FFF0-F when the processor is loading a vector.

Output Y_1 of IC_3 is low for all addresses between 2000 and 3FFF thus selecting the eprom, IC_4. In other words when assembling via the BBC computer, the eprom can be considered as residing in any of four 2Kbyte blocks, 2000-27FF, 2800-2FFF, 3000-37FF or 3800-3FFF, chosen by the user.

Gates $IC_{9a,b,d}$ and IC_{7f} cause IC_4 to be selected when the most significant byte of the address is F9, FB, FD or FF. Unless there is an error in the software, this can only occur when the processor is trying to load a vector. In this way FFFC, for example, on the address bus will cause the contents of 27FC to be placed on the data bus. Vectors may therefore be located so

27FD reset high-byte
27FC reset low-byte
27FB NMI high-byte
27FA NMI low-byte
27FF IRQ high-byte
27FE IRQ low byte

Interrupt use on the BBC microcomputer is complex, but it is possible to use the normal facilities of the 6522, interruptig through IRQ, as long as the interrupt vector is loaded into the computer at 0206 (low byte) and 0207.

Mimcry is likely, but not certain, to be exact as the servicing of an interrupt — even from the v.i.a. in an assembly-language program — will bring the microcomputer's operating system into action, which may interface with the user's routine (see Lists). Using NMI (non-maskable interrupt) is substantially more difficult, not least because one does not have access to the terminal, and is discouraged in the User Guide.

Mimicontoller's board (details later) carries 1Kbyte of ram ($IC_{5,6}$) selected by the Y_0 output of IC_3, giving 256 bytes of page-zero ram. A control program can of course use all of this and the general-purpose ram area of 512 bytes between 0200 and 03FF but the BBC microcomputer only guarantees not to tamper with 32 user bytes (0070-008F). By the time the control routine is called, the computer will have appropriated some of the stack for its own use. In other words, fewer than 256 bytes will be available in the computer but this is more than enough for most amateur control software.

Testing

To test the board List 1, a simple timing/clock program, can be run with a pair of seven-segment displays connected to port B (the user port) through two 74LS47 i.cs and current-limiting resistors. If this program is run on the BBC computer by a call to location 2000 (CALL&2000) the seven segment display will count seconds (approximately). Load the reset vector into the computer by

?&27FC=&00
?&27FD=&20

and transfer the code to eprom. The software should give an identical count rate on Mimicontroller.

List 2, a variation of List 1, illustrates interrupt use. The program is put into an endless loop until an interrupt occurs, i.e. when timer one times out after 10ms. The loop count in the index register (X) is decremented in the interrupt routine at location 2100, and the display on the port changed if necessary. Lines 200 and 210 load the interrupt vector into the IRQ2V locations in the microcomputer and line 220 runs the program. To transfer the program to eprom, first set up the IRQ vector using

?&27FF=&21
?&27FE=&00

Again, identical operation should be seen on Mimicontroller.

When the software is run on the microcomputer, the sound generator comes into action after about 25s — one illustration of the interaction of interrupts with the system. Secondly, the SED instruction at line 160 (2109_{16} in assembled code) would be more economically placed in the first block of code at, say, 201C or line 45. In the microcomputer it is rendered ineffective by the operating system, which tampers with the processor status register when the interrupt is serviced.

In summary, use the assembler and board with abandon when no interrupts are involved. The computer will not only assemble the code but also run it so it can be tested. Be aware though of the extent to which the computer uses interrupt and do not be surprised if it will not run code which involves interrupts. Software using interrupts can of course be assembled and transferred to eprom for testing directly on Mimicontroller.

The controller has been made on a p.c.b. measuring 160 by 100mm. Careful design allows a single-sided board with a manageable number of links. Current drawn by the circuit is about 350mA so it can be driven by NiCd batteries and used on a 'buggy' for example. Use of 65C02, 65C16 and 2114L devices reduces power consumption by a factor of four, but increases cost.

List 1. Simple clock program counting seconds on two seven-segment displays may be used to test Mimicontroller.

```
10  DDRB=&FE62:ACR=&FE6B:PB=FE60
20  IER=&FE6E:INFR=&FE6D
30  T1CL=&FE64:T1CH=&FE65
40  FOR PASS=0 to 3 STEP 3:P%=&2000
50  [OPT PASS
60  SED:LDA#&FF:STA DDRB
70  LDA#&00:STA ACR:STA IER
80  .JOE:STA PB
90  LDX#&64
100 .BILL:LDA#&10:STA T1CL
110 LDA#&27:STA T1CH
120 .SAM:LDA INFR:BEQ SAM
130 DEX:BNE BILL
140 CLC:LDA PB:ADC#&01:JMP JOE
150 ]NEXT
```

List 2. This variation of List 1 illustrates interrupt use.

```
10  DDRB=&FE62:ACR=&FE6B:PB=FE60
20  IER=&FE6E:T1CL=&FE64:T1CH=FE65
30  FOR PASS=0 TO 3 STEP 3:P%=&2000
40  [OPT PASS
50  LDA#&FF:STA DDRB
60  LDA#&C0:STA IER
70  LDA#&40:STA ACR
80  LDA#&10:STA T1CL
90  LDA#&27:STA T1CH
100 CLI:LDX#&64
110 .WATT:JMP WAIT:JMP WAIT
120 ]
130 P%=2100
140 [OPT PASS
150 LDA T1CL:DEX:BNE SKIP
160 LDA PB:SED:CLC:ADC#&01:STA PB
170 LDX#&64
180 .SKIP RTI
190 ]NEXT
200 ?&206=00
210 ?&207=&21
220 CALL&2000
```

Continued from Page 20

rently programs logical colour two to actual colour eight (flashing black/white). Removing it will leave logical colour two at its default actual colour, yellow, in any case leave the second half of this instruction intact. This sets logical colour one to black. Curious effects will occur without it.

Line 2690 checks input for a synchronization error which, if found, causes printing of a message and stops the program. One way of dealing with this is to add these lines.

```
245 CLS
90*KEY1 ?&FE6C=&D0|M
    ?&FE6C=&F0|MGOTO245|M
```

then if the message 'SYNC ERROR' appears, press function key one. This sends a pulse through CB_2 to step IC_{10} so press the key as many times as is necessary to regain synchronization. Alternatively, a hardware reset can be instituted by including a push switch to connect pin two of IC_{10} to V_{cc} through a 1kΩ resistor.

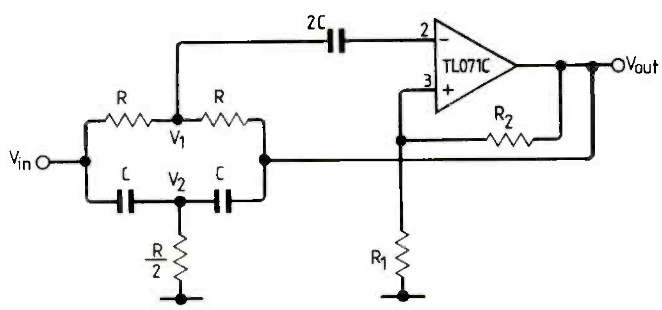
Software synchronization could be made completely automatic by a subroutine that sent a pulse through CB_2 whenever the first byte read was not FF. Some synchronization problems were experienced initially with the prototype due to switching transients. This was cured by inclusion of a low-pass filter consisting of a 1kΩ resistor and 68pF capacitor in the output of one of the multiplexers.

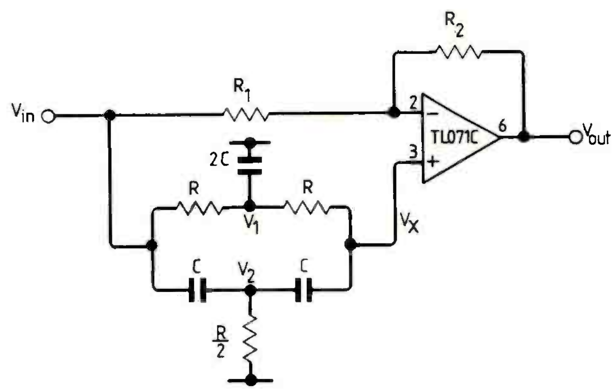
Once the program has been run, the assembler section can be removed if the assembled version is saved as machine code using *SAVE. After running the program press the escape key then type *SAVE <filename> 5500 +300. Lines 270, 360-380, 420-440 and 510-2660 can then be deleted from the program and the shorter version saved. Line 390 must be then changed to NEXT:NEXT:NEXT and the instruction 165 *LOAD <filename> added. This speeds up initialization of the program considerably since it no longer has to calculate frequencies of the equal-tempered scale.

No attempt has been made to make the program 'tube' compatible, the main reason being that the software is still of an experimental nature.

There would be no difficulty in making the program compatible with OSBYTE calls, though these appear to operate some 20 times slower than direct addressing of the devices. Whether this would be of any significance depends on the application.

CIRCUIT IDEAS





Twin-T filters

These band-pass and all-pass filters use twin-T networks. Transfer function of the band-pass circuit is

$$\frac{V_{out}}{V_{in}} = \frac{(1+4sCR+s^2C^2R^2)}{(1+4skCR+s^2C^2R^2)}$$

where $k=R_1/(R_1+R_2)$.

Attentuation of the filter depends on the choice of k. For example, at the resonant frequency ω_0, attenuation is 26.02dB for $k=1/10$, 32.04dB for $k=1/20$, 40dB for $k=1/50$ and 46dB for $k=1/100$. It is pointless to choose a value for k smaller than about 1/50.

Transfer function of the all-pass filter is

$$\frac{V_{out}}{V_{in}} = \frac{(1-4sCR+s^2C^2R^2)}{(1+sCR+s^2C^2R^2)}$$

At the resonant frequency ω_0, output voltage of the twin-T network is zero and output of the op-amp is $-V_{in}$. The twin-T network with fixed capacitance values is suitable for direct implementation as an i.c. with many useful applications.

Kamil Kraus
Rokycany
Czechoslovakia

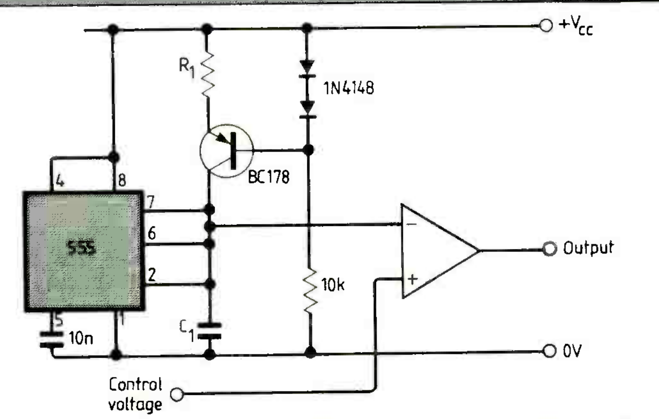
Further equations relating to this idea can be obtained by sending an s.a.e. marked Twin-T filters to *E&WW's* Editorial offices.

Voltage controlled duty cycle

Forming part of an automatic voltage regulator for an alternator, this simple circuit gives a rectangular output waveform with a duty cycle between 0 and 100% depending on the control voltage. Frequency is determined by R_1 and C_1 and is independent of the mark/space ratio.

The 555 is configured as an astable circuit, Tr_1 providing a constant current charge for C_1. This results in a linear ramp at the input of the voltage comparator which varies between about one and two-thirds of the supply voltage. Varying the control at the comparator's non-inverting input causes the output duty cycle to vary between 0 and 100%.

E.H. Rice
Exeter
Devon



HDTV or EDTV?

by Tom Ivall

Extended definition television — building up picture resolution gradually, flexibly and compatibly — is being considered as an alternative to all-out high-definition television on completely new standards. This report outlines some of the current investigations into ways of achieving higher definition pictures, as described in papers at IBC 84, the 10th international Broadcasting Convention at Brighton.

As long as the broadcasters continue to produce a succession of technical innovations, like rabbits out of a hat, to add to their systems, they will be relatively safe from the rival methods of distributing television programmes. Transmission standards, colour, additional channels, teletext, stereo sound, have all in their turn provided new opportunities for selling more consumer equipment and advertising time.

To judge from papers and demonstrations presented at the recent International Broadcasting Convention, the transmission standards, and other related standards, are now coming round for another rejuvenating pick-me-up. "High definition" is on everyone's lips again — as it was once before, in 1936, when used to distinguish the UK's then new 405-line tv service from earlier 30-, 150- and 240-line experimental systems.

The previous *WW* report on the biennial IBC (December 1982 issue) focussed on the great significance to tv broadcasters of the then newly established CCIR digital coding standard for studio equipment. Many realised that this internationally agreed standard, based on luminance and chrominance components rather than on the composite colour signal, would open up all kinds of extra possibilities for improving picture quanlity.

Using the latest digital processing and storage technology, video information could be 'pre-processed' at the studio and 'post-processed' at the receiver without any constraint from the nature of the composite transmission standard. Picture-source and receiver-display standards need not be the same as the standard used for transmission over the air. Some of the proposals for 'enhancing' picture quality in this way were outlined.

Since 1982 several things have happened which have brought these proposed enhancement much closer to reality. In 1983, for example, a number of European broadcasters showed their involvement by putting on demonstrations of HDTV at the Montreux television symposium. Then in January 1984 the Japanese launched an operational direct broadcasting satellite (DBS) which was intended eventually to carry experimental transmission derived from NHK's provisional 1125-line HDTV standard. (In the meantime this satellite has had transponder faults — see September issue, p.14.)

And during this two-year period the European Broadcasting Union (EBU) has officially recommended a DBS transmission standard. Based on a proposal from the IBA and called C-MAC/packets, it is expressly designed to allow future compatible higher definition transmission.

All the work now being done by broadcasters and manufacturers seems to be based on certain assumptions. The first is that higher definition services will be provided through 12GHz DBS transmissions in 27MHz or 24MHz f.m. channels. Another is that sufficient money will be available to meet the considerable costs.

It is also assumed there will be available large-screen displays of at least 1 metre diagonal, with a wider aspect ratio than that of existing tv receiver screens — probably about 5:3. This wider display, according to K.H. Powers of RCA Laboratories, has proved to be more pleasing to viewers than 4:3, increasing their feeling of involvement with the programme material.

Beyond this common ground there are differences of engineering opinion on how higher definition services should be introduced. As pointed out by K.H. Powers, there are several options available for utilising the extra bandwidth offered by DBS channels — increasing the horizontal resolution and/or the vertical resolution and/or the aspect ratio, and the possibility of using time multiplexed analogue components to avoid the cross-colour, cross-luminance and noise impairments experienced with composite signals.

But the main difference of approach seems to be: 'straight' HDTV versus 'extended definition' television (EDTV). Is it bet-

Lines per picture	Fields per second	Interlace factor	Line scan frequency kHz	Improvements or cures			
				Large area flicker	Interline twitter	Line crawl	Static raster
625	50	2:1	15·625	NO	NO	NO	NO
625	50	1:1	31·25	NO	YES*	YES	NO†
1250	50	2:1	31·25	NO	YES*	YES	YES
625	100	2+2:1	31·25	YES	NO	NO	NO
625	100	2:1	31·25	YES	YES*	YES	NO
1250	100	4:1	31·25	YES	YES*	NO	NO
625	100	1:1	62·5	YES	YES	YES	NO†
1250	100	2:1	62·5	YES	YES	YES	YES

* Subject to interpolation algorithm

† There is, however, some subjective improvement due to sequential display

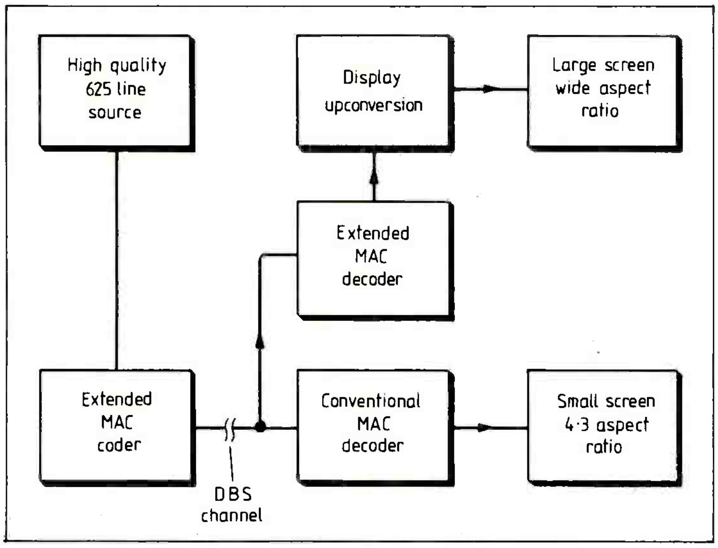


Fig.1. **IBA's compatible approach to higher definition television using extended MAC in a C-MAC/packets DBS channel. Other researchers think there is further benefit to be obtained by starting with a high line-number HDTV picture source and down-converting to 625 lines for transmission.**

ter to establish a new high-resolution system in one go, or gradually to extend the resolution capabilities of existing 625-line and 525-line systems while preserving compatibility?

As an example of the 'straight' HDTV approach, E. Kimura and Y. Ninomiya of NHK Research Laboratories, Japan, described the NHK system intended for HDTV transmission through the Japanese DBS satellite. It has 1125 scanning lines, 2:1 interlaced, a field frequency of 60Hz and a 5:3 aspect ratio.

In each line, the relevant luminance and chrominance signals are sent as time multiplexed components, with R−Y and B−Y chrominance information on sequential lines. This means that these two components have to be time compressed so that they can be contained within the line period. With the initial video bandwidths (e.g. 20MHz luminance) this results in a baseband width too large for the normal DBS channel. So the signals are bandwidth-reduced by sub-Nyquist sampling over a 4-field sequence and thus transmitted in analogue form. Two companded digital audio signals are multiplexed in the field blanking period. The baseband for transmission via the satellite is then 8MHz wide.

In the receiver a 4-field memory is necessary to store the sub-Nyquist samples distributed over the 4 fields at the transmitting end. Pictures are reconstructed by interpolation from these to give a bandwidth of 25MHz for stationary parts of the scene and 15MHz for moving parts. Because the basic process introduces unacceptable blurring on slow, uniform movements in the scene, a motion compensation technique is added. This uses inter-frame comparisons at the transmitting end to produce a signal which is used at the receiver to shift the read-out address of the 4-field memory accordingly.

The NHK transmission standard is broadly comparable with the EBU-recommended DBS standard in that they both use time-multiplexed analogue components, time compression of these components and digital audio. But, as is well known, C-MAC/packets fits into the normal time frame of the existing 625-line standard for compatibility purposes, and video information is time multiplexed with 751-bit packets of digital data which can be used as required for digital audio channels or other data. The 'C' in the name is simply a code letter for the particular method chosen for multiplexing the analogue video components and the digital audio and data.

But in another paper, M.D. Windram and R. Morcom of the IBA showed how C-MAC can become E-MAC — extended MAC — to carry higher definition pictures on the gradualist EDTV principle discussed above. This provides a wide aspect ratio, extended resolution, and MAC's complete separation between luminance and chrominance components that overcomes the cross-chrominance, cross-luminance and noise problems of composite transmission signals.

To provide the 25% extra picture information need for a 5:3 aspect ratio over a 4:3 ratio, some additional line time is obtained from the field blanking interval and some from the data period, still leaving enough audio data for two sound channels. But extra time compression is needed at the edges of the picture to achieve the full 5:3 ratio.

To increase the vertical resolution, the display at the receiver is up-converted to sequential 625-line scanning (non-interlaced), thus providing an apparent 40% increase in this resolution. But moving parts of the picture need a motion-adaptive conversion technique to avoid blurring (described by T.J. Long and G.J. Tonge in another paper). Horizontal resolution is increased by using a greater than normal baseband bandwidth of about 11MHz, which allows an uncompressed luminance bandwidth of over 7MHz.

Figure. 1 shows how E-MAC would be used in compatible approach to high definition. The viewer can use either a conventional C-MAC/packets decoder and ordinary televison set or an E-MAC decoder with scan up-conversion and a large, wide-aspect display screen. The conventions C-MAC/packets receiving equipment simply ignores the extra information provided by the E-MAC system and decodes the signal as a normal 4:3 picture.

Philips Research Laboratories have also been considering various MAC type methods of coding for EDTV based on the 625-line time frame. These all assume a horizontal bandwidth of 8.4MHz. In one method, as described by S.L. Tan and R.W. Jackson, the luminance and chrominance information is interleaved vertically rather than horizontally. Chrominance signals are line sequential and time compressed by 4:1. This had the advantage of allowing the full 8.4MHz channel bandwidth to be used for the luminance signal, now uncompressed.

In another method the B−Y chrominance signal is inserted in the field blanking interval and the R−Y signal is time multiplexed horizontally with the luminance information. Here, one advantage is that the R−Y information is no longer line-sequential, thus improving the vertical chrominance resolution.

The Philips researchers claim that, in conjunction with over-sampling and non-interlaced display scanning, such coding systems allow transmission of signals with up to 390,000 picture elements in an 8.4MHz channel. This compares with conventional PAL resolution of 147,000 pixels. A further system being investigated, using two DBS channels, offers an overall resolution of 780,000 pixels.

As part of an international research effort on world-wide standards for HDTV picture sources, the BBC has been studying the large-screen display at the receiver — a logical starting point for investigating HDTV signal parameters. I. Childs and A. Roberts of the BBC Research Department described how they have used a conventional picture tube to simulate one quarter of a large-screen display.

To test the belief that 625-line pictures can be significantly improved by display processing alone, regardless of the transmission standard, they tried a number of scan up-conversions with different line numbers, scanning frequencies and interlacing factors (including 1:1, or sequential scan). The results obtained are shown in the table.

The authors conclude that display up-conversion can substantially remove the major limitations of 625-line displays (right-hand column headings in table). But there is a problem with scene movement when extra lines are generated. To get optimum results a suitable algorithm is needed to calculate the right information to go in these lines, and probably an adaptive technique will be needed.

Similar work on up-converted displays was described by D.W. Parker and L.J. van de Polder of Philips Research Laboratories. Their systems include: 625-line sequential displays at 50Hz field frequency using one-line, one-field and and two-field stores for interpolating the extra information required; 1249-line displays with 2:1 interlace; and up-conversions with 100Hz field frequency to overcome large-area flicker.

These researchers say that, if a free choice of display standard were available, they would plump for a system with about 800 lines sequentially scanned at a field rate of about 60Hz.

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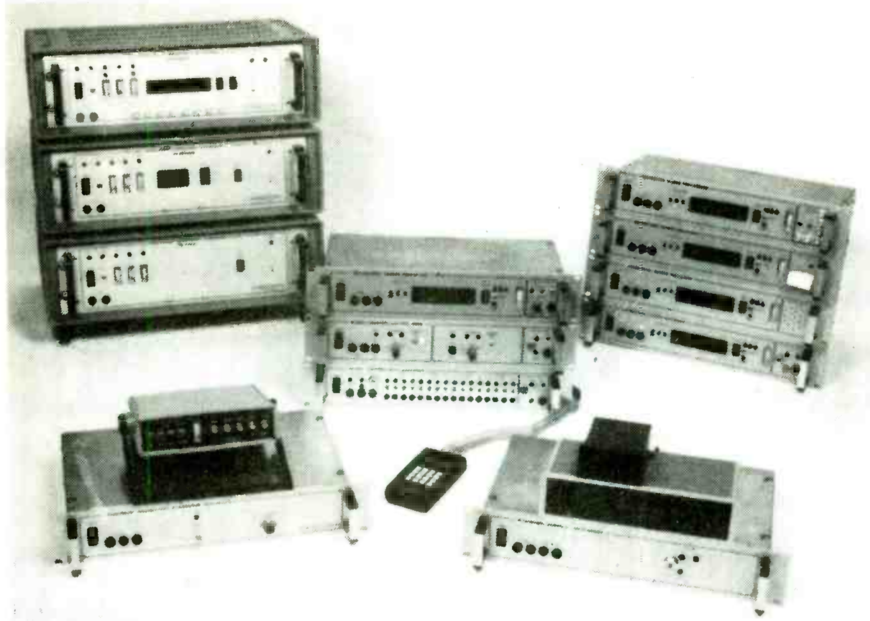

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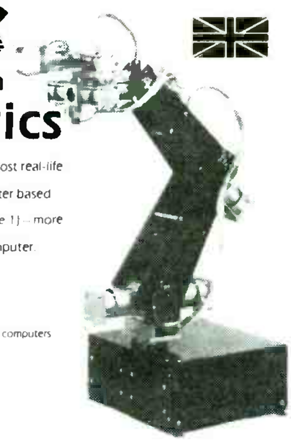

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		Optional extra three fingered gripper	£75.00
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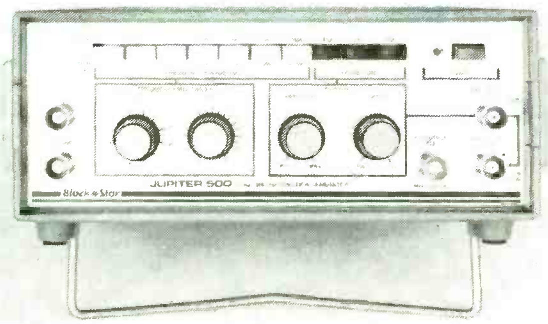

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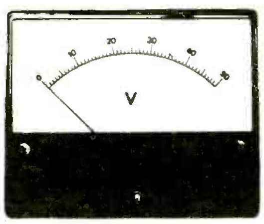

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CIRCLE 49 FOR FURTHER DETAILS.

Hand-held multimeters

Third and final article in our digital multimeter series brings together price and performance data for hand-held d.m.ms on the UK market.

We found many more hand-held digital multimeters than we initially thought were on the market. The large number found — over 160 — is partly due to the widespread practice of 'own-label' branding of products made in the Far East, chiefly in Korea and Japan but also in Taiwan, which results in many instruments having identical or very similar functions, ranges, errors and construction. We summarize their data in this month's table.

As with last month's tables for bench and systems multimeters, we have singled out the basic direct voltage range as being the most telling in terms of sensitivity and error; the function converters invariably degrade error specification. October's issue gave the errors that would arise in using non-sinusoidal waveforms on alternating ranges without the use of a 'true r.m.s.' converter, although if the crest factor of the waveshape being measured is known corrections can often be applied. (A rectangular wave with a pulse duty cycle of 40% can be measured without correction, provided adequate bandwidth is available, as the table on page 74 of that issue hints.) Those meters that measure the mean value but display a scaled r.m.s. value for sine waves will give the reading in column two of October's table for a one-volt peak input. So column one is what is sensed, col. two what is indicated, and col. three the heating equivalent value, with the error in col. six. Crest factor, usually taken as a measure of deviation from a sine shape, is peak value divided by r.m.s. value (form factor, less often used, is r.m.s. value divided by mean value). In the table the second row refers to *both* triangle and sawtooth waveforms, and the fourth row to *both* rectified and 90°-chopped sine waves.

As well as Intel devices comprising analogue-to-digital converter and display drive on one chip listed on page 76 of October's article, a number of others are available, some as original approaches to the application, some as exclusive custom-designed chips jealously guarded, and some simply on a second-source basis.

National Semiconductor's four c-mos circuits are of the pulse modulation kind requiring no external reference components, though a voltage reference is needed. Linearity is within ±0.05% of full scale, typically 0.025%. Two are microprocessor compatible, with bcd outputs for $3\frac{1}{2}$ or $3\frac{3}{4}$-digit operation, while two others offer $3\frac{1}{2}$ or $3\frac{3}{4}$-digit multiplexed seven-segment outputs with a reading speed of either 5 or 2.5 per second, respectively.

Of Ferranti's interestingly wide range of converters that includes ramp, successive approximation, tracking, flash, charge balancing and dual-slope types, the $3\frac{1}{2}$-digit dual-slope chips are most applicable to voltmeter design. ZNA116 and 216 both drive multiplexed seven-segment l.e.d. displays, consume about 50mW but require additional analogue circuitry for the integrator and comparator sections.

The latest device ZN451 is the most useful. Not only is it a single chip circuit requiring only passive external components (for a basic voltmeter), but because it uses a digital auto-zero mode it obviates the need for the capacitor to store error voltage. And additional signal, conditioning circuitry andded to the main circuit can be included within the auto-zero loop to guarantee zero reading for zero input. A voltmeter evaluation kit which includes p.c.b., display and conditioning i.cs, is available (£29.50), though the chip is equally suitable for applications such as thermometry and transducer bridge interfacing.

Multimeters built into test probes are no longer new but perhaps a pen-style one that clips into the pocket will be. Middle photo: Japan's Soar 3200 (from HI); lower photo: another Japan-made probe sold under various names (Anders, Pantec, Beckman, Häwa, Hioki, Taylor); upper photo: not yet available.

Bench digital multimeters in addition to page 61/2 table, November issue.

Maker	Digits	Model	Basic price	Sens. d.v.	Basic error(1)	f_{max} a.v.(2)	Crest factor	Res. (3)	µP (4)	Other (5)
AOIP (Danesbury)	$4\frac{1}{2}$	5120		100µV	0.05%+1	20kHz	—	✓		diode test
		5121	338	10	0.03%+1	400	4	✓		G£261
		5122	474	1	0.03%+1	400	4	4		dB, G£255
Delristor	$4\frac{1}{2}$	Exis 200	850	10µV	0.03%+1	20kHz	3	✓		Safety cert.
Hioki	$3\frac{1}{2}$	3209	342	100µV	.2+1%+1	20kHz	—	✓		C, battery
(Doran Smith)	$4\frac{1}{2}$	3222	874	10	.04%+2	200k	?		2,4,7,12	f, G.
Rohde & Schwarz	$4\frac{1}{2}$	UDL4	365	10µV	0.03%+2	20kHz	5	✓		charges

1. Figures are direct voltage ±(reading%+digits) or ±(reading + f.s.) % over 12 months unless otherwise noted.
2. Level limit may differ e.g. −1dB, 1%, 3dB
3. 4: four-wire measurement, hi/lo: high and low test voltages
4. Microprocessor functions, see November table (9: variance, standard deviation, and r.m.s.)
5. G: GPIB interface, B: bcd/parallel interface, C: capacitance, dB: decibels

Korea's Hung Chang meters are still difficult to beat for price/performance ratio.

Autoranging multimeters (above and below) are sold under a variety of names — see table.

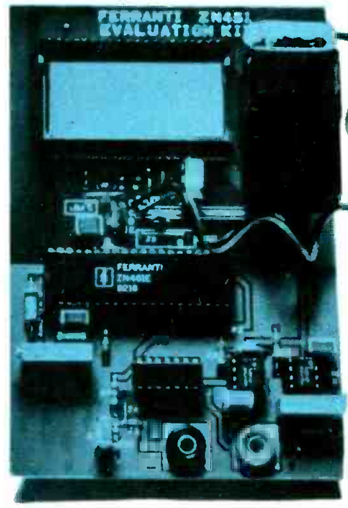
Hand-held digital multimeters

Brand	Model	Price (ex VAT)	Type (digits)[1]	Basic error[2]	f_{max} (note 3)	Ranges: (note 4) min d.v.	I	R	Device test[5]	Cont. (audio)[6]	Other (note 7)
Amprobe	AM4	171	3½	0.8%	400Hz	200mV	5	6	R	—	T
(Canadian Inst.)	AM5	124	B	1%	400	200	3	3	—	—	h. duty
	AM7	97	R	0.05%	similar to Soar ME550						
	AM8	112	R	0.5%+2	similar to ME540						
	AM9	126	R	0.35%	similar to ME530 range extending adapters available						
'Alta 1'	KD25C	32	3½S	1+.2%		2V	3	4	—	—	
	KD30C	37	R	.8+.2%		200mV	6	6	—	—	
	KD55C	47	R	similar to KD30 except 10A range							
	KD305	31	.S	0.8%	500Hz	2V	4	4	—	—	
	KD615	40	R	0.8%	500	200mV	5	6	h_{FE}	—	
Anders	SK6010	45	2½B	0.5%	similar to Lutron 6010						
	SK6500	49	3½R	.5%+%	similar to Ishii DM3350						
	SK6590	54	B	.5%+4	500Hz	2V	—	A4	—	<19Ω	probe
	SK6507	67	R	.5+.2%	500	200m	3	A5	✓	<1.9Ω	hold
	SK6330	89	B	similar to SK6507 but with button switches							
AOIP (Danesbury)	5102	115	3½R	0.1%	1kHz	200mV	5	6	✓	—	cmos
	5103	172	R	0.1%	data as above						cf:4
	5105	129	R	0.1%	data as above					✓	
AVO	2000	68	3½S	0.25%	450Hz	2V	2	3	R	<IkΩ	
(Thorn)	2001	90	S	0.25%	Ik	200m	6	6	R	<900Ω	
	2002	107	S	0.5%	—	200V	2	2	R	<30Ω	
	DA116	152	R	0.5%	10k	200m	6	6	0.5mA	✓	
	DA211	68	R	0.8%		200	6	6	✓		
	DA212	97	R	0.25%		200	5	5	—	—	
Beckman	3020	139	3½R	0.1%	10kHz	200mV	6	6	2mA	—	
Industrial	3030	175	R	0.1%	20k	similar to 3020					cf:
	300	99	R	0.25%		200	5	6		—	h.d.opt
	310	109	R	similar to 300 except 10A range							
	4410	212	4½R	.05%+2		200	5	6	✓	✓	cf:
	DM10	33	3½R	0.8%	400Hz	200	4	5	.8mA	—	
	DM15	43	R	0.8%	500Hz	200	4	6	1mA	—	
	DM20	51	R	0.8%	1k	200	5	6	1	—	G,h_{FE}
	DM25	58	R	0.8%	1k	200	4	6	1	<	G,C
	DM40	49	R	0.8%	1k	200	5	6	1	—	
	DM45	65	R	0.5%	1k	200	6	6	1	<100	
	DM73	40	S	0.5%+4	500	2V	—	A4	—	✓	probe
	DM77	46	R	0.5%+4	500	200m	A2	A5	—	<19	hi/lo
Bewa	6002/	36	3½B	0.5%		200mV	5/6	6	—	—	10,20A opt
(House of	3002/	39	B	0.25%	similar to Hung Chang 601(0)						
Instruments)	3510	52	B	0.1%	500Hz	200	6	6	—	—	
	3571	67	B	0.1%	10k	similar to HC7030					
	3610	130	B	0.1%	500	data as 3510					cf:
Brown Boveri	2011	65	3½R	0.5%	4kHz	200mV	%	&	—		cmos
	2012	78	R	0.25%	4kHz	200mV	5	5	—		
B & K	2804	73	3½R	0.5%+2	similar to Soar ME540						
(Canadian Inst.)	2806	87	R	0.7%+2	500	200	5	A6	.6mA	<20	man opt.
	2807	133	R	0.5%+2	data as above						
	2816	174	R	0.25%+2	data as above						
	2817	220	R	0.1%+2	data as above		6				hold
	2818	271	R	0.1%+2	data as above		6				cf:3,hold
Data	935	110	3½B	0.1%	500Hz	200mV	%	5/6	—		
Precision	936	125	B	data as above							
(Farnell)	945	205	4½	.05%+2	1kHz	200mV	5	6	—	✓	
Eagle	TS350	22T	3½S	1%		2V	3	4	—		Z_{in} 1MΩ
	500	30T	S	1%	similar Kwang Duk KD25C						
	750	50T	R	0.8%	similar Kwang Duk KD55C						
	4000	75T	R	0.25%	1kHz	200mV	6	6	✓		limits
Fluke	25	193	3¾R	0.1%	30kHz	320mV	5	6	.5mA	<150	G
	27	216	R	0.1%	data as above						max/min
	73	65	A3¾R	0.7%	10kHz	320mV	A3	A6	✓	—	
	75	79	A3¾R	0.5%	data as above				✓	<150	
	77	99	A3¾R	0.3%	data as above				✓	<150	holds
	8020	156	3½B	0.1%	450Hz	200mV	4	6	R	<600	6 ranges
	8021/2	103	B	0.25%	data as above						8021pk
	8024	198	B	0.1%	data as above					<	hold,G
	8026	155	B	0.01%	10kHz as above						cf:3
	8060	275	4½B	.04%+2	100k	200	5	A8	1mA	<10%	freq,dB
	8062	220	4½B	.05%+2	30k	200	5	A8	1mA	<50%	cf:3,rel.
Heathkit	2215	$100	3½B	0.25%		200mV	4	6	—		
(Maplin)	7215	$130	B	0.1%		data as above					
Hitachi	3550	82	3½B	.5%+2			200mV	6	6	.6mA	<20
(Thurlby-	3525	105	B	.25%+2		data as above					
Reltech)	3510	135	B	.1%+2		data as above					
Hung Chang	5010*	36T	3½R	0.25%	500Hz	200mV	7	7	3mA	<200	h_{FE},G,T
(Armon,	601(0)**	33	B	0.25%	400	200	6	6→	→		hi/lo
**Altaras,	604(0)	30†T	B	0.25%	data as above						
*Robin)	703(0)**	41	B	0.1%	5k	200	6	6→	→		hi/lo
	704(0)	37T	B	0.1%	data as above						
Ishii	DM2350	57	3½B	.8+.2%	500Hz	200mV	A1	A4/5	—	<2Ω	hi
(Altaras)	DM3350	42	3½R	.5%+4	500	200	A2	A4/5	—	<1.9Ω	hi/lo
Iskra	Digimer30	140	3½R	0.5%	4kHz	200mV	(6)	5	—	—	l.c.d
Hioki	3200	69	3½R	.35%	5kHz	200mV	5	A6	✓	✓	hold
(Dorman Smith)	3205	173	R	.3+.1%	1k	200	A4	A6	—	—	
	3207	50	B	.7%+4	500	200	A2	A5	✓	✓	hi/lo
	3208	75	B	as 3207 but with calculator (shared display)							

Hand-held digital multimeters

Brand	Model	Price (ex VAT)	Type (digits)[1]	Basic error[2]	f_{max} (note 3)	Ranges: (note 4) min d.v.	I	R	Device test[5]	Cont. (audio)[6]	Other (note 7)
Häwa (Kelgray)	3201	42	3½S	0.5%+4,	similar to model by Anders, Beckman, Pantec, Seiko						
	3212	58	R	0.5%+4,	similar to model by Beckman, Ishii, Pantec						
	1350	30	B	0.5%+4	similar to model by Anders, Beckman, Seiko, etc						
		58	B	.8+.2%	similar to Ishii DM2350 but with 20A						
Kane-May (E.T.I.)	KM28	55	3½	0.5%	400Hz	200mV	6	6	1mA	<30Ω	h_{FE},C
	Similar to Metex 3500										
Keithley	128	145	3½R	0.5%	500Hz	2V	1	4	R	✓	limits
	129	79	3½R	0.5%	500	200m	5	5	R		
	130A	115	R	0.25%	500	200	5	5	R		
	132	225	R	0.25%	500	200	4	5	R		cf:3,T
	135	265	4½R	0.05%	20k	2V	2	5	R		
	136	175	4½R	0.04%	1k	200mV	A3	A6	1mA	<18Ω	hold
Kwang Duk	(Kingdom)	See Altaras listing									
Kikusui (Telonic)	1506	69	3½B	.5%+2	500Hz	200mV	6	A6	—	<20Ω	man. opt.
Kyoritsu (Robin)	K1003	89	3½B	0.5%		200mV	6	5	—	✓	T opt
Lascar	2020	29	3½S	0.6%	500Hz	2V	4	4	✓		
Lutron (Contemp)	6010	40	3½B	0.5%	500Hz	200mV	5	5	✓		
	6011	50	B	0.5%	500	200	5	4	✓		h_{FE}
	6012	60	B	0.5%	500	200	5	5	✓		h_{FE},hi/lo
	6014	70	B	0.5%	500	200	3	4	✓		400A
Metertech	— See Lutron										
Metex (HI, Lawtronics	3500ser	34-45	3½R	0.5%	400Hz	200mV	6	6	1mA	opt	options
	3501ser	37-51	R	0.1%	400	200	6	6	1	opt	C,h_{FE}
Metrix (Sifam)	522	67	3½R	0.5%	45Hz	200mV	3	5	✓		
	562	95	R	0.2%	450	200	4	6	✓	✓	
	563	155	R	0.1%	3k	200	5	6	✓	✓	dB cf:
	575	175	R	.05%+2	20k	200	3	6	✓		freq cf:
MIC	3300A	42	3½R	0.8%	500Hz	200mV	6	6	.2mA	—	h_{FE} no ac
	7000	150	4½	0.05%	3kHz	200	6	6			G,f
	6000Z	46	3½R	0.8%	—	200	6	6	.2mA	✓	h_{FE}
Micronta (Tandy)	22189	35	3½R	0.2%	10kHz	2V	3	4			
	22191	45	R	0.2%	10k	200mV	3	6	✓	<300	
	22193	65	R	0.1%	10k		A	A	✓		
Norma (Cropico)	1214	102	3½R	0.4%	400Hz	200mV	5	6	R	—	
	1216	128	R	0.2%	5k	200	5	6	✓	<50	
Pantec (Solent, Cirkit)	Brisk	46	3½R	similar to Ishii DM3350							
	Zip	49	B	.5%+4	500Hz	2V	—	4	similar to Anders SK6590		
	2001	99	B	0.2%	30k	200mV	6	7	✓	—	osc,C
Philips (Pye Unicam)	2517	180	4R	.2+.05%	20kHz	100mV	2	5	1mA		cf:2
	2518	165	A4½R	.1+.02%	20k	200	5	6	1mA	✓	cf:9
Racal Dana	2000	188	3½R	0.2%	10kHz	200mV	6	7	—	—T	
Robin	OM100	59T	3½B	0.8%	similar to Lutron 6011						
	OM120	69T	R	0.25%	similar to Hung Chang 5010						
	K1003	89T	3½B	data for Kyoritsu							
Rohde & Schwarz	UDL33	157	3½B	0.1%	20kHz	similar to Hung Chang					
Ross	186	62T	3½P	0.8%	500Hz	200mV	6	6	✓	—	h_{FE},G
	187	55T		data as above							
	188	57T	3½B	0.8%	similar to Lutron 6011						
	189	88T		data as above, Similar to Soar 8050							
Sanwa (Servo & Electronics)	Plug-in adapters available for circuit checks, n, T, C										
	MD180	85	3½	.2+.15%	200mV	4	6	✓	—		hi/lo
	MD250	106	R	0.35%	200	4	A6	✓	✓		
	LD510	96	R	.7+.2%	200	A2	A5	optional			hi/lo
	LD520	147	R	.5+.2%	data as above						h_{FE}
	LD530	160	R	.5+.2%	data as above						C
	FD750	203	4½	.06+.03%	200	3	6	R	✓		
Siemens	B1002	125	3½R	0.2%	similar to Norma 1216						
	B1008		R	0.4%	similar to Norma 1214						
Sifam	2200	43	3½	.3%+2	700Hz	2V	4	5	—	—	
Simpson (Bach Simpson)	470	120	3½R	0.15%		200mV	5	6	—		
	474	189	4½R	0.03%		200	5	5	✓		
Soar (House of Instruments, *Maplin, †Eagle, ††Ross)	ME531*	56	3½R	0.8%		200mV	A2	A5	✓	✓	cmos
	ME530	49	R	.35%+2	500Hz	200	5	A6	.6mA	<20	cmos
	ME540	39	R	.5%+2	500	200	2	A6	.6mA	<20	
	ME550	37	R	.5%+2	500	200	1	A6	—	<20	cmos
	3025	149	B	0.25%	500	200	A6	A6	.6mA	<20	comparator
	3030	99		data as above but without comparator function							
	3100	39	B	.5%+3	500	200	—	A6	—	<150Ω	probe
	3400		4½B	.1%+2	500	200	A5	A6	1mA	<2Ω	
	8025†	75	3½R	0.2%	sold as Eagle TS4000						
	8050††	88		0.8%	sold as Ross RE 089						
Taylor (Thorn)	TD20	39	3½S	Seiko probe to BS4743, data as Anders SK6590							
Thandar	354	40	3½S	0.75%	500Hz	2V	4	4	✓		
Weston (Electroplan),	6100		3½B	0.5%	1kHz	100mV	4	5	✓	<1Ω	<1V,2V
	7310	165	B	0.5%	1k	200	4	6		<1Ω	<1V,2V
	7320	85	R	0.1%	1k	20V	—	A3	✓	<10Ω	
TMK (Harris)	3300	70	3½R	0.4%	400Hz	200mV	6	7	✓	—	cmos
	Two further models tba.			0.5%	450	200	A	A			

Notes. 1: B button, R rotary, S slide. 2 Basic (d.v.) error is ± (reading % +1 digit), or ±(rdg + f.s.)%, unless shown otherwise. 3 f_{max} (a.v.) limits may differ. 4: Minimum range shown for d.v., upper range typically 100d.v. and 750 a.v. Ranges for I, R are decades except for top I, normally limited to 10A. 5: Normally scaled to read forward voltage. R means maker suggests 2kΩ range. 6: Audible signal for continuity, maximum resistance value given where known. 7: Crest factor (cf) given for true rms meters. G conductance range, C capacitance, T temperature. hi/lo R switch gives >0.7V or <0.3V for in-circuit resistance measurement. For cmos devices battery life is quoted as 500-2000h.



For under £30 this evaluation kit provides a dvm with f.s. range of 2mV.

Correction. Because of a last-minute breakdown in facsimile reception of proofs certain pages of the November issue went unchecked. Readers will have spotted the most embarrassing errors (e.g. zero 'ironings' instead of crossings in the caption to Datron's Autocal multimeter on page 65) but those in the tables are less obvious. Please correct Brown Boveri's 2110 basic error to 0.05%+1, and Farnell's 141 error to 0.03%+2. A zero slipped in the R & S UDS5 error but its best figure over 12 months is 0.009%+1, and its rated a.v. max is 200kHz with a crest factor of 5.5 for true r.m.s. readings.

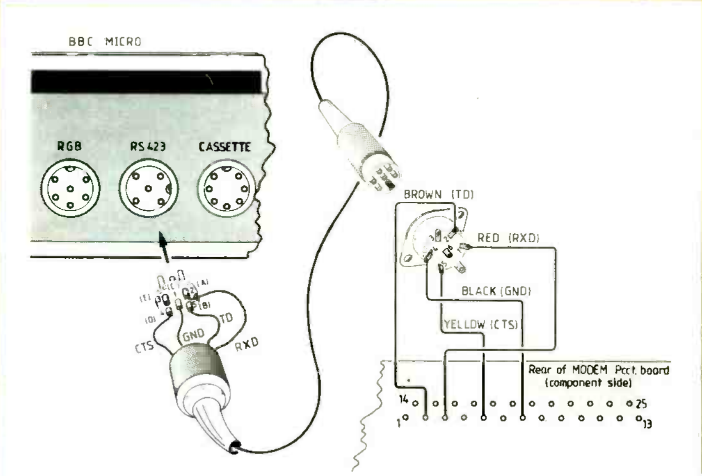
4½ digit meters are usually set to display their maximum value for photography but this Fluke display could be misleading in suggesting full five-digit capability.

by Richard Lambley

Multi-standard modem

Connections and modifications

Fig.1. Using the RS423 port of a BBC Micro. At the modem, it is cheaper to fit a six-pin DIN socket rather than the p.c.-mounting D-connector: connections shown are those found on certain commercial modems.



Several readers have asked for fuller information about connecting the modem to the BBC Micro, which lacks a full RS232 interface. Figure 1 shows pin details of the computer's RS423 connector and the corresponding terminals on the modem. The polarizing notch in the five-pin domino connector goes in on the side nearer the cassette port.

Notice that the RTS line from the computer is not used: this is to avoid the risk of line drop when the computer turns its attention to other matters, as it does during disc or tape filing operations. RTS is best tied high at the modem either by linking RTS to DSR, or (if IC7 has been omitted, as it may be when a full RS232 interface is not required) by linking pins 13 and 14 on IC_5.

Figure 2 shows a modification to take care of the opposite problem, a possible failure by the modem to disconnect the line when the user logs-off a viewdata system. This may occur if a noise on the line is interpreted by the modem as a burst of carrier.

The two inverters form a monostable which triggers when the line-seize relay drops out. Until the monostable times out (its period is a second or two) RL_1 cannot close again. The purpose of the diode pump circuit is to trigger the monostable if a succession of rapid transitions occurs on IC_8's carrier-detect output: this will make sure that the modem does not try to demodulate dialling tone.

Several spare inverters are to be found on the p.c.b. though BBC Micro users who have added the interface for the autodialler may find it less untidy to use spare inverters in that.

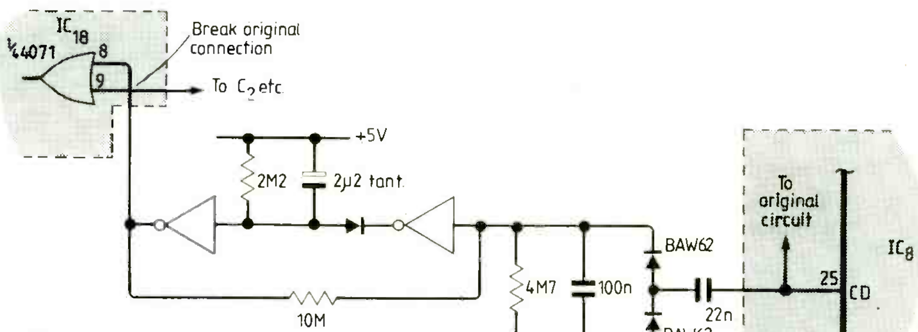


Fig.2. An additional monostable ensures that the line is dropped cleanly after a Viewdata call.

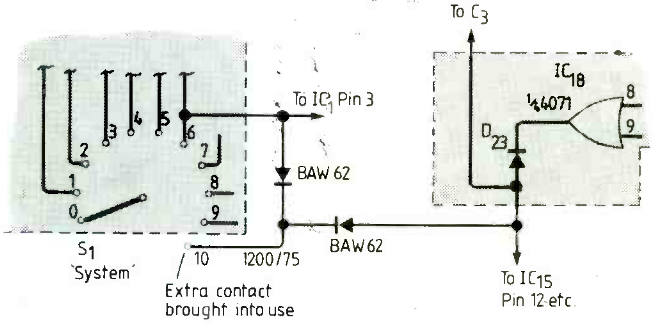


Fig.3. An extra mode for file exchange at 1200 baud.

However, there are times when you may want to hold on to the line regardless; for example, when exchanging files at 1200 baud with someone else. Reversing the direction of transmission can be made less hazardous by means of two diodes and the use of a spare contact on S_1. This provides an extra 1200/75 mode in which the modem will continue to hold the line even when there is no carrier (Fig.3).

To insure against possible instability in the auto-answer circuit, it is worth adding a high value resistor between pin 7 of IC_{11} and the 0V rail. The value is not critical; anything between 1 and 10MΩ seems to work successfully.

A further small addition to the board may be needed if you have been supplied with a 40147 for IC_1. This device is not a direct replacement for the 74HC147 since it has a connection to pin 15. If you fit a 40147, be sure to tie pin 15 to the 0V rail. Failure to do this may produce puzzling effects. One such modem I have seen appeared to be working all right except in the Bell 103 originate mode (for which all inputs to IC_1 are pulled high): it turned out then that IC_1 was driving the mode-select inputs of the Am7910 with 2MHz square waves.

Auto-dialler

An enhanced version of the auto-dialler (October issue) can be downloaded free of charge from the Microweb bulletin board in Stockport on 061-456 4157 (300 baud CCITT). The file is stored as Ascii text: when you have saved it you should reload it using *EXEC rather than CHAIN. The program includes one or two improvements, among them a facility for inserting pauses between digits to give time for a further dialling tone to appear.

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DF92 0.60
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DF97 1.00
DH63 1.20
DH77 0.90
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DH149 2.00
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DK92 1.20
DK96 2.50
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ECC83 Brimar/Mullard 1.35
ECC83 Philips 1.95
ECC84 0.50
ECC85 0.60
ECC86 2.75
ECC88 0.85
ECC91 2.00
ECC180 0.72
ECC189 0.78
ECC801S 3.50
ECC803S 3.50
ECC804 0.60
ECC2000 12.00
ECF80 0.85
ECF82 1.15
ECF86 1.70
ECF200 1.85
ECF202 1.85
ECF801 0.85
ECF804 6.00
ECF805 2.50
ECF806 10.25
ECH3 2.50
ECH4 3.00
ECH35 2.15
ECH42 1.00
ECH81 0.65
ECH83 0.78
ECH84 0.69
ECH2000 1.50
ECL80 0.60
ECL82 0.65
ECL83 2.50
ECL84 0.74
ECL85 0.69
ECL86 0.80
ECL805 0.69
EF37A 2.00
EF39 1.10
EF41 3.50
EF42 3.50
EF50 2.50
EF55 4.95
EF71 1.50
EF72 1.20
EF73 1.00
EF80 0.55
EF83 3.50
EF85 0.50
EF86 2.25
EF86 Special Quality 3.15
EF89 0.85
EF91 1.50
EF92 2.15
EF93 0.95
EF94 0.95
EF95 1.50
EF97 0.90
EF98 0.90
EF183 0.65
EF184 0.65
EF730 1.80
EF731 3.50
EF732 3.50
EF800 11.00
EF805S 13.50
EF806S 14.50
EF812 0.65
EFL200 1.50
EH90 0.72
EK90 0.72
EL32 0.95
EL33 4.00
EL34 2.25
EL34 Mullard 3.95
EL34 Philips 4.50
EL36 1.50
EL37 9.00
EL38 4.75
EL41 3.50
EL42 2.00
EL81 6.95
EL82 0.58
EL83 5.95
EL84 0.75
EL85 4.50
EL86 0.85
EL90 1.50
EL91 6.00
EL95 0.70
EL153 12.15
EL183E 3.50
EL18P 3.50
EL360 6.75
EL500 1.40
EL504 1.40

EL509 5.25
EL519 6.95
EL802 3.65
EL821 8.50
EL822 12.95
EM1 9.00
EM4 9.00
EM80 0.70
EM81 0.70
EM84 1.65
EM85 3.95
EM87 2.50
EN10 8.00
EN32 13.50
EN91 1.10
EN92 4.50
ESU150 14.95
ESU872 25.00
EY51 0.80
EY81 1.50
EY83 1.50
EY84 5.95
EY86/87 0.50
EY88 0.55
EY91 5.50
EY500A 1.50
EY802 0.70
EZ35 0.75
EZ40 2.75
EZ41 2.75
EZ80 0.75
EZ81 0.75
EZ90 1.50
F6064 2.95
FW4/800 2.95
G55/1K 9.00
G180/2M 9.00
G240/2D 9.00
G400/1K 14.00
GC10B 17.50
GC10D 17.50
GC10/4B 17.50
GC10/4E 17.50
GC12/4B 17.50
GD86W 6.00
GDT120M 5.00
GE10 9.00
GN4 6.00
GN10 15.00
GR10G 4.00
GS10C 16.50
GS10H 12.00
GS12D 12.00
GT1C 14.00
GT1C S/S 13.00
GTE175M 8.00
GTR150W 1.00
GU20 35.00
GU50 17.50
GXU1 13.50
GXU3 24.00
GXU50SS 14.50
GY501 1.20
GY802 1.00
GZ30 1.00
GZ31 1.00
GZ32 1.00
GZ33 4.50
GZ34 2.15
GZ34 MUL 3.95
GZ37 4.50
HAA91 1.00
HABC80 0.90
HBC90 0.75
HBC91 0.80
HF93 0.75
HF94 1.50
HK90 1.05
HL2K 3.50
HL23DD 4.00
HL41 3.50
HL42DD 3.50
HL90 0.70
HL92 1.50
HL133/DD 3.50
HR2 4.00
HY90 1.00
HVR2 3.00
JP9-7A 60.00
K3118 85.00
KR6/3 45.00
KT8C 7.00
KT33C 3.50
KT36 2.00
KT44 4.00
KT45 4.00
KT61 4.00
KT63 2.00
KT66 OSRAM 10.50
KT66 USA 6.90
KT66 GEC 14.95
KT77 Gold Lion 9.50
KT81 7.00
KT88 USA 9.00
KT88 Gold Lion 16.95
KT88 GEC 13.95
KT67 9.00
KTW61 2.50
KTW62 2.50
KTW63 2.00
KTZ63 2.50
L63 1.50
L102/2K 6.95
L120/2K 12.00
LB7-20 95.00
LS9B 6.95
M502A 60.00
85.00
M537A 60.00
M5143 155.00
M8079 6.00
M8082 7.50
M8083 3.25
M8091 7.50
M8096 3.00
M8098 5.50
M8099 5.00
M8100 5.50
M8136 7.00
M8137 5.50

M8161 6.50
M8162 5.50
M8163 5.50
M8190 4.50
M8195 6.50
M8196 5.50
M8204 5.50
M8223 4.50
M8224 2.00
M8225 3.50
ME1401 29.50
ME1402 29.50
ME1501 14.00
MH4 3.50
MHLD6 4.00
ML4 4.50
MS4B 5.50
MU14 1.50
MZI-100 125.00
N37 12.50
N78 9.85
OA2 0.85
OA2WA 1.50
OA3 2.50
OB2 0.85
OB2WA 1.25
OC2 2.50
OC3 1.50
OD3 1.70
OM4 1.00
OM5B 3.00
OM6 1.75
ORP43 2.50
ORP50 3.95
P61 2.50
P41 2.50
PABC80 0.50
PC86 0.75
PC88 0.75
PC92 3.50
PC97 1.10
PC800 1.10
PC900 1.25
PCC84 0.40
PCC85 0.54
PCC88 0.70
PCC89 0.70
PCC189 0.70
PCC805 0.70
PCC806 0.80
PCE82 0.80
PCF80 0.65
PCF82 0.60
PCF84 0.65
PCF86 1.20
PCF87 0.40
PCF200 1.80
PCF201 1.80
PCF800 0.40
PCF801 1.35
PCF802 0.60
PCF805 1.25
PCF806 1.00
PCF808 1.25
PCH200 1.50
PCL82 0.85
PCL83 2.50
PCL85 0.80
PCL86 0.85
PCL800 0.80
PCL805 0.90
PD500 3.50
PD510 3.65
PE1-100 69.00
PEN25 2.00
PEN40DD 2.50
PEN45 3.00
PEN45DD 3.00
PEN46 2.00
PFL200 0.95
PL21 2.50
PL36 0.95
PL38 1.50
PL81 0.72
PL81A 0.72
PL82 0.60
PL83 0.52
PL84 0.78
PL88 1.00
PL95 1.75
PL302 1.00
PL345 12.50
PL500 1.10
PL504 1.15
PL508 1.75
PL509 4.85
PL519 4.95
PL802 5.95
PL802T 3.50
PL820 2.95
PL5557 29.50
PY32 0.60
PY33 0.50
PY81 0.70
PY82 0.70
PY83 0.70
PY88 0.65
PY500A 1.95
PY800 0.79
PY801 0.79
QB3-300 30.50
QE03-10 3.50
QE08-200 145.00
QF40 65.00
QP25 1.00
QQE03-12 6.50
QQE03-20 27.00
QQV02-6 19.50
QQV03-10 5.50
QQV03-10 Mullard 9.50
QQV03-20 18.50
QQV03-20B 32.00
QQV06-40A 19.50
QQV07-50 63.50
QQZ03-20 42.50
QQZ06-40A 45.25
QS72/20 1.50
QS75/40 3.00
QS92/10 5.00
QS95/10 4.85
QS108/45 4.00

QS150/15 6.95
QS150/30 1.15
QS150/45 7.00
QS1200 3.95
QS1202 3.95
QS1203 4.15
QS1205 3.95
QS1206 1.05
QS1207 0.90
QS1208 0.90
QS1209 2.00
QS1210 1.50
QS1211 1.50
QS1212 3.20
QS1213 5.00
QS1215 2.10
QS1218 5.00
QU37 9.50
QV03-12 4.95
QV05-25 1.75
QV06-20 29.50
QV08-100 145.00
QV2-2500 45.00
QY3-125 49.50
QY4-250 65.00
QY4 400 71.95
R10 4.00
R16 12.00
R17 1.50
R18 2.50
R19 2.50
R20 1.20
R1169 55.00
RG1-125 4.95
RG1-240A 14.50
RG3-250A 3.50
RG3-1250A 35.00
RK2K25 62.50
RG4-1000 10.00
RK-20A 12.00
RL16 1.50
RPL16 12.00
RPY13 2.50
RPY43 2.50
RPY82 2.50
RR3-250 15.00
RR3-1250 33.50
RS613 45.00
RS685 54.95
RS688 52.15
S6F17 5.95
S6F33 28.95
S11E12 38.00
S30/2K 12.00
S104/1K 10.00
S109/1K 15.00
S130 5.95
S130P 5.95
SC1/800 5.00
SC1/1100 6.00
SC1/1200 5.00
SC1/1300 6.00
SC1/2000 9.00
SD6000M 45.00
SP2 1.50
SP41 5.00
SP42 3.00
SP4B 4.95
SS501 35.00
ST11 1.50
STV280/40 11.95
STV280/80 19.95
SU42 4.95
TB2.5/300 85.00
TB2-300 45.00
TB3/2000 3.95
TBL-2-300 275.00
TD1-100A 25.00
TD03-10F 35.00
TD3-12 4.00
TDD4 5.50
TP25 1.50
TSP4 7.00
TT11 1.50
TT15 34.95
TT21 34.95
TT22 34.95
TT100 57.00
TTR-31MR 65.00
TY2-125A 85.00
TY4-400 70.00
TY8-600W 365.00
TYS2/250 375.00
U18-20 2.75
U19 11.95
U24 2.00
U25 0.90
U26 0.90
U37 9.00
U41 6.95
U50 2.00
U82 3.00
U191 0.70
U192 1.00
U193 0.65
U251 1.00
U801 0.75
UABC80 0.65
UAF42 1.00
UBF80 0.60
UBC41 2.95
UBC81 1.50
UBF89 0.60
UBL21 1.75
UC92 1.20
UCC84 0.70
UCC85 0.60
UCF80 1.00
UCH21 1.20
UCH41 2.50
UCH42 2.50
UCH81 0.65
UCL82 1.75
UF85 1.20

UF41 1.15
UF42 1.15
UF80 0.80
UF89 2.50
UL44 3.50
UL84 0.85
UU5 3.50
UU7 8.00
UU8 9.00
UY41 3.50
UY85 0.70
V235A/1K 250.00
V238A/1K 295.00
V240C/2K 225.00
V241C/1K 195.00
V2464A/2K 315.00
V339 3.50
V453 12.00
VLS631 10.95
VP4B 4.50
VP133 2.00
VR75/30 3.00
VR101 2.00
VR105/30 1.50
VR150/30 1.15
VT52 2.50
VU29 4.50
VU39 1.50
W21 4.50
W77 5.00
W729 1.00
W739 1.50
X24 1.00
X66/X65 4.95
X76M 1.95
XC24 1.50
XC25 0.50
XFW47 1.50
XFW50 1.50
XG2-6400 135.00
XG5-500 22.50
XL1-5V 1.50
XL628FT 7.50
XNP12 2.50
XR1-1600A 49.50
XR1-3200A 79.50
XR1-6400A 99.50
Y503 25.00
Y65 6.95
Y602 12.00
YD1100 75.00
YJ1060 265.00
YL1020 29.00
YL1070 115.00
YL1071 135.00
YL1290 65.00
Z77 1.20
Z302C 12.00
Z359 9.00
Z505S 15.00
Z520M 4.00
Z521M 8.00
Z700U 3.00
Z749 0.60
Z759 19.85
Z800U 3.00
Z803U 18.95
ZA1000 12.50
ZA1001 1.50
ZA1002 1.50
ZC1040 8.00
ZM1005 8.00
ZM1020 8.95
ZM1021 8.00
ZM1023 7.95
ZM1041 14.00
ZM1082 9.00
ZM1084 10.00
ZM1177 9.00
ZM1202 55.00
ZM1263 4.00
ZM1612 3.00
1A3 4.50
1AC6 1.20
1B3GT 1.95
1B22 10.00
1B24 14.95
1B35A 29.50
1BC2A 2.50
1C1 2.50
1C5GT 2.50
1D5 2.50
1FD1 2.50
1G3GT 2.50
1K3GT 2.50
1L4 0.60
1L6 1.50
1LA6 1.00
1N2 4.50
1N5GT 2.50
1P28 25.00
1S2 0.55
1S5 0.70
1T4 0.70
1U5 1.00
1X2B 1.40
1Z2 8.95
2B7 1.50
2B22 69.50
2C21 1.00
2C39A 23.50
2C39BA 39.50
2C40 37.00
2C40A 55.00
2C42 29.50
2C51 0.75
2C53 32.00
2CY5 1.50
2D21 0.95
2D21W 2.50
2E26 7.95
2J42 93.00
2K25 24.95
2K25 Raytheon 75.00

2K26 95.00
3A/107B 12.00
3A/108A 9.00
3A/109B 11.00
3A/110B 12.00
3A/141K 11.50
3A/147J 7.50
3A/167M 10.00
3A2 3.95
3A3A 3.95
3A4 1.10
3AL5 0.95
3AT2 3.35
3B2 3.00
3B4 7.00
3B7 4.50
3B24 10.00
3B26 24.00
3B28 12.00
3BZ6 1.50
3C4 1.00
3C45 24.00
3CB6 1.50
3CN3A 2.50
3CS6 0.95
3CX3 2.50
3CY5 1.50
3D6 4.50
3D21A 29.50
3D22 19.50
3E22 49.50
3EH7 1.95
3EJ7 1.95
3W4GT 2.50
4B551B 115.00
4-65A 59.00
4-250A 65.00
4B32 19.50
4BQ7A 1.75
4BZ6 1.95
4C27 25.00
4C28 25.00
4CB6 1.95
4CX250B I.T.T. 37.50
4CX250B EIMAC 49.00
4CX250B surplus ex-government 12.50
4CX250B tested ex-equipment 6.00
4CX250BM EIMAC 75.00
4CX250K EIMAC 95.00
4CX125C 125.00 EIMAC
4CX350A 71.50
4D26 75.00
4GS7 2.25
4GV7 2.25
4J52 75.00
4JC6A 2.95
4X150A 25.00
5A/102D 9.50
5A152M 9.00
5A163K 10.00
5A170K 6.25
5A-180M 9.00
5A-206K 10.00
5AMB 2.15
5ANB 1.20
5AR4 2.00
5AU4 1.50
5B8 2.50
5B.110M 10.00
5B-254M 14.50
5B-255M 19.50
5B-256M 9.00
5B-257M 9.00
5B-258M 14.50
5C22 89.50
5R4GB 2.80
5R4GY 2.80
5T4 5.95
5U4G 1.95
5U4GB 2.50
5V4G 1.25
5Y3GT 1.95
5Z4GT 0.85
6/30L2 0.70
6A/203K 9.00
6A7 4.95
6A8G 1.50
6AB8 0.66
6AC7 2.00
6AF4A 2.50
6AF9 4.15
6AG5 1.00
6AG7 1.95
6AH6 2.50
6AJ4 2.00
6AJ7 2.00
6AK5 1.50
6AK6 2.00
6AL5 0.60
6AM4 3.25
6AM5 6.00
6AM6 1.50
6AN5 2.65
6AN8A 2.65

6AQ5 1.50
6AQ8 0.85
6AR8 3.95
6AS5 1.50
6AS6 2.50
6AS7G 4.50
6AT6 0.75
6AT8 1.75
6AU4 2.00
6AU6 0.95
6AV6 0.75
6AW8A 2.50
6B8G 1.50
6BA6 0.95
6BA7 4.50
6BA8A 3.50
6BC8 1.00
6BD4 1.50
6BD6 1.00
6BE6 0.72
6BF5 1.60
6BG6G 3.00
6BH6 1.95
6BH8 1.50
6BJ6 1.20
6BK4 4.00
6BK7A 1.95
6BM8 0.58
6BN4 1.65
6BN6 1.65
6BN7 4.50
6BN8 2.35
6BQ5 0.75
6BQ7A 0.72
6BL7GTA 3.95
6BL8 0.65
6BR5 0.70
6BR7 4.95
6BR8 2.15
6BR8A 2.15
6BS7 5.50
6BS8 2.50
6BW4 1.50
6BW6 5.35
6BW7 1.50
6BW8 4.00
6BX6 0.48
6BX7GT 3.50
6BZ6 2.50
6BZ7 2.95
6C4 1.10
6C5 1.95
6C6 2.50
6C8G 1.50
6C11 2.50
6C15 2.50
6C18 2.50
6CA4 0.60
6CA7 3.50
6CB5 3.95
6CB6 1.95
6CD6GA 4.50
6CF6 1.50
6CH6 6.95
6CL3 3.95
6CL6 3.25
6CL8A 2.00
6CM5 1.60
6CM7 2.95
6CS6 0.75
6CW4 6.50
6CY5 1.00
6CY7 2.50
6DC6 2.35
6DE6 1.15
6DQ5 3.35
6DQ6B 2.50
6DW4 2.15
6EA4 4.95
6EA7 2.50
6EA8 2.50
6EB8 1.75
6EM5 2.50
6EM7 2.50
6EU7 1.95
6EU8 1.75
6EV7 2.95
6EW6 1.50
6EW7 4.50
6F1 2.00
6F5 4.95
6F6G 2.00
6F7 5.50
6F12 1.50
6F13 3.00
6F14 1.00
6F17 2.75
6F21 2.50
6F22 0.70
6F23 0.60
6F24 1.25
6F25 1.25
6F28 1.25
6F32 1.25
6F33 17.00
6FG5 1.95
6G6G 5.50
6GH8A 0.80
6GK5 1.50
6GK6 1.95
6GS7 2.15
6GV7 2.50
6GW6 2.50
6H1 9.50

6H3N 1.10
6H6 1.35
6H6GT 1.95
6HS6 4.95
6J4 2.15
6J4WA 3.15
6J5 2.50
6J6 0.65
6JB6A 3.95
6JE6C 4.95
6JU8 2.50
6JS6C 4.95
6J7 4.15
6K7G 0.70
6K8 3.95
6KD6 5.50
6KM8 2.50
6KT8 2.95
6L1 2.50
6L15 3.15
6L19 3.95
6L6GC 2.95
6L6GC(GE) 3.95
6L6GT 1.15
6LD20 0.60
6LF6 4.50
6LJ8 2.50
6LQ6 4.95
6N7 2.50
6N7GT 2.50
6P15 1.50
6P25 4.00
6P26 4.00
6P28 2.00
6Q7 1.20
6Q7GT 1.20
6R7G 3.15
6S4A 1.50
6S7 1.10
6SA7GT 1.35
6SC7 1.50
6SG7 1.35
6SH7 1.35
6SJ7GT 1.20
6SK7 1.35
6SK7GT 1.35
6SL7GT 0.85
6SN7GT 1.35
6SQ7 1.35
6SS7 1.95
6U4GT 1.75
6U8 1.15
6U8A 1.50
6V6GT 0.85
6X2N 1.00
6X4 1.50
6X5GT 1.00
6X5GTY 1.00
6X8A 2.25
7A6 4.50
7A7 2.00
7AD7 1.75
7B7 2.50
7C6 2.50
7E7 2.50
7AU7 1.50
7J7 5.50
7Y4 2.50
8B8 2.50
8B10 2.50
8BQ5 1.95
8FQ7 1.95
10D2 1.25
10DE7 2.50
10F1 0.75
10GK6 1.95
10P14 2.50
10P18 0.78
10LD11 1.00
10LD12 0.65
11E3 55.00
12A6 3.95
12AD6 1.50
12AG8 1.50
12AL5 1.00
12AT6 0.95
12AT7 1.15
12AT7WA 2.50
12AU6 1.50
12AU7 0.55
12AV6 0.80
12AX4GT 1.00
12AX7 0.65
12AX7WA 2.50
12AY7 3.95
12AZ7A 1.95
12B4A 3.50
12BA6 1.50
12BE6 1.95
12BH7A 2.50
12BL6 1.75
12BY7A 2.75
12BZ6 4.95
12CA5 1.95
12CX6 1.20
12DQ6B 3.50
12DW4A 3.50
12DW7 2.50
12E1 17.95
12E14 28.00
12GN7 3.95
12HG7 4.50
12HG7A 4.50

12J7GT 0.70
12J7GT 3.50
12K5 1.00
12K7GT 0.60
12K8 1.10
12SA7GT 1.00
12SG7 4.75
12SH7 1.00
12SK7 1.00
12SJ7 0.60
12SN7GT 1.85
12SQ7GT 1.50
13D3 3.20
13D7 3.20
13D9 3.20
13DE7 2.50
13DR7 2.95
13EM7 3.50
14S7 1.00
17EW8 0.95
17JZ8 2.75
18D3 1.60
19AU4GT 2.50
19G3 17.00
19H4 23.95
19H5 33.50
19Q6 9.00
20A2 10.50
20D1 0.70
20LF6 3.50
20L1 0.95
20P1 0.55
20P3 0.60
20P4 1.95
20P5 1.15
21LU8 2.50
24B1 39.50
25L6GT 1.75
25BQ6 1.75
29C1 19.50
30C17 0.40
30C18 1.48
30F5 0.95
30FL1 1.00
30FL2 1.35
30FL12 0.95
30FL13 1.10
30FL14 1.25
30L1 0.45
30L15 0.60
30L17 0.60
30P4MR 1.00
30P12 1.00
30P18 0.60
30P19 1.00
30PL1 2.50
30PL13 0.60
30PL14 1.75
31JS6A 5.50
33A/158M 19.50
35A5 4.50
35L6GT 2.00
35W4 0.70
35Z3 1.85
38HE7 4.50
40KD6 5.50
42 6.95
47 6.00
50A5 1.50
50C5 0.95
50CD6G 1.15
50EH5 1.50
50JY6 2.95
52KU 2.00
53CG 15.00
61SPT 4.50
75B1 2.50
75C1 2.50
83 8.50
84 3.00
85A1 6.50
85A2 1.50
90AV 10.00
90C1 2.70
90CG 13.50
91AG 9.00
92AG 19.50
92AV 12.50
95A1 6.50
108C1 1.50
150B2 6.95
150C2 1.50
150C4 2.15
155UG 25.00
185BT 1.50
274A 15.00
307 5.00
328A 15.00
388A 17.50
425A5 8.00
431U 2.00
572B 35.00
705A 8.00
708A 8.00
715A 6.00
715C 45.00
725A 275.00
803 14.95
805 39.00
807 1.60
810 45.00
811A 12.95
813 18.50
813USA 45.00

829B 14.50
833A 60.00
866A 4.50
872A 27.50
873 80.00
884 5.50
930 9.95
931A 13.95
954 1.00
955 1.00
958A 1.00
1299A 0.60
1619 2.50
1625 3.00
1626 3.00
2050W 4.50
2050 3.95
3545 4.00
404A 10.95
927 15.00
1927 25.00
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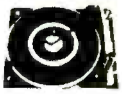

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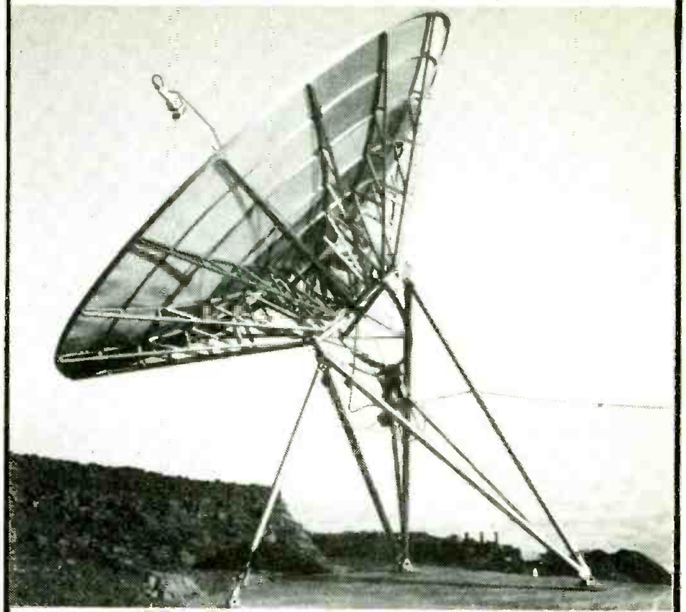

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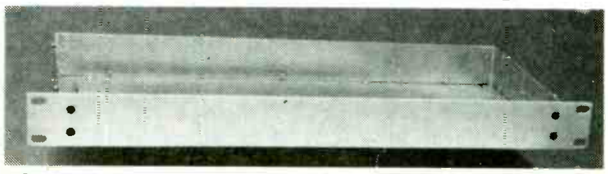

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CIRCLE 41 FOR FURTHER DETAILS.

Intelligent eprom programmer

Having its own processor, this intelligent programmer can quickly copy eproms up to the 27512 and list eprom data on a serial printer — under computer control it programs one-chip microcomputers. Part two discusses computer control software and construction.

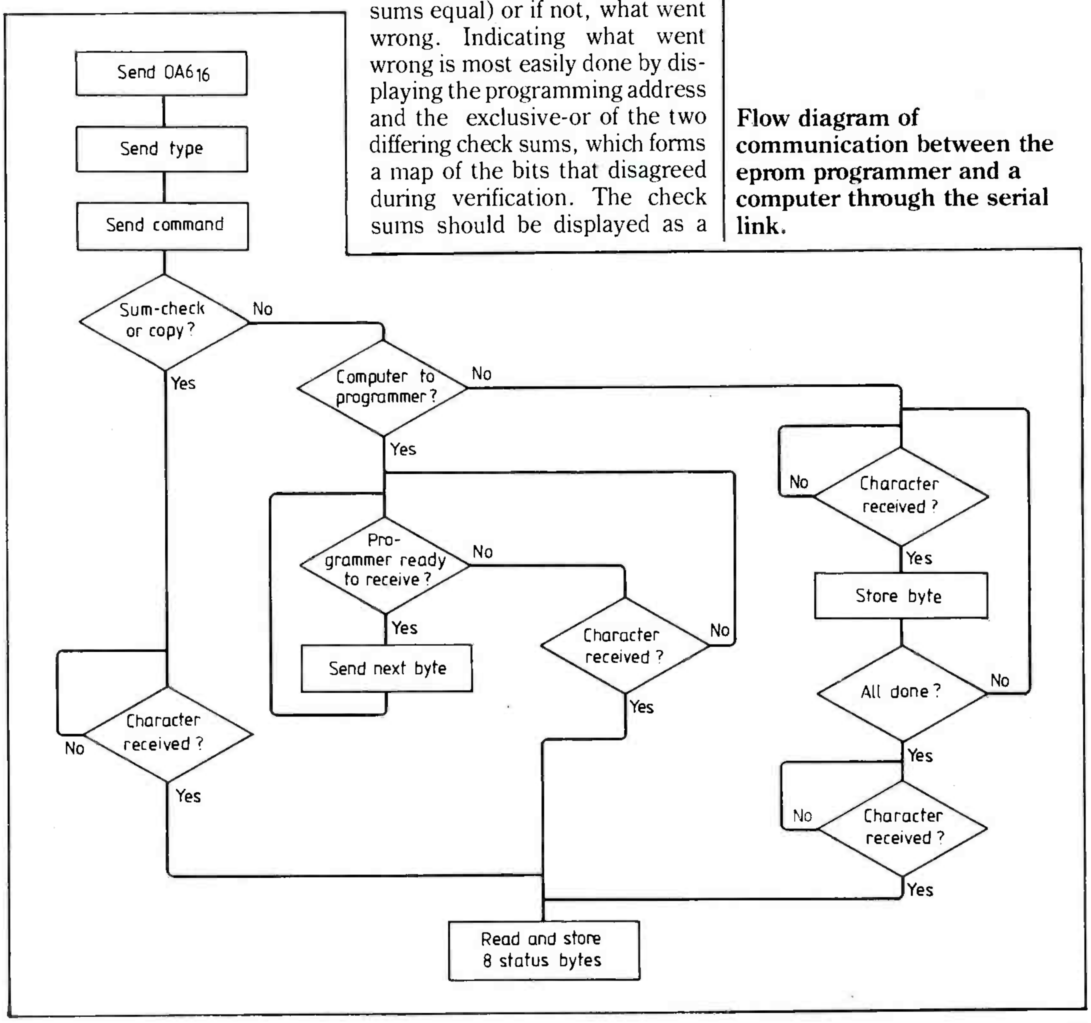
by J.H. Adams, M.Sc.

My control program for SC84* is written in assembly language but a program written in a high-level language could be used at the expense of speed. The SC84 program uses CP/M-compatible system calls so it should be possible to adapt it for other CP/M computers. The only 'non-standard' requirement is that the program needs to know the serial-port status, i.e., whether it is ready to be sent a character or whether there is a character in its receive buffer. Software for the eprom programmer is in an eprom provided with the kit. The SC84 control program is available separately on disc (details later).

Computer software for remotely controlling the eprom programmer needs to display eprom types and programming commands available, and to input and validate the user's selection If the operation involves a disc file, the program has to receive and validate the file identification. It must also react if a file for passing data to the programmer doesn't exist, or a file for receiving data from the programmer already exists.

When the eprom type has been established, the program must draw the length of the eprom from a table for use during file transfer. Communication between the computer and programmer is outlined in the flow diagram. The $A6_{16}$ byte sent before each operation is an arbitrary code signalling the start of the operation. It is used so that the programmer is not put off by any odd character that the computer might have waiting in its transmit buffer when the two are connected.

At the end of the transfer, the program must examine eight bytes returned by the programmer. These bytes consist of a 24-bit check sum of data read from the master socket, a 24-bit check sum of data read from the slave socket, and the 16-bit address of the last programmed location plus one. By manipulating these figures, and a check sum of the data file where appropriate, the program should be able to indicate to the user whether programming was successful (check sums equal) or if not, what went wrong. Indicating what went wrong is most easily done by displaying the programming address and the exclusive-or of the two differing check sums, which forms a map of the bits that disagreed during verification. The check sums should be displayed as a



Flow diagram of communication between the eprom programmer and a computer through the serial link.

*SC84 was described in the May, June, July, September and October issues of E&WW

source of information after a 'sum-check only' command is ended.

These are minimum requirement for the program. Other almost essential elements are some form of progress indicator and a routine that recognizes files containing Intel hexadecimal code (a standard form for assembler or linker output files) and translates it into hexadicimal form before it is sent to the programmer. My program for the SC84 includes these features and more.

Typical screen displays are shown in Fig. 1(a-d) You are first prompted for the eprom type and then for the operation required. In each case, only a single letter is entered. If commands A or B are chosen, they execute immediately. Any other command results in a prompt for a file name to be used for the destination or source of data. Invalid file names of more than eight characters or invalid file types of more than three characters are rejected.

The file is searched for on the disc and extra prompting occurs, Fig. 1(b), if the destination file already exists (commands C to E) or cannot be found (command F). Once a correct file specification has been entered and initiated, the message 'programming now' appears on the screen and progressively tuns into reverse video as programming proceeds. Previously entered information about the eprom type is used by the software to work out how to scale the progress of this operation so that there are always the same number of changes. The rate of change varies faithfully in terms of bytes programmed as the programming algorithms skip or shorten programming time.

Programming ends when all locations are programmed or an error occurs. After successful programming, check sums of the eprom and disc file are displayed. One of these is derived by the computer, the other by the programmer, so they provide additional cross-checking of the programming. If an error occurs, both check sums are displayed together with an error pattern consisting of a hexadecimal byte in which logic ones represent faulty bit positions in the eprom location, and the address location of the error. Status leds on the programmer are set to reflect the result of the programming.

An extra option is available when using command F. If the file specification given as the data source is a .HEX type, the file is assumed to contain code in Intel hex. form and is compiled accordingly, with the starting address assumed to be the first location in the eprom. Data in the file is all ascii which makes the transfer of data between computers much easier. Actual data in an Intel hex. file consists of lines or 'records' of ascii characters each consisting of a colon, the count of the number of data bytes in the line, a null byte, the data bytes, a check sum of the characters in the line followed by carriage-return and line-feed characters. The last record in the file has a zero data count and holds the program start address as its starting address.

Fig.1. **Displays presented by John Adams' SC84 software for controlling the eprom programmer. The first of these, (a), shows a sum check of two erased 2716 eproms. An attempt to read data from a 2732 in the slave socket into a disc file in which the file EPROM.COM already exists is shown at (b). Screen (c) is a simulation of a bad-programming error produced by attempting to copy a 2732 to an empty slave socket and (d) shows a successful attempt reading an eprom's content into a disc file.**

```
SC 84 Eprom Programmer Control
Program Version 1.00
A - 2716      B - 2732      C - 2732A      D - 2764
E - 2764A     F - 27128     G - 27128A     H - 27256
I - 27512     J - 27513     K - 8741/8     L - 8749

      Enter your EPROM choice, A to L, now...A

A - ABORT session               B - SUMCHECK only
C - Read MASTER to COMPUTER     D - Read SLAVE to COMPUTER
E - COPY MASTER TO SLAVE        F - PROGRAM SLAVE
                                    from COMPUTER

  Enter your COMMAND choice, A to F, now...B
SUMCHECK of MASTER EPROM is 07F800
SUMCHECK of SLAVE EPROM is 07F800
```

```
A - 2716      B - 2732      C - 2732A      D - 2764
E - 2764A     F - 27128     G - 27128A     H - 27256
I - 27512     J - 27513     K - 8741/8     L - 8749

      Enter your EPROM choice, A to L, now...B

A - ABORT session               B - SUMCHECK only
C - Read MASTER to COMPUTER     D - Read SLAVE to COMPUTER
E - COPY MASTER TO SLAVE        F - PROGRAM SLAVE
                                    from COMPUTER

  Enter your COMMAND choice, A to F, now...D

ENTER the name of the DATA FILE ... EPROM.COM

This FILE does ALREADY EXISTS. Do you want toA - INPUT a NEW
FILE NAME, or,
B - OVER-WRITE the FILE
  Enter your choice, A or B, now...
```

```
A - 2716      B - 2732      C - 2732A      D - 2764
E - 2764A     F - 27128     G - 27128A     H - 27256
I - 27512     J - 27513     K - 8741/8     L - 8749

      Enter your EPROM choice, A to L, now...B

A - ABORT session               B - SUMCHECK only
C - Read MASTER to COMPUTER     D - Read SLAVE to COMPUTER
E - COPY MASTER TO SLAVE        F - PROGRAM SLAVE
                                    from COMPUTER

  Enter your COMMAND choice, A to F, now...E
SUMCHECK of MASTER EPROM is 0000E9
SUMCHECK of SLAVE EPROM is 0000FF
ERROR Pattern is 16
PROGRAMMING ADDRESS is 0000
```

```
A - 2716      B - 2732      C - 2732A      D - 2764
E - 2764A     F - 27128     G - 27128A     H - 27256
I - 27512     J - 27513     K - 8741/8     L - 8749

      Enter your EPROM choice, A to L, now...B

A - ABORT session               B - SUMCHECK only
C - Read MASTER to COMPUTER     D - Read SLAVE to COMPUTER
E - COPY MASTER TO SLAVE        F - PROGRAM SLAVE
                                    from COMPUTER

  Enter your COMMAND choice, A to F, now...C

ENTER the name of the DATA FILE... B: F8086. OBJ
SUMCHECK of MASTER EPROM is 078200
SUMCHECK of DISC FILE is 078200
```

Construction

These notes assume that you are using the kit and p.c.bs mentioned at the end of this article. The main board has components mounted on both sides. All of the components on side two of the board, i.e. all but the leds, push buttons and zero-insertion-force (zif) sockets, should be mounted and soldered first. Then mount the zif sockets by setting the lever to its lock position and working the socket carefully into the relatively tight-fitting holes on the p.c.b.

Push buttons and leds should be mounted next, but not yet soldered. Make sure that the leds are the right way round, with their anodes connected to the adjacent resistor. Fit the p.c.b. to the top panel of the case using the M3 nuts, screws and spacers. With the board centralized against the top panel and the nuts tightened, adjust the switches so that they are square within their cut-outs before soldering them in. Next, align the leds so that they stand vetically and square in their panel holes and solder them. The 6MHz crystal stand upright and can be swathed in silicone compound to strengthen its mounting if required.

The cable linking the main board and power-supply p.c.b. should be between 16 and 17cm of the ribbon cable stripped of the black wire. The 9-way plug should be fitted to the main p.c.b. and a 9-way connector fitted at one end of the cable with the gap in the connector between the violet and grey wires. Solder the cable at the power-supply p.c.b. with the wires in the same order as at the connector. To link the transformer and power-supply board, a short length of ribbon cable is soldered to the transformer at one end and fitted to a five-way connector with pins two and four removed at the other.

A 20cm length of 5-way ribbon

cable with a 5-way connector at one end and soldered to a 25-way female D-type connector at the other forms the serial data connection, Fig 2. The D-type connector conforms to the standard 'output-to-peripheral' configuration for an RS232 port and can be connected to a printer using a direct pin-for-pin printer cable. For communications with a computer, a special cable will be needed to suit the computer's socket. For SC84, the serial port of which is wired exactly as the programmer's, this consists of a cable terminated with male connectors and with its data and hand-shake lines crossed over as shown in Fig. 3.

A 2732 eprom is supplied with the programmer control program; for this device LK1 (the long one) should be made. The other link is allows a 2716 to be used.

Both the 8035 and 8243 are available in cmos as the 80C35 and 82C43 and a version of the programmer has been constructed using them. There are no problems in doing so as the cmos versions have the same current sinking capabilities and interface levels as equivalent nmos parts. Using cmos devices saves power, but the three cmos i.cs cost two to three times more than three equivalent nmos devices — which together can cost less than just one of the 28-pin zero-insertion-force sockets.

Setting up

After carefully checking the construction, connect just the transformer to the power supply and test this part of the circuit, Fig. 4, before connecting the main board. Your voltmeter must be accurate to 250mV and cover the range 0 to 30V. Check that the 5V line is correct and that the +12 and −12V rails are within 2V of their nominal values. Check that V_{pp} is zero then temporarily link PSU ON to +5V and check that V_{pp} rises to somewhere between +12 and 30V and falls back to zero when the link is removed.

When the supply is operating as described switch off, connect the programmer board and switch back on again. The two leds indicating 2716 and the OK led should light. If not, check the supply rails, wiring of the leds (especially if one or two of those expected to light do light) and general construction.

Next press the UP button to test all of the eprom indicator leds. With the indicator again set to 2716, press and release the PROGRAM button. A relay should operate and the OK led should go out and the PROGRAM led light for around 1 to 2s. If this happens press and release the UP button, checking that the indicator reads 2732. Press the PROGRAM button. One relay should release and another activate followed by about 4s of attempted programming.

To set the progamming V_{cc} supply, switch the programmer off then on again. Insert a 120Ω resistor in pins 14 and 28 of the slave socket, lock the socket, and measure the voltage on pen 28. It should be between 4.75V and 5.25V. Short of the base of Tr_1 to its emitter and adjust VR_1 on the main board until the reading is 6V. Remove the short and the resistor.

To set the programming voltages, connect a 1W, 680Ω resistor between V_{pp} and 0V (e.g. in parallel with C_7) and connect the voltmeter across it. Switch the programmer on, press the LIST button, and adjust R_{108} on the power supply board to set V_{pp} to 25V.

Switch the programmer off, pause, then switch it back on again. Select 2732A programming using the UP button then press LIST. Adjust R_{109} on the supply board to set V_{pp} to 21V. Switch off, pause then switch on again, select 27256 press list, and adjust R_{110} on the power supply to set V_{pp} to +12.5V. Switch off and remove the 680Ω resistor. Note that R_{108} affects all voltages and so the programming voltages must be set up in this order.

To test the listing function connect a printer and, if it is set for one of the available data rates other than 9600 baud, use the UP or DOWN buttons to move the pointer to the desired rate and press the LIST button to select that rate. Move the pointer to 2716 and press the LIST button, whereupon the printer should

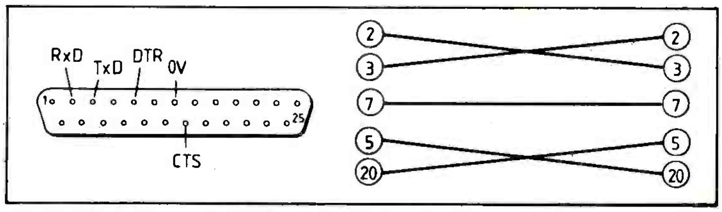


Fig. 2. **The serial interface D connector on the programmer used for computer connection or printer driving, left.**

Fig. 3. **Cable connections for connecting the programmer to SC84. These crossovers are required as the computer and programmer have the same pin numbering. Normally, connection to a printer wil be pin for pin.**

Main circuit correction. The circuit around pin 1 of the master and slave sockets shown last month is revised as shown.

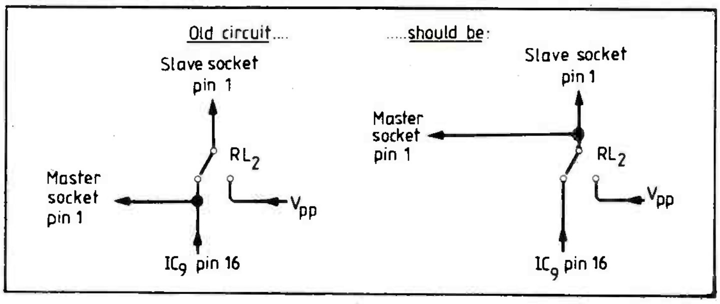
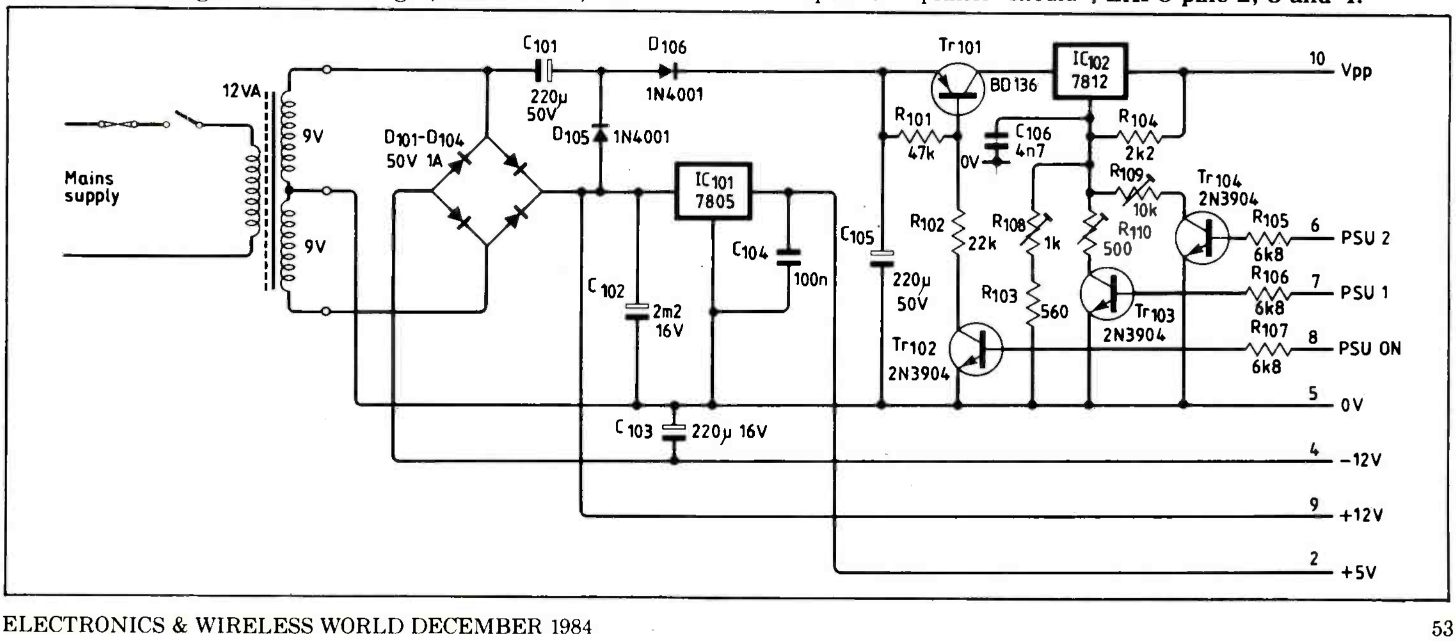


Fig.4. **Multi-rail power supply for the intelligent eprom programmer. Programming voltage V_{pp} is determined by the processor through input/output expander EXPO pins 2, 3 and 4.**



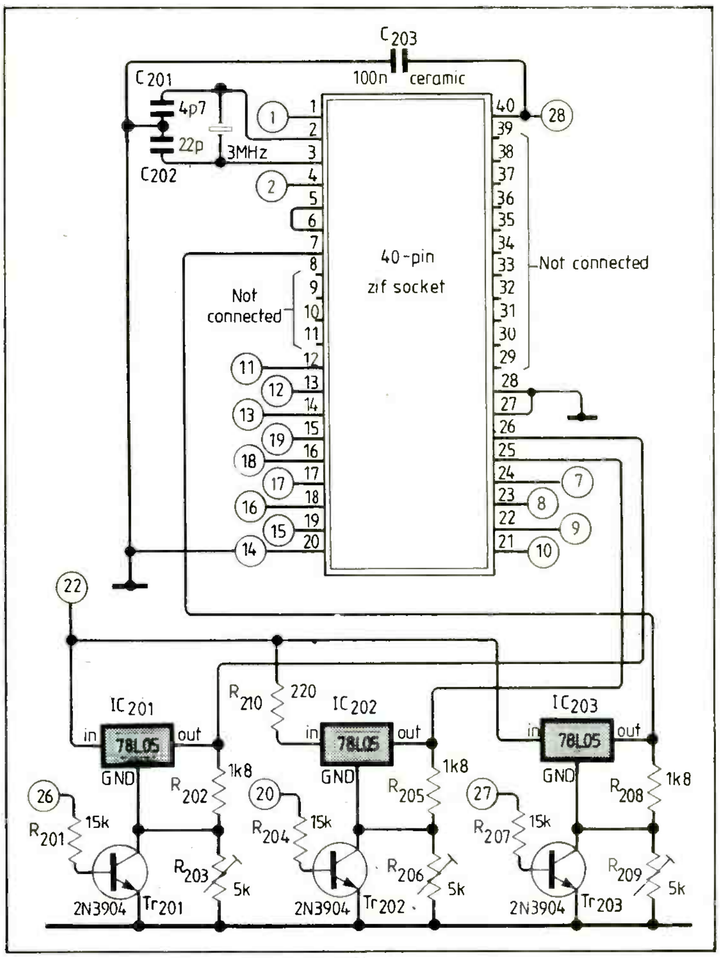


Fig.5. **8741/8/9 microcomputer programming adaptor. Numbers in circles refer to pins on the eprom programmer slave socket into which this adaptor is plugged. These extra components are needed to drive the processor clock and switch voltage levels.**

A complete kit of parts for the eprom programming unit including transformer, zif sockets, unpunched case, connectors, hardware and programmed eprom but not p.c.bs and parts for the microcomputer adaptor can be obtained by sending £77.50 including postage but exclusive of vat to John Adams at 5 The Close, Radlett, Hertfordshire, telephone Radlett 5723. Parts for the adaptor excluding p.c.b. but including sockets are an extra £15.00. A disc with the SC84 control program is £5.50 excluding vat but including postage — please state disc size, etc. A set of p.c.bs including a plated-through and silk-screened main circuit board are available from Combe Martin Electronics, King Street, Combe Martin, North Devon EX34 0AD for £17 including UK/overseas postage. The microcomputer programming board is an extra £4 including postage.

start to list memory as a series of FFs. Note that as yet, no eproms have been inserted into either the master or slave sockets.

When using the programmer, do not remove or insert eproms from or into the slave socket unless the OK or ERROR leds are lit since the V_{pp} programming voltage will be present on the slave socket. During listing, all three status leds stay off until the end of the operation. When programming, the end of the operation is indicated by the PROGRAM led going out and either the OK or ERROR leds lighting to indicate good or unsuccessful programming respectively.

At the end of each line printed during listing, the programmer checks the keyboard so that a listing may be interrupted by pressing and releasing the UP or DOWN key. If LIST is selected and a printer is not connected, the system will need to be switched off and then on again to regain control.

Programming one-chip processors

Design of this programmer is flexible enough to be adapted to virtually any eprom device, due primarily to the general-purpose nature of most of the signal connections to the programming socket. One example of an unusual programming task is to program microcomputers with built-in eprom.

Several such microcomputers — including the one used in this programmer — are available with built-in eprom. The idea of such a device with eprom is that it more closely emulates the final rom version of a one-chip microcomputer during development of a circuit. Using external memory as the program store means that signal lines have to act as data and address lines which severely restricts their use as general i/o lines. Further, as anything up to 16 pins are freed to act as i/o lines, use of the eprom version reduces the need for peripheral i.cs.

Rather as with eproms, manufacturers saw the eprom microcomputer as a development tool and thus a small-volume product. Just as with eproms, manufacturers appear to have been caught out by their massive use in production as a means of maintaining product flexibility. Main suppliers of eprom microcomputers are Intel and NEC, types offered being the 8741A, 8748, 8749 and the more advanced 8751 and 8744.

Being 40-pin i.cs the programmer requires an adapter, which comes in the form of a small p.c.b. with a few components, a 40-pin zif socket and a 28-pin plug. One adapter is suitable for programming 8741A, 8748 and 8749 i.cs, Fig.5. Devices in the 8748 series are more difficult ot program, needing three controlled high voltages and multiplexed addresses and data. The programmer provides all of the control signals and even scrambles data to and from the 40-pin socket in order to made p.c.b. layout simpler.

As the adaptor only has one socket, direct copying of one 40-pin device to another is not possible. A bigger p.c.b. would be needed for this. Direct copying of these devices is not frequently required so I opted for the cheaper solution — one zif socket costs more than the rest of the adapter put together. The adapter always fits into the slave socket as it needs high voltages for both reading and writing. When the adaptor is used, the programmer should be controlled by computer, whence all operations except direct copying are possible. Copying can of course be carried out by reading the master device into a disc file and then programming other devices using the file.

The address for the 8748 programming operation is not generated by the programmer's CD4040 as it is for eproms, but from a count kept in one of the 8035 ram locations. This counter is incremented after each location programmed and the 4040 is clocked every time the eight-bit counter passes through zero. Thus low-order address lines on the 28-pin socketlact as the higher-order address lines on the 40-pin one. Four such lines have been laid to the socket so that the adapter has the potential to program devices with up 4Kbyte of eprom. These don't exist yet but if an 8750 is produced, the system is ready to program it.

As mentioned earlier, the data lines are scrambled. This illustrates one of advantages of programmable over discrete logic. There are many occasions when a little software saves a lot of p.c.b. design effort. Perhaps too few electronic designers have to design their own p.c.bs as well! In this case, the top five lines are reversed, D_7 going to D_3, D_3 to D_7, D_6 to D_4 and D_4 to D_6. As well as being the optimum solution to p.c.b. layout, this mirror transposition allows the same software routine to both scramble the data prior to programming and unscrable data read back for verification.

To set up the adapter fit it to the programmer, select 8749 and press the LIST button without a printer connected. Resistor R_{209} is adjusted to set the voltage on pin 7 of the 40-pin socket to 18V. Short of base of Tr_{202} to its emitter and set R_{206} to give 18V on pin 25 of the 40-pin socket. Finally, short the base of Tr_{201} to its emmitter and set R_{203} to give 21V on pin 26 of the 40-pin socket. After completing this procedure, switch the programmer off to clear the list instruction. Don't forget to remove the shorts.

Working of the programmer and the software controlling it are subjects of the next article.

The 8048

There are five types in this family of one-chip microcomputer, namely the 8035, 8039, 8049 and 8748, each with varying memory type/capacity, see table. All can address up to 4Kbyte of external program rom, 256 byte ram and have 32 bytes of dedicated ram.

I/O facilities

Port zero is an eight-bit port which may be used for parallel i/o. When accessing external memory, this port multiplexes the lower eight bits of the memory address and data read from or written to memory. Separate $\overline{WR}$, $\overline{RD}$ and $\overline{PSEN}$ signals are available to strobe data to and from external memory and from program memory respectively.

On eight-bit port one, the lines may be used as individual inputs or outputs. The output structure of these lines is interesting. When set high, only a weak pull-up resistance of about 50kΩ holds the line high but during the actual transition from low to high, a strong pull up is temporarily applied to ensure speedy action. In its high state, as well as being a high output, the line may also be used as an input.

On port two, also eight bits, the upper four lines act in the same way as those of port one. The lower four lines are available for i/o but also output the higher-order memory address lines during external program memory access, and act as a four-bit command and data bus between the microcomputer and any expanders fitted to the system.

Test inputs T_0 and T_1 can be used as subjects of conditional jumps in the program. A special instruction sets T_0 and T_1 can be used as subjects of conditional jumps in the program. A special instruction sets T_0 as a clock output running at one third of the crystal frequency. Test line T_1 may also be used as the input to the event counter. An active low maskable interrupt input, $\overline{INT}$, may also act as a test input for conditional jumps.

Other pins are a strobe for the expanders, $\overline{PROG}$, an address-catching latch, ALE, a single-stepping input, $\overline{SS}$, and an input forcing the processor to access external memory, whatever its type.

The microprocessor accesses external memory automatically when a program-counter address exceeds the limit of the internal rom. The incrementing section of the 8048 program counter is actually only an 11-bit register. To access 4Kbyte, an extra address line is required so the contents of the memory bank flag (MBF) form the twelfth bit of the address. This bit is set or cleared by the instructions SEL MB0 and SEL MB1 and transferred into the program counter on the next jump or call operation.

8048 family characteristics, values in bytes

Type	Internal rom	Other ram
8035	None	32
8039	None	96
8048	1K	32
8049	2K	96
8748	1K (eprom)	32

Programmer control lines

Line	8035
P_{10-17}	Data bus to eproms
INT	Serial data input
T_0	Serial hand-shake input
P_{24}	Select EXP0
P_{25}	Select EXP1
P_{26}	Serial handshake output
P_{27}	Serial data output

Internal facilities

An eight-bit counter/timer capable of interrupting the system is provided. When used as a timer it is clocked at 1/480 of the crystal frequency; it can set a flag and interrupt the system when the count passes through zero. The processor's built-in clock generator requires only a crystal and two capacitors externally. Only one capacitor is required by the power-on reset circuit.

Crystal frequencies for the 8048 may be as high 11MHz, this being divided by 15 to give the basic instruction rate. A typical crystal frequency is 6MHz giving a cycle time of 2.5μs and a basic timer unit of 80μs. Some 60% of the instructions execute within one cycle. The remainder, mostly immediate instructions where a second byte of data has to be fetched as part of the instruction, take two cycles.

Two identical banks of eight 8-bit registers which may be alternated between are used (similar to the Z80's). Two registers in each bank, R_0 and R_1, may be used as pointers to ram for indirect operation, the others are solely general purpose. Lastly, the 8048 has two settable and testable flags, one of which is automatically preserved during an interrupt.

Instructions

Data movement between registers, the accumulator and internal/external memory is fully catered for. In particular there are indexed instructions of the 'get the byte pointed to by the A register from a particular page of rom and put it in the A register' form. This allows a particular page to act as a very efficient area for look-up tables.

There are basic arithmetic and logical commands capable of acting directly on the A register and input/output ports, allowing direct mainipulation of from 1 to 8 bits a port. There are long jumps as well as short ones (i.e. within a page) which can be conditional on zero in the accumulator, the carry bit, any of the accumulator bits, a timer overflow, internal flags, the test lines or the interrupt line.

Z80-style decrement and jump-on-not-zero instructions (DJNZ) are available for all 16R registers. Of particular interest is a jump of the form — go to the location pointed to by the A register in the current page, get the byte there and put it into the lower byte of the program counter. This allows very efficient transfer of execution to one of many routines depending on the contents of the A register.

Standard call and return mechanisms are used for subroutines although there are no PUSH and POP instructions for storing information on the stack. The stack is within an area of memory devoted to ram and is eight return addresses deep. When a subroutine is called or an interrupt accepted, the 12-bit program counter and four status flags (carry, half-carry, internal zero and register bank) are pushed on to the stack. There are two types of return instruction. One just reinstates the program counter, the other, designed to make the call operation more transparent, reinstates flag bits too. The latter type is usually used for interrupts.

Line	IC_9 (EXP0)	IC_8 (EXP1)
P_{40}	PSU on	LED row 0
P_{41}	PSU select 12V	LED row 1
P_{42}	PSU select 21V	LED row 2
P_{43}	Slave V_{cc} select	LED row 3
P_{50}	S22 through RL_2	LED column 0
P_{51}	S20	LED column 1
P_{52}	Counter clock, M22	LED column 2
P_{53}	Counter reset	LED column 3
P_{60}	RL_1, S23	Sounder
P_{61}	RL_2, S22	OK led
P_{62}	RL_3, S1, M1	ERROR led
P_{63}	RL_4, S26, M26	PROG led
P_{70}	A_{12}, M2, S2	S1 UP key
P_{71}	A_{13}, M26, S26 through RL_4	S2 DOWN key
P_{72}	A_{14}, M27, S27	S3 PROG key
P_{73}	A_{15}, M1 through RL_3	S4 LIST key

Note, abbreviation M refers to pins on the master zif socket, S to pins on the slave socket (last month's circuit diagram).

Semiconductor suppliers

An Electronics and Wireless World survey

At EWW we receive a regular stream of enquiries for the sources of components. In order to answer it is often quite a task to wade through suppliers' catalogues to find the information. We have constructed this list in order to provide some clues as to the possible whereabouts of semiconductors. It is not comprehensive but we have tried to identify those companies who do supply the end user rather than representative or agency companies. We hope to publish a list of manufacturers and their UK agents — as a supplement to this survey at a later date.

We have had direct contact with all the companies listed either through their postal answers to our questionnaire or by telephone. One question which we considered of importance was whether the distributors were willing to sell "small quantities to private buyers." We were pleased and a little surprised that a large proportion of them were and we have indicated this by C.W.O. (cheque with order), after their addresses. Others were marked 'trade'. We also asked if any of their lines were exclusive to the individual company and if they specialized in any particular field. Their answer are recorded in each entry. All of them claim to be able to respond to an order on the same day or within 24 hours. Most of them are willing to identify substitutes and provide them as alternatives if the desired components are not available, but only after consulting the customer.

All say that they can provide data sheets for the products they distribute and do not charge if the product is purchased at the same time. Most companies also said that they were abot to offer technical advice on the the applications of components.

Considering the current interest in microcomputers and communications, we thought it would be interesting to see if any of the companies offered data bases and computerized ordering. None of them did, but a few were thinking of it or were installing equipment to do so.

ABACUS ELECTRONICS,
Kennett House,
Pembroke Road,
Newbury, Berks RG13 1BX.
Telephone: 0653 30680.
Trade. Exclusive distribution of Scanbe, Holmberg, TEEE.

ACE MAILTRONIX,
3A Commercial Street,
Batley, W. Yorks WF17 5HJ.
Telephone: 0924 441129
C.W.O.

ACTIVE ELECTRONICS,
Duke Street,
High Wycombe, Bucks HP13 6EE.
Telephone: 0494 441129
C.W.O. Speciality: Computer peripherals.

ADD-ON DEVICES,
11 Shield Road,
Ashford Industrial Estate,
Ashford, Middlesex TW15 1AU.
Telephone: 07842 47141.
c.w.o. Minimum order £25.
Speciality: Surface-mounted components.

AEROMEL INTERNATIONAL,
17 Harland Way,
Southborough,
Tunbridge Wells, Kent TN4 0TQ.
Telephone: 0892 37977
Trade. Speciality: Milspec. devices.

ALTEK MICROCOMPONENTS,
22 Market Place,
Wokingham, Berks RG11 1AP.
Telephone: 0734 791579
c.w.o. Speciality: Microprocessors and memories.

AMBAR COMPONENTS,
Gatehouse Road,
Aylesbury, Bucks HP19 3ED
Telephone: 0296 34141
c.w.o. Speciality: Microprocessors etc.

ANGLIA COMPONENTS
Burdett Road,
Wisbech, Cambs PE13 2PS.
Telephone: 0945 63281
c.w.o. Exclusive distribution: Promax

ARIES ELECTRONICS,
159 Boyn Valley Road,
Maidenhead, Berks SL6 6DT.
Telephone: 0628 37431
c.w.o.

ARROW ELECTRONICS,
Leader House,
Coptfold Road,
Brentwood, Essex CM14 4BN.
Telephone: 0277 219435
Trade.

AVIQUIPO OF BRITAIN,
St. Peters Road,
Maidenhead, Berks.
Telephone: 0628 34555
c.w.o. "We can supply any semiconductor."

BARLEC-RICHFIELD
Foundry Lane,
Horsham, W. Sussex RH13 5PX.
Telephone: 0403 51881
Trade.

BARRIE ELECTRONICS,
Unit 221, Stratford Workshops,
Burford Road, London E15 2SP
Telephone: 01 555 0228
Retail. Speciality: Transformers.

BETA DEVICES,
6 Sun Street,
Waltham Abbey, Essex.
Telephone: 01 971 6529
c.w.o. Postage "at cost."

BI-PAK SEMICONDUCTORS,
63A High Street,
Ware, Herts SG12 9AG.
Telephone: 0920 3182
c.w.o.

BOSLEDGE,
27 Church Street,
Manachester, M4 1PE.
Telephone: 061 834 7339
Trade.

BOSLEDGE,
27 Church Street,
Manchester, M4 1PE.
Telephone: 061 834 7339
Trade.

CAMPBELL COLLINS,
162 High Street,
Stevenage, Herts.
Telephone: 0438 69466

CIRKIT,
Park Lane,
Broxbourne, Herts.
Telephone: 0992 444111
c.w.o. Mail-order catalogue.

CONSORT ELECTRONICS,
Rosebank Parade,
Reading Road,
Yateley,
Camberley, Surrey GU17 7RN.
Telephone: 0252 871717
c.w.o. Exclusive distribution: Solitron, Microsemi.

CURZON ELECTRONICS,
17c London Street,
Basingstoke, Hants RS21 1NT
Telephone: 0256 51841
Trade.

DTV GROUP,
2 Ernest Avenue,
West Norwood, London SE27 0DJ.
Telephone: 01 670 6166
c.w.o. Retail counter.

D.W. ELECTRONICS (CAMBRIDGE),
Tudor House, High Street,
Fenstanton, Huntingdom PE18 9JZ.
Telephone: 0480 67666
c.w.o.

DAGE EUROSEM,
Rabans Lane,
Aylesbury, Bucks
HP19 3RG
Telephone: 0296 32881
c.w.o. Speciality: Digiral i.cs, Power fets.

DIALOGUE DISTRIBUTION,
Watchmoor Road,
Camberley, Surrey, GW15 3AQ
Telephone: 0276 682001
c.w.o. Speciality: Digital i.cs, Power fets.

DISTRIBUTED TECHNOLOGY,
Talboys House,
Oxted, Surrey RH8 9PA.
Telephone: 08833 6161
c.w.o. Exclusive distribution: Trelec, TIC. Speciality: Power Semicond, r.f. devices.

ELECTRONIC RESOURCES,
Henlow Trading Estate.
Henlow, Beds SG16 6DS.
Telephone: 0462 815555
c.w.o.

ELECTROVALUE,
28 St. Judes Road,
Englefield Green,
Egham, Surrey TW20 0HB,
Telephone: 0784 33603
c.w.o. Retail shop.

FARNELL ELECTRONIC COMPONENTS
Canal Road,
Leeds, Yorks LS12 2TU.
Telephone: 0532 636311
Trade.

G.E. Electronics (London) Ltd.
Earley House,
182 Campden Hill Road,
London W8 7AS.
Telephone: 01 727 0711
c.w.o.

GAIN ELECTRONICS,
63 High Street,
Prices Risborough,
Aylesbury, Bucks.
Telephone: 084 447116
c.w.o. "Visitors welcome."

GOTHIC CRELLON,
380 Bath Road,
Slough, Berks SL1 6JE.
Telephone: 06286 4300
c.w.o. It is necessary to open an account. Exclusive distribution: Varo, Arifa.

GREENWELD,
443 Millbrook Road,
Southampton SO1 0HX.
Telephone: 0703 772501
Retail shop.

HARMSWORTH, TOWNLEY & CO.
Harehill,
Todmorton, Lancs OL14 5JY.
Telephone: 070 681 4931
c.w.o.

HAWKE ELECTRONICS,
Amotex House,
45, Hamworth Road,
Sunbury-on-Thames, Middlesex.
Telephone: 01 979 7799
c.w.o.

HAWNT ELECTRONICS,
Firswood Road,
Garretts Green,
Birmingham B33 0TQ.
Telephone: 021 784 2485

HB ELECTRONICS,
Lever Street,
Bolton, Lancs BL3 6BJ.
Telephone: 0204 386631

HERO ELECTRONICS,
Dunstable Street,
Ampthill, Beds MK45 2JS
Telephone: 0525 405015
c.w.o. Speciality: Sharp components, opto-electronics.

HI-TEK DISTRIBUTION
Trafalgar Way,
Bar Hill, Cambridge CB3 8SQ.
Telephone: 0954 81996
Trade.

HOUSE OF POWER,
Electron House, Cray Avenue,
Orpington, Kent BR3 3QJ.
Telephone: 01 667 1531
c.w.o It is necessary (but easy to open an account. Exclusive distribution: Symbol

HUNTER ELECTRONIC COMPONENTS,
Unit 3, Central Estate,
Denmark Street,
Maidenhead, Berks SL6 7BN.
Telephone: 0628 75911
Trade.

HY-COMP,
11 Shield Road,
Ashford, Middlesex TW15 1AU.
Telephone: 07842 46273
Trade.

IMPULSE ELECTRONICS,
Hammond House,
Caterham, Surrey CR3 6XG.
Telephone: 0883 46433
Trade.

JATA (ELECTRONICS),
9 Heaton Road,
Bradford, W. Yorks BD8 8QK.
Telephone: 0724 42636

JERMYN DISTRIBUTION,
Vestry Estate,
Sevenoaks, Kent 0732 450144
Trade.

L.S.W. Components Service,
Wyvern House,
High Street,
Bognor Regis, W. Sussex PO21 1SP.
Telephone: 0234 826824

LANGREX SUPPLIES,
Climax House,
Fallsbrook Road,
London SW16 6ED.
Telephone: 01 677 2424
c.w.o. Speciality: Obsolete components.

MCP Electronics,
38 Rosemount Road,
Alperton, Middlesex HA0 4PE
Telephone: 01 902 6941
c.w.o. (£25 minimum order)
Speciality: r.f. and digital signal processing.

MDL COMPONENTS,
10 Cowley Road,
Nuffield Industrial Estate,
Poole, Dorset. BH17 7UJ.
Telephone: 0202 681331
c.w.o.

MACRO-MARKETING,
Burnham Lane,
Slough, Berks SL1 6LN.
Telephone: 06286 4422
c.w.o. or A/c. Particularly proud of their technical advice department.

MAPLIN ELECTRONIC SUPPLIES
PO Box 3, Rayleigh, Essex SS6 8LR.
Telephone: 0702 554155
Mail-order catolgue and retail shop.

MARCO TRADING,
The Maltings,
High Street,
Wem, Shropshire SY4 SEN.
Telephone: 0939 32763
Mail-order catalogue and retail shop.

MEDL DISTRIBUTION,
East Lane,
Wembley, Middlesex HA6 7PP.
Telephone: 01 904 9303
Trade.

MEMEC,
Thame Park Road,
Thame, Oxon OX9 3XD.
Telephone: 084 421 4561
c.w.o. Speciality: Microprocessor and memeory i.cs.

MERLIN ELECTRONICS,
Granada House,
Gabriels Hill,
Maidstone, Kent ME15 6JP.
Telephone: 0622 678888
c.w.o.

MICROLOG,
Elizabeth House,
Duke Street, Woking, Surrey GU21 5BA.
Telephone: 04862 66771
c.w.o. Speciality: Linear i.cs, programmable logic arrays.

MICROMARK ELECTRONICS,
157 Boyn Valley Road,
Maidenhead, Berks SL6 4DI
Telephone: 0628 72631
c.w.o.

MS COMPONENTS,
Zephyr House,
Waring Street,
W. Norwood, London SE27 9LH.
Telephone: 01 670 6166
c.w.o. Trade/retail counter.

MCLELLAND ELECTRONICS,
3a Bankfield Industrial Estate,
Kitson Road, Leeds LS10 3YY.
Telephone: 0532 460572
Trade.

NEWTEC DISTRIBUTION,
Beadle Trading Estate,
Ditton Walk,
Cambridge CB5 8QD.
Telephone: 0223 211211
c.w.o (formerly Lock Distribution)

NORSEM ELECTRONICS GROUP,
4 Heron Industrial Estate,
Spencers Wood,
Reading, Berks.
Telephone: 0734 884588
Trade.

NEWECO,
Cresto House,
Water Lane,
Wilmsow, Cheshire.
Telephone: 0625 529523
Trade.

PHAB ELECTRONICS,
7 Centenary Estate,
Jeffreys Road,
Enfield, Middlesex EN3 7UF.
Telephone: 01 805 4060
c.w.o. (£10 minimum order).

PHILIPS SERVICE,
604 Purley Way,
Whaddon,
Croydon, Surrey CR9 4DR.
Telephone: 01 686 0505
(Spares for Philips and Mullard equipment)

POLAR ELECTRONICS
Europa House,
West Street,
Leighton Buzzard, Beds LU7 7ND.
Telephone: 0525 377093
c.w.o.

PRONTO ELECTRONIC SYSTEMS,
466 Cranbrook Road,
Gants Hill,
Ilford, Essex IG2 6LE.
Telephone: 01 554 6222
c.w.o. Speciality: I.cs (no discrete components)

QUARNDON ELECTRONICS (SEMICONDUCTORS),
Slack Lane,
Derby DE3 3ED.
Telephone: 0332 32651
Trade.

RS COMPONENTS,
PO Box 427,
Epworth Street,
London EC2P 2HA.
Telephone: 01 253 1222
RS components are sold as 'own brand' and therefore they do not list their manufacturers. Most semiconductors in the RS catalogue are listed as 'similar to' recognised components. Trade only.

RASTRA ELECTRONICS,
275 King Street,
Hammersmith, London W6 9NF.
Telephone: 01 748 3143.
c.w.o. or credit card. (£10 minimum) Retail counter.

REGISBROOK,
215 King Street,
Reading, Berks RG1 4LS.
Telephone: 0734 665955.
Necessary (but easy) to open an account

S.E.M.E. Ltd,
2E Saxby Road Industrial Estate,
Melton Mowbray, Leics LE13 1BS.
Telephone: 0664 65392
Trade.

SEMELAB,
Bank Street,
Lutterworth, Leics.
Telephone: 04555 4711
Trade.

SEMI COMPONENTS,
Vine House,
104 Ashley Road,
Walton-on-Thames,
Surrey KT12 1HP.
Telephone: 0932 241866
c.w.o. Speciality: Microprocessors memory and display.

SEMICOMPS,
Halifax Road,
Keighley, W. Yorks BD21 5HT.
Telephone: 0535 65191
Necessary (but easy) to open an account

SEMICONDUCTOR SPECIALISTS,
Carrol House,
159 High Street,
Yewsley,
West Drayton, Middlesex UB7 7XB.
Telephone: 08954 45522
Trade.

Continued on page 81
Table on pages 60 & 61

components

GILRAY ROAD, DISS, NORFOLK. TEL: 0379 4131

INSULATION DISPLACEMENT CONNECTOR SYSTEM

HEADERS

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

CABLE ASSEMBLIES

IDC JUMPERS SINGLE ENDED

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

DIP JUMPERS

Single Ended

	— 24" cable
14 pin	1.73
16 pin	1.90
24 pin	2.73
40 pin	3.96

Double Ended

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

SOCKETS

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

CARD EDGE

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

DIP PLUGS

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

TRANS. CONNS.

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

D-TYPE SOCKETS

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

D-TYPE PLUGS

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

DISC DRIVE CONNECTING CABLES

34 way card edge to 34 way card edge 1M	11.30
34 way card edge to 2 × 34 way card edge 1.5M	18.00
34 way card edge to 34 way IDC SKT (BBC) 1M	8.50
34 way card edge to 2 × 34 way IDC KT (BBC) 1.5M	14.50
BBC Power Cable — Single Drive	3.50
BBC Power Cable — Dual Drive	4.75

RIBBON CABLE (PRICED PER FOOT)

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

BBC MICRO CONNECTORS

DIN PLUG 7 PIN	0.40
DIN PLUG 6 PIN	0.40
DIN PLUG 5 PIN 180°	0.40
DIN PLUG 5 PIN DOMINOE	0.40
POWER PLUG (36" CABLE)	3.00
ANALOGUE INPUT PLUG	2.25
5 WAY DIN SKT 180°	0.90
5 WAY DIN SKT DOMINOE	0.90
6 WAY DIN SKT	0.90
7 WAY DIN SKT	0.90
15 WAY DIN SKT	2.15

Connecting cables for personal computers

A comprehensive range of high quality interconnecting cables for popular micro computers. All cables utilise high quality connectors and are individually tested to ensure trouble free use.

Part number	Description	Computer	
Video cables			
CON100	Phono plug to phono plug (2M)		1.20
CON101	Phono plug to BNC plug (2M)		2.95
CON102	BNC plug to BNC plug (2M)		3.95
CON107	6 pin DIN to open end (1M)	BBC	1.05
CON108	6 pin DIN to 6 pin DIN (1M)	BBC	1.50
CON119	Phono plug to coax plug		1.35
CON160	DIN plug to 2 phono plugs	Dragon	1.20

Cassette recorder cables

CON109	7 pin DIN to open end	BBC	1.25
CON110	7 pin DIN to 2 × 3.5mm + 1 × 2.5mm J/plug	BBC	2.50
CON111	7 pin DIN to 5 pin DIN + 2.5mm J/plug	BBC	2.50
CON118	5 pin DIN to 2 × 3.5mm J/plugs	Spectrum/ZX	2.50
CON117	5 pin DIN to 2 × 3.5mm + 1 × 2.5mm J/plug	Dragon	2.50

Parallel printer cables

CON130	36 way plug to 36 way plug (2M)	Sirius/Apricot	18.00
CON131	36 way plug to 36 way plug (5M)	Sirius/Apricot	26.50
CON132	36 way plug to 36 way socket (2M)		18.00
CON133	36 way plug to 36 way socket (5M)		26.50
CON144	36 way plug to 25 way male D type (2M)	IBM/TI PC	19.00
CON145	36 way plug to 25 way male D type (5M)	IBM/TI PC	27.50
CON134	36 way plug to 25 way male D type (2M)	RML/Apple	19.00
CON135	36 way plug to 25 way Male D type (5M)	RML/Apple	27.50
CON142	36 way plug to 20 way IDC socket (2M)	Dragon	13.95
CON139	36 way plug to 26 way IDC socket (2M)	BBC	9.95
CON140	36 way plug to 26 way IDC socket (5M)	BBC	22.95
CON141	36 way plug to 34 way card edge (2M)	TRS80 Lev 1	18.50
CON143	36 way plug to 34 way IDC socket (2M)	TRS80 Lev 2/ Memotech	10.95

RS232 Cables

CON106	25 way male D type to 5 pin DIN	BBC	5.85
CON128	'Universal' RS232 cable (pins 1-8, 20 connected and 20 jumpered as required) 2M		15.95
CON164	'Universal' RS232 cable as above but 5M		20.95
CON120	25 way male to male 1-25 connected (2M)		16.95
CON121	25 way male to male 1-25 connected (5M)		22.50
CON122	25 way male to male 1-25 connected (10M)		32.50
CON123	25 way male to male 1-25 connected (30M)		68.00
CON124	25 way male to female 1-25 connected (2M)		15.45
CON125	25 way male to female 1-25 connected (5M)		21.00
CON126	25 way male to female 1-25 connected (10M)		31.00
CON127	25 way male to female 1-25 connected (30M)		66.50
CON129	25 way male to 9 way male	Spectrum	15.95
CON162	25 way male to 9 way male	Mackintosh	15.95
CON163	25 way male to 5 pin DIN	RML 480Z	14.95

PART NO.	DESCRIPTION	MAIL ORDER PRICE
BBC MICROS AND ACCESSORIES		
ANB01	BBC Model B Micro	£325.00
ANB02	BBC Model B Micro with Econet I/F	£385.00
ANB03	BBC Model B Micro with Disc I/F	£406.00
ANB04	BBC Model B Micro with Disc & Econet	£445.00
ALA01	Acorn Electron	£139.00
ANB21	DNFS ROM	£17.91
ANB23	Disc Interface Kit	£71.65
ANB14	Speech Interface	£40.00
ANK01	IEEE488 Interface Adaptor	£277.75
ANB22	Econet I/F Kits	£35.00
BBC 45	Joysticks	£8.00
STAND	Monitor Stand	£7.50
SRE1	Sideways ROM Expansion Board	£25.95
DISC DRIVES WITHOUT POWER SUPPLY		
BBC30	Single 100k TEC 40 track single sided	£99.95
BBC31S	Single 100k TEC (expandable to dual) 40 track	£115.00
BBC31D	Dual (2 × 100k) TEC 40 track single sided	£225.00
BBC34	Single 400k TEC 80 track double sided	£174.00
BBC34S	Single 400k TEC (expandable to dual) 40/80 track switchable double sided	£194.00
BBC34SW	Single 400k TEC 40/80 track switchable double sided	£184.00
BBC34D	Dual (2 × 400k) TEC 40/80 track switchable double sided	£310.00
BBC34S/80	Single 400k TEC (expandable to dual) 80 track double sided	£184.00
BBC34D/80	Dual (2 × 400k) TEC 80 track double sided	£300.00
DISC DRIVES WITH POWER SUPPLY		
BBC30P	Single 100k TEC 40 track single sided with P.S.U.	£130.00
BBC31SP	Single 100k TEC (expandable to dual) 40 track with P.S.U.	£150.00
BBC31DP	Dual (2 × 100k) TEC 40 track single side with P.S.U.	£250.00
BBC34P	Single 400k TEC 80 track double sided with P.S.U.	£209.00
BBC34SP	Single 400k TEC (expandable to dual) 80 track with P.S.U.	£229.00
BBC34DP	Dual (2 × 400k) TEC 40/80 track switchable with P.S.U.	£345.00
MECHANISMS		
FB501	TEC 100k single sided	£91.00
FB504	TEC 400k double sided	£150.00
FLOPPY DISCS		
MD-1C/B	Nashua single sided, single density 40 track (10 discs)	£12.00
MD-1DC/B	Nashua single sided, double density 40 track (10 discs)	£13.00
MD-2DC/B	Nashua double sided, double density 40 track (10 discs)	£15.50
MD-2FC/B	Nashua double sided, quad density 80 track (10 discs)	£17.85
SPECIAL OFFER		
BBC40TD	BASF double sided, double density 40 track (10 discs)	£14.00
DISC STORAGE BOXES		
MDT25/3	3½" Flip 'N' file Micro disc box (cap. 25)	£7.75
DT25/5	5¼" Flip 'N' file lockable disc box (cap. 25)	£18.77
DT60/5	5¼" Standard lockable disc box (cap. 60)	£10.65
MONITORS		
9MON	9 inch green screen high resolution NEC high quality monitor	£125.00
12MON	12 inch green screen high resolution NEC high quality monitor	£135.00
1431	Microvitec 14" RGB colour monitor	£175.00
1441	Microvitec 14" RGB colour monitor high resolution	£410.00
1451	Microvitec 14" RGB colour monitor medium resolution	£295.00
1431/AP/MS	Microvitec 1431 PAL & RGB inputs and sound facility	£225.00
BBC COMPATIBLE SOFTWARE		
SBB03	View Rom	£45.00
SBB04	View Printer Driver	£7.50
AES20	Fileserver Level 1-40 track	£80.50
AES21	Fileserver Level 2-80 track	£202.00
SNB08	Acornsoft Invoicing program	£16.00
SNB09	Acornsoft Mailing System program	£16.00
SNB10	Acornsoft Accounts Receivable program	£16.00
SNB11	Acornsoft Stock Control program	£16.00
SNB12	Acornsoft Order Processing program	£16.00
SNB13	Acornsoft Acounts Payable program	£16.00
SNB14	Acornsoft Purchasing program	£16.00
SNL01	Forth — 40 track	£15.00
SNL02	Lisp — 40 track	£15.00
SNL04	Microtext — 40 track	£47.50
MATRIX PRINTERS		
RX80	Epson RX80 100cps matrix printer	£204.00
RX80F/T	Epson RX80F/T 100 cps matrix printer friction or tractor feed	£231.00
FX80	Epson FX80 150cps matrix printer	£328.50
MT80SP	Mannesmann Tally MT80 matrix printer friction or tractor feed with film ribbon and tear off facility	£209.00
LETTER QUALITY PRINTERS		
HR5	Brother HR5 Thermal printer A/C mains or battery	£115.00
HR15	Brother HR15 Daisy wheel printer (13cps)	£326.00
HR25	Brother HR25 Daisy wheel printer (23cps)	£550.00
UCHIDA	Uchida DWX305 Daisy wheel printer (20cps)	£227.00
PRINTER SUPPLIES		
11241P160	11×9½ 1 part plain listing paper (2,000)	£11.25
11241P2CI	11×9½ 2 part (otc) plain listing paper (1,000)	£14.00
11241P3CI	11×9½ 3 part (otc) plain listing paper (700)	£16.25
11370R160	11×14½ 1 part ruled listing paper (2,000)	£13.50
11370R2NC	11×14½ 2 part (ncr) ruled listing paper (1,000)	£22.50
11370R2CI	11×14½ 2 part (otc) ruled listing paper (1,000)	£15.00
12235P160S	12×9½ 1 part plain listing paper with side perfs. (2,000)	£12.00
HR1R	Brother HR1 ribbon	£2.20
RIB119	Diablo Hytype II Multistrike film ribbon	£1.75
GP205	Diablo Hytype II fabric ribbon	£2.50
MX80	Epson MX80, RX80, FX80, fabric ribbon	£3.00
MT80	Mannesmann Tally MT80 film ribbon	£6.50
RIB117	Uchida DWX305 multistrike film ribbon	£2.75
HR5R	Brother HR5 ribbon	£2.20
HR15R	Brother HR15 multistrike ribbon	£4.00
HR25R	Brother HR25 multistrike ribbon	£4.00
	Brother daisy wheels	£14.00
	Uchida/Qume daisywheels	£4.00
LAB089361C	3½×1 7/16 Labels — 1 wide (12,000)	£20.00
LAB089361S	3½ 1 7/16 Labels — 1 wide (2,000)	£13.00
LAB070363F	2¾ 1 7/16 Labels — 3 wide (1/10") (2,000)	£8.00

CIRCLE 60 FOR FURTHER DETAILS.

continued from page 57

	AEG Telefunken	AEI Semicon	Advanced Micro Dev (AMD)	Advanced Microcomputers	American Micros (AMI)	Analog Devices	Apex Microtech	Codi Semicond	Delco	Diodes	EMM	Electronic Devices	Electronorgtechnica	Emihus	Exar	Fairchild	Ferranti	Fujitsu	General Electric	GIM	General Instruments	General Semicond Ind	Germanium Power	Harris	Hewlett - Packard	Hitachi	Hughes	IDI Semicond	ITT Semicond	Inmos	Integrated Photomatri	Intel	Internat. Rectifier	Intersil	Litronix	Marconi (MEDL)	Matsushita	Microelectronics	Micropower Systems	Microwave Semicond.	Mitel	Mitsubishi	Monolithic Memories	Monsanto
Abacus Electronics																●																												
Ace Mailtronix																			●		●																							
Active Electronics			●		●	●					●				●	●			●	●	●			●		●			●			●												
Add-on Devices																								●																				
Aeromel International			●		●												●							●		●								●									●	
Altek Microcomponents																																												
Ambar Components																		●																										
Anglia Components	●																																											
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Arrow Electronics		●																																										
Aviquipo of Britain			●		●	●										●		●	●							●					●	●												
Barlec-Richfield																●																												
Barrie Electronics																																												
Beta Devices										●						●																			●			●						
Bi-pak Semicond																●																												
Bosledge																	●				●								●								●							
Campbell Collins																				●	●											●												
Cirkit	Wide range of popular semiconductors																										●																	
Consort Electronics			●		●					●						●								●	●		●					●	●											
Curzon Electronics	●		●							●						●		●		●	●			●			●					●	●	●	●									
DTV Group																																	●											
D.W. Electronics																●										●						●		●				●						
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G.E. Electronics																																												
Gain Electronics																																												
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Greenweld	Wide range of popular semiconductors																																											
Harmsworth Townley																																	●											
Hawke Electronics			●																																									
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HB Electronics																		●																				●						
Hero Electronics																			●		●																							
Hi-Tek Distribution																								●																				
House of Power																				●			●																					
Hunter																								●						●														
Hy-Comp																						●		●																			●	
Impulse Electronics																										●																●		
JATA (Electronics)																											●																	
Jermyn Distribution																●			●					●	●							●												
L.S.W. Components																													●									●						
Langrex Supplies		●															●																			●								
MCP Electronics	●																																											
MDL Components																																										●		
Macro-Marketing																●								●	●		●							●	●								●	
Maplin	Wide range of popular semiconductors																																											
Marco Trading	Wide range of popular semiconductors																																											
MEDL Distribution																																●				●								
Memec			●															●						●																				
Merlin Electronics			●		●	●									●	●	●	●	●	●		●		●		●			●			●	●	●				●				●	●	
Microlog																																											●	
Micromark Electronics	●	●	●													●	●			●	●				●							●	●	●				●						
MS Components	Wide range of popular semiconductors																																											
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Newtec Distribution																●																												
Norsem																																			●									
Noweco																●			●					●																				
Phab Electronics		●																											●															
Philips Service																																												
Polar Electronics	●	●	●		●	●										●		●	●	●	●			●		●						●	●		●		●	●					●	
Pronto																																							●		●			
Quarndon			●		●																													●					●					
Rastra Electronics			●												●																			●	●									
Regisbrook					●																																							
S.E.M.E.																					●																							
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Semicomps																	●			●	●																							
Semicond. Specialists					●																●								●															
Semicond Supplies Intl.										●						●	●		●		●		●			●						●												
Solid State Scientific			●												●																			●	●									
STC Electronic																●	●		●										●				●					●						
Steatite																																												
Swift Sasco																	●																											
Thame Components			●																					●																				
Thorp Electronic	●																										●																	
Today Electronics																																												
Trident Microsystems																																												
Verospeed	Wide range of popular semiconductors																																											
VSI Electronics (UK)					●																●	●						●										●						
Watford Electronics	Wide range of popular semiconductors																																											

	Mostek	Motorola	Mullard	NEC	National Semicond	N. American Semicond.	Opcoa	Opto	Optron	Plessey	Precision Monolithic	RCA	Raytheon	Reticon	Rockwell	SGS-Ates
Abacus Electronics					●											●
Ace Mailtronix		●	●	●								●				●
Active Electronics	●	●	●	●	●						●	●	●			●
Add-on Devices													●			●
Aeromel International	●															●
Altek Microcomponents																
Ambar Components																
Anglia Components				●								●				
Aries Electronics		●	●		●							●	●			
Arrow Electronics			●	●								●				
Aviquipo of Britain	●	●	●	●	●							●	●		●	
Barlec-Richfield																
Barrie Electronics																
Beta Devices		●	●	●	●											●
Bi-pak Semicond																
Bosledge		●			●					●						
Campbell Collins	●	●	●	●	●											●
Cirkit		●														
Consort Electronics		●	●	●	●							●	●			●
Curzon Electronics			●	●	●				●			●	●			●
DTV Group			●		●											
D.W. Electronics		●		●	●							●				●
Dage Eurosem																
Dialogue Distribution																
Distributed Technology																
Electronic Resources				●												
Electrovalue																
Farnell			●		●											
G.E. Electronics										●						
Gain Electronics		●										●				
Gothic Crellon		●	●							●		●				●
Greenweld																
Harmsworth Townley																
Hawke Electronics			●													
Hawnt Electronics			●													
HB Electronics										●						
Hero Electronics						●										
Hi-Tek Distribution						●					●					
House of Power																
Hunter																
Hy-Comp												●				●
Impulse Electronics				●												
JATA (Electronics)																●
Jermyn Distribution		●	●		●					●		●				
L.S.W. Components		●	●		●											
Langrex Supplies		●	●		●											
MCP Electronics																
MDL Components		●			●											
Macro-Marketing												●				
Maplin																
Marco Trading																
MEDL Distribution																
Memec	●															●
Merlin Electronics	●	●	●	●	●						●	●	●			●
Microlog																
Micromark Electronics		●	●		●							●				●
MS Components																
McLelland Electronics			●												●	
Newtec Distribution		●														
Norsem				●												
Noweco		●	●		●							●				
Phab Electronics		●	●		●											
Philips Service			●													
Polar Electronics	●	●	●	●	●							●	●		●	●
Pronto	●															
Quarndon										●			●			
Rastra Electronics		●					●		●							
Regisbrook															●	
S.E.M.E.			●													●
Semelab		●	●	●												●
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Semicond. Specialists	●	●		●						●		●	●			
Semicond. Supplies Intl.	●	●	●	●	●							●	●			●
Solid State Scientific		●					●		●							
STC Electronic		●	●		●						●	●				
Steatite		●													●	
Swift Sasco																
Thame Components	●	●														
Thorp Electronic																
Today Electronics																
Trident Microsystems																
Verospeed																
VSI Electronics (UK)	●			●								●	●			●
Watford Electronics																

	Sanken	Sanyo	Semicoa	Semicron	Semiprocesses	Semitron	Sescosem	Siemens	Signetics	Silec	Silicon General	Silicon Transistor	Siliconix	Solid State Scientific	Solidev	Solitron
Abacus Electronics																
Ace Mailtronix								●	●							
Active Electronics								●	●		●		●	●		●
Add-on Devices								●								
Aeromel International								●								
Altek Microcomponents																
Ambar Components																
Anglia Components																
Aries Electronics						●		●					●			
Arrow Electronics																
Aviquipo of Britain								●	●		●			●		
Barlec-Richfield																
Barrie Electronics								●						●		
Beta Devices																
Bi-pak Semicond																
Bosledge																
Campbell Collins								●	●							
Cirkit																
Consort Electronics									●							●
Curzon Electronics								●			●		●			
DTV Group																
D.W. Electronics													●			
Dage Eurosem								●					●			
Dialogue Distribution																
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Electronic Resources						●			●							
Electrovalue								●								
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Gothic Crellon									●							
Greenweld																
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Hero Electronics																
Hi-Tek Distribution																
House of Power																
Hunter					●											
Hy-Comp																
Impulse Electronics					●											
JATA (Electronics)																
Jermyn Distribution										●						
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Macro-Marketing									●				●			
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Micromark Electronics						●							●			
MS Components																
McLelland Electronics																
Newtec Distribution																
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Phab Electronics																
Philips Service																
Polar Electronics									●				●			
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Quarndon									●							
Rastra Electronics											●			●		
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S.E.M.E.				●				●								
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Semicomps																
Semicond. Specialists													●	●		
Semicond. Supplies Intl.									●					●		
Solid State Scientific											●			●		
STC Electronic									●							
Steatite	●															
Swift Sasco									●							
Thame Components																
Thorp Electronic						●										
Today Electronics																
Trident Microsystems																
Verospeed																
VSI Electronics (UK)																
Watford Electronics																

	Spectron	Sprague	Supertex	Synertek	TAG	TI	TRW	Teledyne	Thomson-CSF	Toshiba	Transitron	Unitrode	Vactec	Westinghouse	Xciton	Zilog
Abacus Electronics									●							
Ace Mailtronix		●				●										
Active Electronics		●		●		●		●	●	●						●
Add-on Devices						●			●							
Aeromel International									●							
Altek Microcomponents																
Ambar Components																
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Aries Electronics						●			●							
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Aviquipo of Britain						●		●		●						●
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DTV Group																
D.W. Electronics			●											●		
Dage Eurosem																
Dialogue Distribution		●							●							
Distributed Technology														●		
Electronic Resources																
Electrovalue						●										
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G.E. Electronics																
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Gothic Crellon																●
Greenweld																
Harmsworth Townley														●		
Hawke Electronics						●										
Hawnt Electronics																
HB Electronics		●													●	
Hero Electronics																
Hi-Tek Distribution																●
House of Power																
Hunter		●				●										
Hy-Comp		●				●										
Impulse Electronics										●						
JATA (Electronics)		●								●						
Jermyn Distribution						●										
L.S.W. Components						●									●	
Langrex Supplies																
MCP Electronics							●									
MDL Components						●	●									
Macro-Marketing				●		●		●								●
Maplin																
Marco Trading																
MEDL Distribution																
Memec																
Merlin Electronics	●	●		●		●		●	●					●		●
Microlog																
Micromark Electronics						●		●	●							
MS Components																
McLelland Electronics																
Newtec Distribution																
Norsem								●	●							
Noweco																
Phab Electronics						●										
Philips Service																
Polar Electronics		●		●		●		●	●	●				●		●
Pronto				●					●					●		
Quarndon						●										
Rastra Electronics				●												
Regisbrook																
S.E.M.E.																
Semelab						●			●							
Semi Components										●						
Semicomps								●								
Semicond. Specialists		●							●					●		
Semicond. Supplies Intl.		●				●	●	●	●	●						●
Solid State Scientific				●												
STC Electronic						●								●		
Steatite									●	●						
Swift Sasco		●														
Thame Components				●								●				
Thorp Electronic																
Today Electronics																
Trident Microsystems																
Verospeed																
VSI Electronics (UK)						●										
Watford Electronics																

BECKMAN
CIRCUITMATE DM73
Probe Type Miniature Multimeter

£45.50

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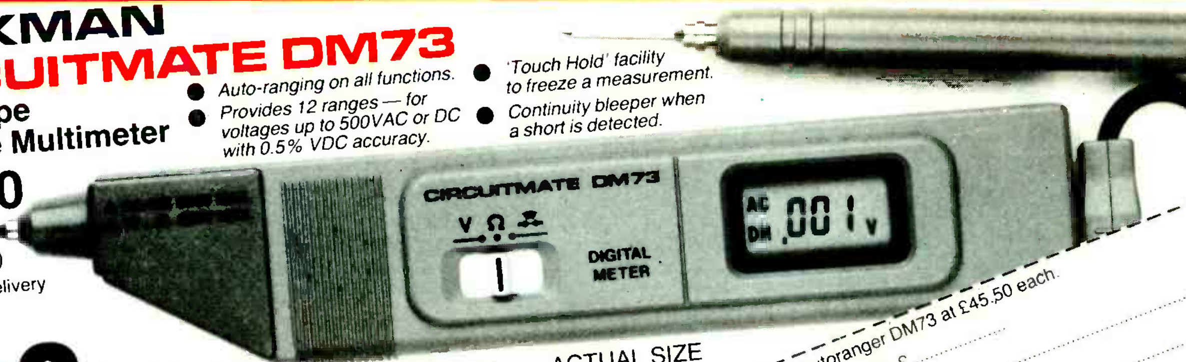
Allow 14 days delivery

- Auto-ranging on all functions.
- Provides 12 ranges — for voltages up to 500VAC or DC with 0.5% VDC accuracy.
- 'Touch Hold' facility to freeze a measurement.
- Continuity bleeper when a short is detected.



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Address ....

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CIRCLE 55 FOR FURTHER DETAILS.

TRANSFORMERS EX-STOCK

MAINS ISOLATORS
Pri/Sec 120V×2

VA	Price	P&P
*20	5.82	1.60
60	9.49	1.80
100	11.08	2.00
200	15.69	2.25
250	18.97	2.64
350	23.47	2.70
500	29.23	2.95
750	41.28	3.70
1000	53.00	4.00
1500	68.37	4.70
2000	82.27	5.10
3000	115.35	OA
6000	203.65	OA

*115 or 240V sec only.

400/440V ISOLATORS
400/440 to 200/240V CT

VA	Price	P&P
60	9.50	1.80
100	11.08	2.00
200	15.68	2.25
250	18.97	2.40
350	23.47	2.70
500	29.23	2.95
1000	52.98	4.00
2000	82.27	5.00
3000	115.37	DA
6000	228.75	OA

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

12V (AMPS)	24V	Price	P&P
0.3A	.15	2.41	.90
1	.5	3.19	1.20
2	1	4.25	1.20
4	2	4.91	1.60
6	3	7.69	1.60
8	4	8.98	1.60
10	5	9.82	1.80
12	6	10.89	1.90
16	8	12.97	2.12
20	10	17.46	2.44
30	15	21.69	2.64
60	30	44.45	OA
83	41	51.20	4.50

96/48V. Pri 2×120V
Secs 2×36/48V

72/96- (AMPS)	36/48V	Price	P&P
0.5A	1	5.37	1.20
2	4	14.69	2.20
3	6	17.79	2.40
5	10	32.23	3.20
6	12	40.36	3.50
8	16	44.03	3.75

50/25V or 25-0-25V
2×25V Ta) Secs *Volto available* 5, 7, 8, 10, 13, 15, 17, 20, 25, 30, 33, 40, 20-0-20 or 25-0-25V

50V (AMPS)	25V	Price	P&P
0.5	1	4.13	1.40
1	2	5.03	1.50
2	4	8.69	1.84
3	6	10.36	1.90
4	8	14.10	2.12
6	12	18.01	2.20
8	16	24.52	2.70
10	20	30.23	3.00
12	24	36.18	3.20

60/30V or 30-0-30V
Pri 2×120V. 2×30V Tap Secs. Volts available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60, 24-0-24 or 30-0-30V.

60V (AMPS)	30V	Price	P&P
0.5	1	4.70	1.50
1	2	7.15	1.50
2	4	9.20	1.90
3	6	13.31	2.00
4	8	15.15	2.20
5	10	19.16	2.20
6	12	21.86	2.65
8	16	30.72	3.00
10	20	35.76	3.30
12	24	41.22	3.50

MINIATURES

Sec V	Amp	Pri	P&P
3-0-3	.2A	3.11	.90
6×2	1A×2	3.45	1.20
9-0-9	.1	2.59	.90
9×2	.33×2	2.41	.90
8,9×2	.5×2	3.36	1.20
8,9×2	1A×2	4.27	1.40
15×2	.2A×2	2.41	.90
12-0-12	.05	3.11	.90
20×2	.3×2	3.39	1.20
20×2	.15×2	1.50	.50
20,12,0			
12,20	9	4.13	1.30
15,20-2	1A×2	5.60	1.60
15,27×2	.5×2	4.83	1.40
15,27×2	1A×2	7.30	1.60
0-7.5-15V	0-5A	2.53	.90
0-7.5-15V	4A	6.90	1.40
0-27V	1A	1.50	.50
9-0-9V	1A	2.20	.60
13-0-13V	.15A	12V	1M
		1.50	.40

30/15V or 15-0-15V
2×15V Tap Sec. *Volts available* 3, 4, 5, 6,, 8, 9, 10, 12, 15, 18, 20, 24, 30 or 15-0-15V

30V (AMPS)	15V	Price	P&P
0.5A	1	3.19	1.20
1	2	4.32	1.40
2	4	6.99	1.60
3	6	8.10	1.85
4	8	9.67	1.90
5	10	11.95	2.00
6	12	13.52	2.00
8	16	18.10	2.26
10	20	20.88	2.26
12	24	23.20	2.50
15	30	26.60	3.00
20	40	35.64	4.83

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

VA	Price	P&P
80	4.84	1.40
150	6.48	1.60
350	11.84	2.00
500	13.30	2.24
1000	24.14	2.80
1500	28.17	3.20
2000	42.14	4.00
3000	71.64	4.80
5000	108.30	OA

CASED AUTOS
240V to 115V USA skts.

VA	Price	P&P
20	7.21	1.50
80	9.35	1.60
150	12.10	1.90
250	14.73	2.00
500	24.14	2.20
1000	33.74	2.80
2000	60.47	4.50

EDUCATIONAL METERS
Front finger screw terminals 78×98mm

0—10A	
0—2A	£3.98each
0—30V+	.50 p&p

PLEASE ADD 15% VAT TO ALL ITEMS AFTER P&P

INVERTERS
12/24 V DC-240V AC

100W	£65.15
250W	£170.42
500W	£196.19
1000W	£396.72
2000W	£779.90
4000W	£1160.00

CONSTANT VOLTAGE TRANSFORMER 1%
Spike-free stable mains

250VA	£172.40
500VA	£196.69
1KVA	£338.40
2KVA	£594.50
3KVA	£957.73
4KVA	£1266.00
5KVA	£1531.00
6KVA	£1743.00
7.5KVA	£2073.00
10KVA	£3347.00

AVOs & MEGGERs

8Mk6 (latest)	£138.70
DA211 LCD	£68.40
DA200V	£72.80
DA116 LCD.	£154.50
DA117 AUTO	£157.00
Megger Gen	£116.40
Batt Megger	£85.50

P&P £2 VAT 15%

V.W. MODEM PROJECT
Transformers T1, T2
£5.70 inc VAT, P&P

METAL OXIDE ¼W 5% RESISTORS £1/100
12, 20, 33, 47, 75, 390, 430, 510Ω, 560, 1k, 1k1, 1k3, 1k6, 1k8, 2k, 3k, 3k9, 15k, 16k, 24k, 27k, 39k, 56k, 82k, 100k, 110k, 120k, 130k, 150k, 200k, 220k, 270k, 300k. P&P 20p.

BRIDGE RECTIFIERS

400V 1A	.32
200V 2A	.45
100V 35A	£2.60
100V 50A	£3.20
500V 12.5A	£3.40

BARRIE ELECTRONICS LTD
Unit 211, Stratford Workshops
Burford Road, London E15 2SP
Tel: 01-555 0228 (3 lines)

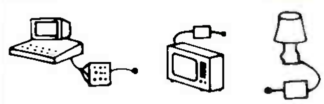
WW-6

CIRCLE 54 FOR FURTHER DETAILS.

HOME CONTROL CENTRE

This kit enables you to control up to 16 different appliances by means of coded pulses in the mains wiring which may be decoded by special receivers anywhere in the house. The transmitter may be controlled manually or by the computer interface enabling your favourite micro to make your coffee in the morning, switch lights anywhere in the house, or your electric blanket in your bedroom. Just think of the possibilities — and no wiring! This kit comprises a transmitter with pre-drilled box and two receivers.

XK112 — £42.00
Additional Receivers
XK111 — £10.00



ELECTRONIC LOCK KIT

With hundreds of uses indoors, garages, car anti-theft devices, electronic equipment, etc. Only the correct easily changed four-digit code will open it! Requires a 5-15V DC supply. Output 750mA. Fits into standard electrical wall box.

Complete kit (except front panel)
XK101 — £11.50

Electric Lock Mechanism for use with existing door locks and the above kit. (Requires relay.) 12V AC/DC coil.
(701 150) — £14.95

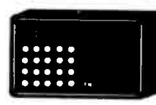
BT STYLE PHONE CONNECTORS

Line Jack Units — Master Unit (first line unit) has bell capacitor and surge arrester.

Flush or surface mounting. Screw connectors.

Master (flush)	(960 110)	£3.00
Master (surface)	(960 112)	£3.00
Master (mini surface)	(960 113)	£3.00
Secondary (flush)	(960 114)	£2.65
Secondary (surface)	(960 116)	£2.65
Secondary (mini surf)	(960 117)	£3.00
Dual outlet adaptor	(960 118)	£4.20
4-way line cord — with plug to spade terminals	(960 120)	£2.00
4-way line cord	(960 130)	£0.20 per m

MICROPROCESSOR TIMER KIT



Designed to control 4 outputs independently switching on and off at preset times over a 7-day cycle. LED display of time and day, easily programmed via 20-way keyboard. Ideal for central heating control (including different switching times for weekends). Battery back up circuit. Includes box.
18 time settings.

CT6000K — £39.00

XK114. Relay Kit for CT6000 includes PCB, connectors and one relay. Will accept up to 4 relays. 3A/240V c/o contacts — £3.90

701 115 Additional Relays — £1.65

TOP QUALITY . . . TOP SERVICE
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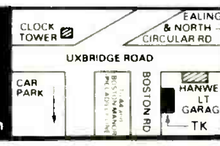
ENQUIRIES 01-579 9794
01-579 2842 TECHNICAL AFTER 3pm



CIRCLE 8 FOR FURTHER DETAILS.

MITSUBISHI

MGF-1400
MGF-1402
MGF-1412

GaAs FETs

FROM STOCK

Aspen Electronics Limited

UK representative for Mitsubishi Electric

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CIRCLE 39 FOR FURTHER DETAILS.

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"ANALYSER"

PERFORMANCE ANALYSIS of LINEAR CIRCUITS using the BBC MODEL B AND SINCLAIR SPECTRUM 48K MICRO'S.

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

Performs FREQUENCY RESPONSE ANALYSIS on Circuits with up to 16 Nodes and 60 Components, for Phase and Gain/Loss, Input Impedance and Output Impedance.

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

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

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

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AME/LRC 12.4.84

CIRCLE 50 FOR FURTHER DETAILS.

B. BAMBER ELECTRONICS

Lot No	Description	Qty.	Price Each As Seen	Price Each Tested
151	Rank Xerox 1385 Photocopier Camera with Spares & Service Manuals. (This is the original Xerox machine	1	£500	—
152	Tektronix Plug-Ins, Type G	19	£15	£20
153	Tektronix Plug-Ins, Type L	15	£15	£20
154	Ditto, Type D	2	£15	£20
155	Ditto, Type E	2	£15	£20
156	Ditto, Type D	5	£20	£60
157	Ditto, Type K	8	£10	£20
158	Ditto, Type Z	1	£10	£20
159	Ditto, Type W	1	£10	—
160	Ditto, Type 82	1	£15	£30
161	Ditto, Type 80	5	£15	£20
162	Tektronix Plug-In Extensions	5	£10	—
163	Tektronix Plug-In, Type N	1	£20	£40
164	Ditto, Type ISI	1	£30	£60
165	Ditto, Type IA2	1	—	£40
166	Ditto, Type IA1	1	—	£40
167	Tektronix Low Level Preamplifier, Type FM122	1	£20	£30
168	Tektronix Oscilloscope, Type 585A Less Plug In	1	£70	£200
169	Tektronix Oscilloscope Camera, Type C12	3	£30	£90
170	Tektronix Hard Copy Unit, Type 4601	1	£100	—
171	Tektronix Storage Display Unit Type 611	1	£140	—
172	Tektronix Oscilloscopes, Type 551 Less Plug Ins	7	£30	£60
173	Tektronix Time Mark Generator, Type 180A	3	£20	£60
174	Tektronix Time Mark Generator, Type RM181	1	£20	£60
175	1 Tektronix Oscilloscope, Type 647 Less Plug Ins	1	—	£150
176	Ditto, Type 555 Less Plug Ins	3	£60	£180
177	Ditto, Type 531A With Type H Plug In	1	—	£120
178	Ditto, Type 547 with Type 1A2 Plug In	1	—	£180
179	Ditto, Type 581A Less Plug In	1	£40	—
180	Ditto, Type 515A Complete	3	—	£100
181	Tektronix Programmable Calculators, Type 31	16	£40	—
182	Tektronix Oscilloscope, Type RM45 Less Plug Ins	35	£20	—
183	Ditto Type 545B	2	£50	—
184	Ditto, Type 545A Less Plug Ins	5	£40	—
185	Ditto, Type 545 Less Plug Ins	3	£30	—
186	Marconi Signal Generators, Type TF995A/5	23	£120	£240
187	Ditto, Type TF995B/5	8	£200	£400
188	Marconi TX & RX Output Test Set, Type TF1065A	21	£40	£80
189	Marconi V.H.F Signal Generators, Type TF1064B/5	33	£50	£120
190	Cossor Mains Radio, Type 358	2	£5	—
191	Pilot Mains Radio	1	£5	—
233	Light Source	3	£5	—
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235	Ex. Equipment Instrument Fans	240	£0.50	—
236	Capacitors, 150mfd 16V	11,500	£0.05	—
237	Sony Empty Video Tape Reels	33	£0.50	—
238	Eddystone UHF Receiver, Type 770S	1	£70	—
239	Soldermaster Desoldering Pump	10	£5	—
240	Avo Meters, Model 7	20	£15	£40
241	Rectifiers, M201	400	£0.50	—
242	Pyrometers	20	£1	—
243	Berco Rheostats	4	£2	—
244	A.C. Chargers, 110V AC Input	1 ctn.	£10	—
245	Attache Cases with Intregral Peg Boards	3	£5	—
246	Baldwin Radiological Densitometers	2	£5	—
247	Reyrolle Metalclad 15 amp Connectors	4 ctn.	£10	—
248	Wild Barfield Incinerator	1	£20	—
249	Schomandl Frequency Meter, Type FD1	8	£25	—
250	C.R.T's Brimar Type D13/47GH	4	£5	—

Lot No	Description	Qty.	Price Each As Seen	Price Each Tested
251	Marconi R.C. Oscillater, Type TF1101	1	£40	£120
252	Pye UHF Signal Generator, Type TFSG5U	1	—	£100
252	Pye UHF Signal Generator, Type TFSG5U	1	—	£100
253	Marconi FM/AM Modulation Meter, Type TF2300	1	—	£185
254	Marconi Delay Generator, Type TF1415	1	—	£85
255	Marconi R.F. Power Meter, Type 0120/	1	—	£65
256	Marconi Valve Voltmeter, Type TF1041C	1	£20	£60
257	Pye SSB Transmitter, Type SSB130	1	£150	—
258	Hewlett Packard Sweep Oscillator, Type 392D	1	£200	—
259	Airmec Oscillator, Type 858	1	£40	—
260	MESL Sweep Signal Generator, 1-2GHz	1	£180	—
261	Comark Time Scale Generator, Type 1401	1	£30	—
262	Marconi A.F. Power Meter, Type TF893A	2	£20	£60
263	Pye VHF Signal Generator	3	£10	£30
264	Airmec Millivoltmeter, Type 301	3	£20	£60
265	Ditto Type 301A	3	£30	£90
266	Hewlett Packard RX Meter, Type 250B	1	—	£150
267	Hewlett Packard SHF Signal Generator, Model 620A	2	—	£300
268	Telequipment Oscilloscope, Type D43	3	£20	—
269	Ditto Type S32A	4	£25	—
270	Advance Signal Generator, Type C2	4	£20	—
271	Solartron Pulse Generator, Type G01101	2	£25	—
272	Hewlett Packard Valve Voltmeter, Type 400D	2	£25	—
273	Marconi A.F. Power Meter, Type TF2500	1	—	£75
274	Marconi 25MHzP Pulse Generator, Type TF2025	1	—	£85
275	Wandel & Golterman Filter Accessory for LDE-2	1	£20	—
276	Marconi 100watt 7db Attenuator, Type TM5280	1	£40	—
277	Bradley Synthesized Digital Signal Generator, Type 235	1	£90	—
278	Hewlett Packard Signal Generator, Model 606A	1	£60	—
279	Pye .F. Signal Generator	3	£10	£20
280	Avo Signal Generator	1	—	£30
281	Wayne Kerr Component Bridge, Type CT3*5	2	£20	£40
282	Marconi Oscilloscope Less Plug In, Type TF2200A/1	1	£50	—
283	Marconi Oscilloscope Less Probe, Type TF1331A	1	£50	—
284	Hewlett Packard Wave Analyser, Type 302A	1	£40	—
285	Dawe True RMS Valve Voltmeter, Type 612A	3	£20	£40
286	Jerrold Field Strength Meter, Type 7043	1	£40	—
287	Marconi Signal Generator, Type TF837	2	£30	—
288	Airmec Sweep Signal Generator, Type 352	1	£30	—
289	Pye Westminster, Low Band 24 volt, Type W30	14	£25	—
290	Marconi White Noise Test Set, Type OA2090B	1	£200	—
291	Bruel & Kjoer Microphone Amplifier, Type 2604	1	£50	—
292	Pye pH Meter, Type PW9418	1	£40	—
293	Marconi Sine Squared Pulse & Bar Generator, Type TF2905/6M	1	£90	—
294	Marconi F.M. Signal Generator, Type TF1066A/1	1	£70	£140
295	E.H. Pulse Generator, Type 139LB	1	£40	—

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296	AIM Pulse Generator	1	£40	—
297	Marconi Universal Bridge, Type TF868A	2	—	£75
298	3pH Variacs, 6 amp	3	£60	—
299	General Radio Unit Oscillator, Type 1209B	3	£40	—
300	Sanders Oscillator, Type CLC 2-4GHz	1	£90	—
301	Solartron Recorder Drive Unit, type H295	1	£20	—
302	Rohde & Schwarz Power Test Adaptor, Type BN4 13116	1	£50	—
303	R. & S. Power Signal Generator, 0.1MHz, Type BN41001	1	—	£125
304	R. & S. Selektomat Type USWV BN15221	1	£50	—
305	Ferranti Video Terminal Type WDM2000	1	£40	—
306	Coutant Power Unit 24V+7V+4V	1	£25	—
307	Trendata Data Test Set, No.5	1	£120	—
308	Rohde & Schwarz Standard Signal Generator, Type BN4 1409	1	£120	—
309	Hewlett Packard SHF Signal Generator, Model 618B	1	£120	£220
310	Dawe Phase Meter, Type 632A	2	£20	£50
311	Pye Deuterium Lamp Power Supply	5	—	£40
312	Solartron Digital Voltmeter, Type LM1420 2	2	£20	—
313	Airmec Wattmeter, Type 319A	4	£20	£40
314	Airmec Oscillators, Type 304A	2	£30	£60
315	Marconi Valve Voltmeter, Type TF1041B	3	£20	£35
316	Marconi Valve Voltmeter, Type TF1300	3	£15	£30
317	Audio Power Meter, Type TF893 Marconi	6	£10	£20
318	Hewlett Packard Microwave Power Meter, Model 430 C	1	£10	—
319	General Radio Unit IF Amp., Type 1216A	1	£10	—
320	General Radio Modular Pulse Generator, Type 1395A	1	£20	—
321	KSM Pulse Generator, Type T18/D	2	£20	—
322	Dawe Transistor Phase Meter, Type 630A	2	£20	—
323	Electric International VHF Preamplifier, Model AP501R	1	£20	—
324	Tekelec Digital Voltmeter, Type TE3BB	1	£15	—
325	Honeywell Power Line Test Set, Type PLY-1	1	£10	—
326	Hewlett Packard D.C. Power Unit, Model 6268B	1	—	£300
327	Wavetek Programmable VCG, Model 155	1	£20	—
328	Marconi Programmble FM/AM Modulation Meter, Type TF2301A	1	£50	—
329	Pye Scalamp Voltmeter, 40KV	3	£20	£60
330	Pye Scalamp Galvanometer	9	£5	£15
331	Rohde & Schwarz Polyskop II, Type BN4245/50	4	£100	£200
332	Rohde & Schwarz VHF Test Receiver	1	£30	—
333	Ditto Enograph Type BN18531	1	£30	—
334	Pye mV Meter, Type 539	7	£20	—
335	Lampkin F.M. Modulation Meter, Type 205A	6	£10	—
336	Hewlett Packard Differential Voltmeter, Type 3420/B	3	£40	—
337	Marconi 20MHz Sweep Generator, Type TF1099	1	£50	—
338	Racal Frequency Meter, Type 9059	1	£70	—
356	Roband Oscilloscope, Type R050A	5	£10	—
357	Marconi VHF Signal Generator, Type TF1060	6	£60	£120
358	Marconi A.M. Signal Generator, Type TF801	6	£40	£80
359	Radiometer FM/AM Signal Generator, Type MS27g	8	£60	£180
360	Electrohome 9in. Video Monitors	8	£25	£50
361	Airmec Modulation Meter, Type 210A	12	£40	£120

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D.C. SUPPLIES

I got lost in Dr Smith's generally excellent article on "D.c supplies from a.c. sources", October issue, when I got to the Appendix, after the first equation on page 68. That equation indeed applies for a square wave of voltage balanced about zero volts.

"If you drive the winding with a unidirectional pulse train..." starts the next paragraph;... Of voltage one assumes pro tem. The core will then certainly "be magnetized in one direction only" in the sense that each application of unidirectional voltage will drive the flux in the same direction, in accordance with Faraday's Law cited on the previous page. But this immediately followed with a reference to Fig. A3 and a peak value of flux which seems to be followed by a reversal of flux change. What voltage accounts for this? (There can in practice be several answers but they all seem to introduce factors which have not been included within the stated problem with its unidirectional pulse (voltage) train.)

If the unidirectional pulses are of current there is no perceivable relevance of flux considerations at all unless by some very indirect route involving permeability.

In my experience a circuit diagram always helps, even in the simplest cases. In Fig. A3 there are two graphs for i, the lower of them labelled "decrease in magnetizing current". Is this shown separately because it is supposed to be in a different winding?

Below A3 a paragraph starts "The usual procedure is to take the ratio of the mean values of flux...". Looking at Fig.A4 and wondering what two or more values of mean flux there might be, I see η used as if it were the ratio between the peak (supposedly equal) positive and negative excursions of flux about the (single unique) mean, at last in the botton part of Fig. A4. But the range of flux change (whether in time T/2 or not depending on unstated assumptions) is then $2\eta\Phi$ where Φ is the mean flux. But by this time the meaning of the symbols is starting to become obscure. Certainly it is a matter requiring proof, to my mind, that

$$\hat{V} = \frac{4\eta}{1+\eta} N\hat{B}Af,$$

which I would be interested to see established.

Finally. I deplore your lapse from the excellent practice, so long maintained after other once-fine journals departed from it, of maintaining a sensible separation between advertising and the rest. I have for years pursued the advertisements thoroughly in *WW* when it has suited me: I am now wondering for how long I will have the patience to avoid the d...d things when I want to read the rest.

R.S. Taunton
Crowborough
East Surrey

BAIRD

I was very surprised to read in the June issue of *Electronics & Wireless World* on page 15 and 16 under the heading 'Communications Commentary' — sub-title 'Baird in history' that "Baird's low definition television was barely ... true television ... since, even in its final broadcast form, it contained no real sync. signals". It does of course depend upon what meaning one attaches to those last four words.

For two years I have been compiling a chronological history of early mechanical television taken from the pages of technical journals and books of the period 1870 to 1937, including our own *Wireless World, Television (& Short Wave World), The Electrician* and many others.

To avoid making this account too long I will confine myself mainly to statements found in text books of the early 1930's when the service was actually in operation and which show that the importance of the synchronizing signals actually transmitted at 375 Hz were well appreciated and were well within the capabilities of all main BBC m.w. broadcast transmitters as explained in the extract from the 1st book.

1. Book of Practical Television edited by G.V. Dowding Publisher: Amalgamated Press, Farringdon St., E.C.1. 1935 Chapter 9, 'Synchronizing a mechanical viewer', p.106:

"In mechanical systems using one rotating member, the positioning of the lines is a fixed factor using one rotating member, the positioning of the lines is a fixed factor in relation to the rotating disc or mirror drum that produces the number of pictures per second. So long as the device rotates at the right speed the number and positions of the lines is bound to be correct. Centering the picture or avoiding it being split is bound to be correct. Centering the picture or avoiding it being split vertically is all that has to be adjusted — as there are 12½ pictures per second, each with 30 lines (with the black spacer at the top), the frequency of the synchronizing pulses will be 375 per second — the 'phonic wheel' synchronizer will have 30 teeth with the distance between each tooth being approx twice the width of each tooth".

2. Television for the Amateur Constructor by H.J. Barton Chapple Publisher: Sir Isaac Pitman & Sons, London. 2nd Edtn 1934

Chapter IX 'Making Vision apparatus', page 194, "— using the 'tuned' synchronising transformer to resonate at 375 c/s to give a strong sync. —" Author's note: This would also enable the sync. signals to be connected in the correct phase, see later explanation.

Television Engineering by J.C. Wilson Publisher: Sir Issac Pitman & Sons, London. 1937.

Chapter IX 'Synchronizing', pages 340/1, Figs 206, 7&8

'Toothed wheel mechanical synchronizing' — moreover the impulses must be positive in the coils of the synchronizer, they must give rise to an increase in the current passing through the coils and *not* a decrease. Circuit 207 shows how this can be accomplished for low definition transmissions (a transformer coupled circuit) — the usual resistance of the two coils in series is between 700 to 1000 ohms with an inductance of some 3 to 4H (page 342).

This book is notable also for the completeness of the various chapter references and for Appendix VII 'Table of early t.v. disclosures' which I have found of great assistance.

In the case of the earlier more 'popular' books, it does not seem to have been appreciated that the synchronizing signal of the Baird-BBC 30-line service was derived from a black line at the top of the picture, scanning being carried out from the bottom right hand corner of the vertical upright picture, the spot moving vertically upwards, covering the picture area from right to left, finishing in the top left hand corner. The lines at the centre of the picture were also more narrow than those at the outside edge to improve centre picture definition.

Various accounts emphasise the need for a strong pulse into the sync. coils for a steady picture. However with the Baird disc scanner receiver where most circuits show the sync. coils connected in series with the neon picture lamp, this would result in a negative picture as well as requiring a high h.t. voltage of over 200 volts, usually derived from batteries. To get a positive picture with strong sync. pulses, the circuit on page 106 of the 'Book of Practical Television' would have to be used with the sync. signals via the transformer phased for positive-going with a positive picture from the negative signal, the black sync. line at the top of the picture giving maximum transmitter output.

An example, however, of the good sync. results that could be obtained from a disc-scanning receiver is given on page 386 of the September 1934 issue of *'Television'* in which the 'Disc Kit' being supplied by British Television Supplies Ltd., of Bush House is being reviewed. The last paragraph states 'the synchronizing gear was effective in holding the picture steady for long periods. We have every confidence in recommending this kit receiver'. In this version the phonic wheel assembly was mounted on the scanning disc spindle, while the driving motor was fixed to the wooden baseboard at one side connected to the spindle by pulleys and a circular form rubber belt to reduce 'hunting'.

Much correspondence and technical notes appeared in the various technical magazines under the heading 'Reversing Negative Pictures' but regretfully almost no attention was given to the importance of strong positive-going pulses in the phonic wheel synchronizer coils by correct phasing from a postive picture signal. A good example of a note under the above heading is at the bottom of page 144 of the April 1934 issue of *'Television'*.

The apparent general failure to appreciate the above probably accounted for the poor overall reputation of the Baird disc-scanner receiver. The later mirror drum versions were much superior and I can personally remember the whole 30 or so minute transmission (including the '8 Step Sisters') without any loss of synchronization and this is confirmed by a *Wireless World* review of the Bush radio, Baird mirror drum receiver in the Sept. 15th 1933 issue, pages 237/8, where favourable comment was made to the steadiness of the picture. "The synchronizing is really good and during a half hour transmission the apparatus often carries through without going out of sync. even once - - - - the lapses from sync. are apparently due more to the transmitter scanner than the receiver, for they invariably occur at the end of an item when the curtain falls to the studio. Apparently this interrupts the sync. impulses".
F. Poperwell
Totteridge
London

RELATIVITY

It was delightful to read that Professor McCausland has finally come down in favour of the anti-relativists. His polite, 'bending-over-backwards' approach to see the relativists point of view must have been quite frustrating. I congratulate him for his succinct conclusion that Special Relativity is now too suspect to be regarded as a tenable theory.

It is also delightful to read Dr Murray's views and comments on one of Einstein's mistakes concerning Relativity theory.

Can I now enter the field with a suggestion? Since *Wireless World* has aggregated an elite band of contributors and letter writers who are dissatisfied with contemporary physics, why not harness such dissident energy? Such a team could re-shape the physics of the world!

I suggest this harnessing could be done by a scheme (produced under the auspices of *Wireless World*) as follows

- Wireless World to publish a series of articles on the new physics.
- Wireless World to issue printed self-adhesive labels for affixing to the above folders.
- Each article to be classified by the Decimal Bibliographical System.
- Introductory pages to be available giving a list of physicists in sympathy with the London School whether contributors or not.
- Every so often *Wireless World* should describe an experiment that should be made in order to test theories put forward by contributors.

A.H. Winterflood
Muswell Hill
London N10

I must have written my letter (July) badly, because I was concerned with what kind of factors would lead us to approve or disapprove of a theory, and not with any application to specific points in relativity. Presumably everyone agrees that special relativity works, in the sense that it gives a good quantitative description of phenomena studied in mechanics. (The first cyclotrons only worked with low energy particles because they assumed Newtonian mechanics to be accurate; only after they were re-designed with relativistic mechanics would they work with higher energies.) So if the theory appears to be nonsensical in some particular application, what are we to make of it all?

One guiding principle is "don't throw the baby out with the bath water"; anyone who does that is not a fit person to bath the baby. Do you remember the bell ringers and the clock maker? Look at all relativity's successes as well as its difficulties and then decide if there is something worthwhile and important in it. Einstein won just fame because he wrote the first worlds on relativity, not the last words; as most of its applications are at the frontiers of science the theory has developed since his day. The helpful thing to do is to show how its flaws can be overcome, not merely to snigger and do nothing constructive. Rightly or wrongly, scientists are impressed by a theory which (in its growing stages) does a lot which is right; they like to work on its rough spots and improve it rather than throwing out the baby.

One thing that I will not do is to give away my own views on the correctness of relativity, so don't try to read between the lines! What I do want people to do is to think about what kind of evidence or arguments are appropriate for use with a theory whose applications are in the frontier districts of science. It has been failure to do this rather than anything to do with relativity which has kept your columns busy.
J.G.D. Pratt
West Horsley
Leatherhead
Surrey

In his article 'The Roots of Relativity' in the May issue Dr Scott Murray claims to reveal a crucial mistake in Einstein's early (1905) account of a 'thought experiment' on the failure of simultaneity in special relativity. He states (p.71, col.3) that "at the instant when the flashes occur the position of M′ coincides with that of M″. With this phrase and in what follows he assumes that if M, the observer on the embankment, interprets the lightning strikes at A and B as occurring at the same instant, i.e. as being simultaneous, then so will the observer on the train, M′. By so doing he invalidates the whole of his subsequent discussion. In fact if M interprets the two strikes as being simultaneous M′ will interpret the strike at B, toward which point he is travelling, as occurring before that at A. It is a safe bet that hardly any of the 'scientifically educated people (who) harbour niggling doubts about it (special relativity) have really grasped what the failure of simultaneity entails. The mutually contradictory nature of the various criticisms of special relativity, which Dr Murray himself remarks upon, reflects the different points in the criticisms at which the assumption of universal simultaneity is slipped in, a process of which Dr Murray's analysis of Einstein's crucial mistake' provides a typical example.

Some hypnotist must have been at work on him to account for the way he fails to register the key provisos 'as judged from' and 'considered with reference to-' 'the railway embankment' which occur in Einstein's exposition. Einstein asserted, not that M′ was hastening away from or toward a beam of light in any absolute sense, but only that he was doing so relative to the observers stationary with respect to the embankment. Consequently light from the strike at B would certainly reach him before it reached M, a commonsense conclusion which for once special relativity allows to be true. Dr Murray's 'routine reminder that the velocity of light from a moving source — a relatively moving source — has never been measured' has now been overtaken by events. The Open University program 'Maths; Space-Time Geometry' broadcast on BBC2 on June 2nd described a measurement carried out in Paris of the velocity of light emitted by electrons travelling round a storage ring at a speed relative to the lab. of some 95% of the speed of light. The ring consists of alternate straight and curved segments, the electrons being bent to follow the latter by magnetic fields. In the curved segments, because of their enforced centripetal acceleration, the electrons generate electromagnetic radiation. By sending bunches of electrons round the the storage ring one can cause this radiation to be generated in pulses, and the velocity of the pulses can be measured in the laboratory, in any chosen direction relative to the motion of the electrons, using suitable collimation to ensure that the radiation observed comes from the right segment. Within experimental error that velocity was found to be equal to the velocity of light. Even natural philosophers are not entitled to ignore the evidence of experiment.
C.F. Coleman
Grove, Nr Wantage
Oxfordshire

FUNDAMENTALS OF ENERGY TRANSFER

It is always refreshing to see a contribution from Ivor Catt even if I do not wholly concur with his conclusions. I am well aware of Heaviside's views that electromagnetic energy leaves a source and enters a load sideways, and he gives an example of a source in London connected by a telegraph wire to a receiver in Edinburgh. Some of the energy from London travels far out into space before converging on the receiver,, but unfortunately I have not been able to find in Heaviside's Electromagnetic Papers any account of how the energy in distant space knows that it is time to start the descent for Edinburgh. However, this is a difficult matter and it is not surprising that the story is incomplete. What is much more difficult to accept is why we should in our theory stumble on the relatively simple matter of a parallel-wire transmission line.

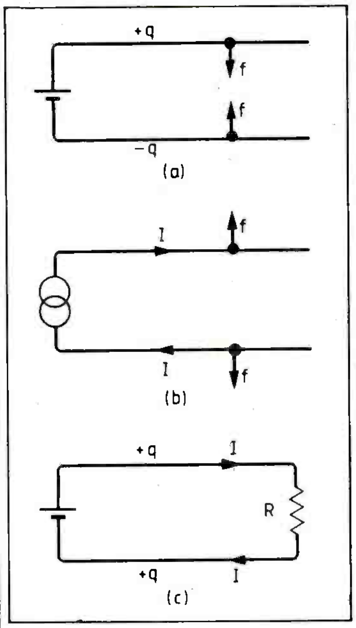
The National Physical Laboratory defines the SI unit of electric current as "The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible cross section, and placed 1 metre apart in vacuum, would produce between these conductors a force equal to 2×10^{-7} newtons per metre of length."

Many text books on electricity, elementary and advanced, use similar wording to define the ampere and indeed the definition is not new. If we substitute centimetre for metre and dyne for newton we have the c.g.s. electrodynamic definition of the ampere that has been used since the beginning of this century, and during this time this piece of scientific nonsense has been for the most part uncritically accepted.

Consider the following relatively short transmission lines:

In diagram (a) the line is open circuit at the distant end hence the conductors experience a mutual electrostatic attraction. In (b) the conductors carry a current and hence mutually repel each other. In (c) we have a combination of electrostatic attraction and electromagnetic repulsion which for some value of R must neutralise each other.

Not very surprisingly the value of R to produce zero resultant force is the characteristic impedance of the line, and that can be achieved by extending the line in diagram (a) infinitely to the right. It seems to have been forgotten



that if a line has $Z_0 = 100\Omega$ then to establish a current of 1A in the line we need a supply of 100V and the electrostatic attraction because of that cannot be ignored.

Forces on the conductors of a transmission line arise from reflections, and the principal characteristic of an infinite line is that it is free of reflections. Now this absence of force on an infinite line follows almost intuitively from the principal of virtual work so it is all the more surprising that the error should have gone undetected for so long. In an infinite line there is equal sharing of the stored energy between the electric and magnetic fields associated with the line. If we increase the separation of the line conductors by a small amount we need a force to overcome the electrostatic attraction, and that can be calculated from f = dw/dx where dw is the increase in stored energy and dx the displacement. Likewise the force associated with increasing the magnetic field energy is f = dw/dx and because of energy sharing equally, dw is the same in each case, as is dx, and the forces oppose each other, so there is a net resultant of zero. Mr Catt rightly says that nothing travels sideways across a transmission line in the TEM mode and that includes force. Lateral forces on the conductors of a transmission line always arise because of reflections that upset the balance of electric and magnetic energy storage in the line. That is only possible with a line of finite length.

Of course it may be objected that the definition does not specify that the two conductors should be the go and return of a single circuit. They could perhaps be the two go conductors of a circuit with a distant common return. Apart from the added complexity due to the third conductor the problem is the same whether the currents in the specified conductors flow in the same or opposite senses. The twin-beam c.r.o. is an example of two parallel conductors carrying current in the same direction. It can be easily shown for this case that for relatively low anode voltages the beams repel each other electrostatically. As the anode voltage is increased the magnetic attraction of the beams becomes greater and would exactly neutralise the repulsion if the electrons in the beams could accelerate to the speed of light and there, as in the case of inifite parallel conductors, the nett force would be zero. Examination questions on this part of c.r.t. science are not uncommon and take the form of "Show that, no matter how the beam electrons are accelerated, the force between beams can never become attractive". The short answer to that is that we can never get the electron velocity up to the energy propagation velocity of the parallel conductors.

It is quite understandable how the definition of the ampere comes to be as it is. A line of finite length has end effects that we do not know how to take into account, so what could be simpler than to remove them to infinity? Unfortuntely this ploy leaves us with a useless line as far as the measurement of force is concerned.

In practice, the SI definition makes no difference for no one pays any attention to it. The ampere is standardised using an Ayrton-Jones current balance in which the conductors are arranged as circular coils and not as straight lines. In the Ayrton-Jones balance we are dealing with equivalent lines finite length short-circuited at the far end so that all the energy is stored in the magnetic field and none in the electric field, so we have no problems.

However, the definition does make a difference of those of us like Mr Catt and me who have some responsiblity for educating the young in fundamentals of our science. How can Mr Catt persuade his students that nothing traverses a transmission line in the TEM mode sideways, when in all quarters, they see "authoritative" statements to the contrary?

Chris Parton
Bell College of Technology
Hamilton
Scotland

Mr Catt's article (September 1984) treads some very shaky ground: I consider many of his statements to be rather questionable but I think I can lay the rest the so called 'Catt Anomaly'.

If I understand Mr Catt correctly he is unwilling to accept that a charge pulse can travel down a transmission line at a speed greater than the speed of light local of the copper of the conductors.

In fact, the speed of light in the conductors (or, for that matter, the electron drift speed of some millimetres a minute) has no bearing at all on the speed of an EM pulse travelling down the transmission line. In 1 nanosecond charge does not have to travel 1 foot down the wire: all that is required is for a drift of charges to occur at the leading edge of the pulse, as it moves, so as to leave a net charge on the wire, in the wake of the pulse.

If this does not seem clear, consider the case of a low amplitude sound pressure pulse, travelling down a pipe: the air in the pipe, behind the wavefront travels very slowly indeed, while the pressure front travels forwards at the speed of sound.

I should like to add that I consider the issue of whether EM fields in a waveguide cause currents in the conductors, or vice versa, to be a meaningless, unanswerable question: field and currents are related by the physics of the situation, one does not preceed the other in time, and no wave or pulse travels without both.

There are a great many statements in Mr Catt's article to which I take exception, but I lack the enthusiasm to describe all the fallacies, or research his reference list to isolate their origins.

N.C. Hawkes
Abingdon
Oxfordshire

Mobile radio system and techniques

by N.S. Cawthorne, MIEE

Topics discussed at the IEE conference recently held in York.

Efficient use of the radio spectrum was the theme that ran through many of the papers presented at the IEE's September 1984 conference in York on "Mobile Radio Systems and Techniques". The radio spectrum is a natural resource of finite quantity, much of which is subject to an ever increasing demand from spectrum users, including the land mobile radio services.

Mobile radio in the UK today is going through a period of changes. The two new cellular networks at 900MHz are now being installed by Racal and TSCR in a dramatic race to be first on the air and to be operational by early 1985. At lower frequencies, the UK's Bands I and III tv transmitters are to be turned off for ever at the end of 1984, leaving over 70MHz of prime spectrum available for other services. Band III (174-225MHz) has already been ear-marked for land mobile radio use.

Internationally too, mobile radio is seeing many changes with new cellular radio network being planned or installed in several countries. The choice of system to be used (AMPS, TACS, NMT, S-900, MATS-E etc) is still being heatedly discussed in many countries. Consequently, there was no shortage of topics for the 341 delegates from 22 countries to discuss during the four days of conference!

Spectrum efficiency

In his opening address, Mr W.H. Bellchambers, one of the five members of the Geneva-based International Frequency Registration Board, made pleas for a greater awareness of both spectrum engineering and spectrum efficiency. This should include the establishment of research posts into "frequency management" at universities and more standardization on the use of frequencies internationally.

Mr Bellchambers went on to question the wisdom of having two incompatible services operating in the same frequency band in neighbouring countries, as will soon be the case in Band III. The UK will be using these frequencies for new land mobile radio services while the UK's continental neighbours will continue to use these frequencies for tv transmissions.

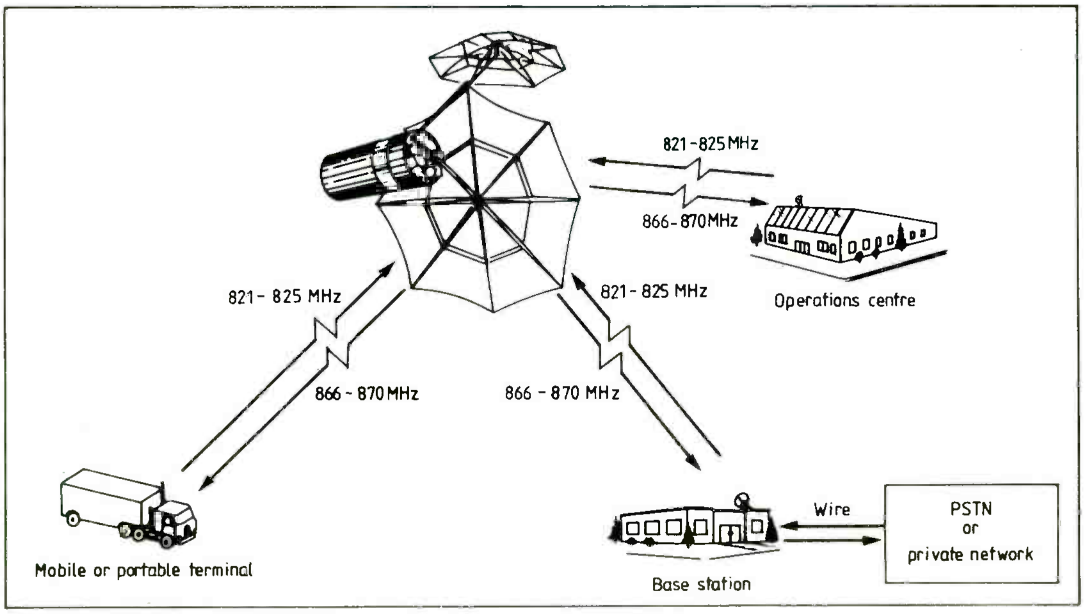
The planning of the international radio spectrum is currently done through a programme of ITU conferences, starting with the administration conferences, such as the WARC held in 1979, which are followed by a series of detail Planning conferences, spread over a number of years. The time taken for the implementation of new frequency allocations has been up to 20 years. Mr Bellchambers wondered if there was not a better way of managing the spectrum internationally, that could take less time and be more responsive to changes in technology. Mr Bellchambers urged the delegates to start planning now for the next WRAC in five years time, and to bring to that conference ideas for streamlining the international frequency spectrum management process.

In conclusion, Mr Bellchambers wondered whether the technology of the future would enable today's method of "frequency allocation" which defines specific frequencies, to be replaced by a spectrally more efficient system where a given service would be allocated a "band" of frequencies. The equipment itself would be continuously frequency agile and would allocate itself a frequency within the given band to give optimum performance under the given circumstances. This was a direct challenge to engineers to design more spectrally efficient systems.

Cellular radio

The present phase of cellular radio being planned or installed by European administrations will not be compatible on a truly pan-European basis. Cellular radio users will have to wait until the next generation of cellular mobile radio equipments are available in

Fig.1. **Proposed Skylink America mobile satellite service for coverage of North America from a single geostationary satellite using up and down links in the upper u.h.f. bands. Mobile users would access the satellite directly.**



the early 1990's before they can drive from one country to another and still use their car radio-telephone.

Cellular radio installations in Ireland, Hong Kong and Finland were described at the conference by representatives of the respective administrations.

The Irish PTT earlier this year scrapped plans to use a 450 MHz network and has now opted for a TACS network on 900MHz that would be compatible with the network currently being installed in the UK.

Delegates heard with interest about the experience gained with the Hong Kong 450 MHz cellular network that operates throughout the colony's tightly packed high-rise building areas.

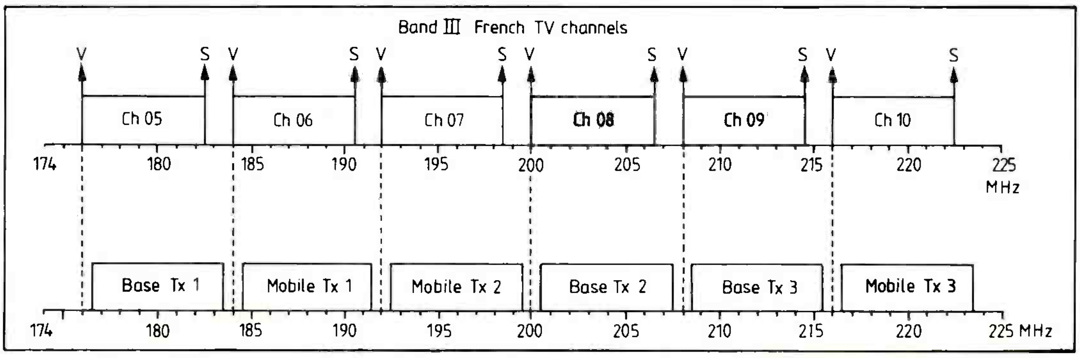


Fig.2. **UK land mobile services sub-bands in Band III, planned to avoid vision carriers of the new French fourth channel programme 'Canal Plus'.**

Cellular radio users in the four Scandinavian countries using the NMT system on 450MHz can move across borders within Scandinavia and stil have access to the radio-telephone network. Future development of the NMT system will include the installation of a 900 MHz network. Even though the frequencies used may be the same as other European cellular networks (eg: the UK TACS systems will also be on 900 MHz), the different signalling procedures used make the systems incompatible.

Satellite versus cellular

Papers describing possible future land mobile services in North America described how coverage would be available to mobile radio users in rural and remote areas via satellite. Areas that would never likely be covered by cellular radio networks because of the low user density could be served directly by the propposed satellite land mobile network.

Skylink Corporation of America described their proposal for a mobile, portable and limited fixed services network operating in two 4 MHz sectors (821-825 MHz receive, 866-870 MHz transmit) from a single geo-stationary satellite over the North American continent.

A paper describing a proposal for a UK land mobile communications satellite experiment which would use four satellites (3 live and 1 standby) in a Molniya orbit to give 24 hours coverage was presented by a team from the University of Bradford. An extended feasibility study has been undertaken by a number of UK universities and the Rutherford-Appleton laboratory. Apart from the super-synchronous, pear shaped Molniya orbit proposed, the other major feature of the study project is the proposed use of on-board microprocessor facilities for signal and message handling to maximize the efficiency of resource usage.

Band III in the UK

Mr K.P. Fisher of the Radio Regulatory Department of the DTI described in detail some of the technical background to the Band III frequency allocation proposals for land mobile services in the UK Government's May 1984 Green Paper on the future uses of Bands I and III after the closedown of 405-line tv transmissions on at the end of 1984.

The DTI was well aware that any new land mobile service on the band III frequencies would have to be very carefully planned to avoid interference to the services from the transmissions from neighbouring countries that will continue to use band III for the foreseeable future.

In planning the future use of band III for mobile services in the UK, Mr Fisher stated that it is the level of interference caused to continental tv viewers that is the limiting system design contraint rather than the interference caused to the mobile services by the overseas tv signals. Mr Fisher informed the delegates that an agreement had been drawn up with the French administration setting out the highest permissible signal strengths from UK land mobile services in France.

A large response had been received from industry and interested parties to the Government's Green Paper on the future uses of these frequencies. Mr Fisher informed the conference that the RRD would be making an announcement concerning its preliminary findings at the IEE colloquium to be held on 8th November.

"Refugees from Band II"

The mobile radio networks run by the UK's utilities (Electricity, Gas and Coal) are currently operating on frequencies just above the present f.m. Band II (104-108 MHz). As the f.m. broadcast band limit is to be increased to 108 MHz on an exclusive basis by 1995 at the latest, the radio networks operated by the utilities will have to be relocated. The utilities because of the nature of the services provided, need to have nationwide communications facilities. Units operating in one part of the country might have to be transfered to another to meet a particular local requirement and the communications facility needs to go with them.

Mr C.E. Dadson of the Electricity Council speaking on behalf of the mobile radio services of the nationalized power industries said that they need wide area mobile radio coverage in order to be able to provide communications for essential services. The present proposal is that the utilities should relocate from their Band II frequencies to the new mobile services allocations in Band III.

Mr Dadson expressed fears that, in practice, land mobile services operating in Band III in competition with continental stations might be put out of service for days on end because of interference caused through troposheric propagation and ducting conditions. Coastal areas, where operating restrictions in Band III would be the greatest, were often just those areas where the nationalized power industries needed to have the best communications. In conclusion he asked for special consideration of the national coverage requirements of the "refugees from Band II"!

H.f. radio

Although the majority of the papers related to v.h.f. u.h.f.

systems, there were two papers on h.f. techniques. One by Mr N. Gerdes of the School of Signals described a low-cost h.f. propagation prediction method which could be run on a BBC computer. Comparisons between actual and predicted propagation on different h.f. paths are the subject of continued investigation, but so far there appears to be close correlation. The method is intended as a low-cost alternative to the prediction programs run on main-frame computers by bureaux.

The second papers on h.f. described an experiment being carried out at the University of York into improved design for h.f. communication networks involving mobiles. The study centred around a network of sereral interconnected h.f. base stations and a mobile station. The objective was to increase the reliability of communication to and from the mobile station by the interchange of data between the base stations concerning the reception of the mobile. This was described as "geographic diversity". As part of the study a low-power h.f. link is to be set up between York and Canterbury.

Pagers

Paging systems are also users of the radio spectrum and as they develop forward from the basic "bleeper" to carriers of messages, both numeric and alphanumeric, they bring together radio engineering and data transmission technologies. Papers described recent developments in the integration of pagerr receivers. One such paging receiver, described by a team from Philips Research Laboratories had only 12 "off-chip" components (but 13, including the battery!).

The POCSAG paging code originally devised by the UK Post Office has bow become standardized by the CCIR for international use.

Amateur radio experiment

As with any meeting of international mobile radio specialists ther was a good number of amateur radio operators among the delegates. One of the presented papers described an amateur radio experiment which involved using a number of mobiles fitted with 144MHz transceivers to build up a propagation map of an area around Birmingham in order to determine the relative performance of different sites for use in a possible emergency communications operation as part of Raynet. Unlike professional propagation analyses which rely on expensive test-gear, this amateur experiment relied more on the enthusiasm of the participants that it did on test gear. (Although presumably the computer required to solve the 300 odd complex simultaneous equations after the event in order to produce the results could have been classified as "expensive test gear"!).

The IEE's Conference on Mobile Radio Systems and Techniques came at a time of unprecedented change and developments in the area of mobile radio in the UK. By the time that the next such conference is held, both cellular radio and the new Bank III mobile services will have been put into operation and it can be expected that there will then be more papers based on actual experience and less on predictive techniques that was the case this year.

References
1. IEE Conference Publication 238 "Mobile Radio Systems and Techniques".
2. HMSO Cmnd 9241, "Bands I and III" Consultative Document

CIRCUIT IDEAS

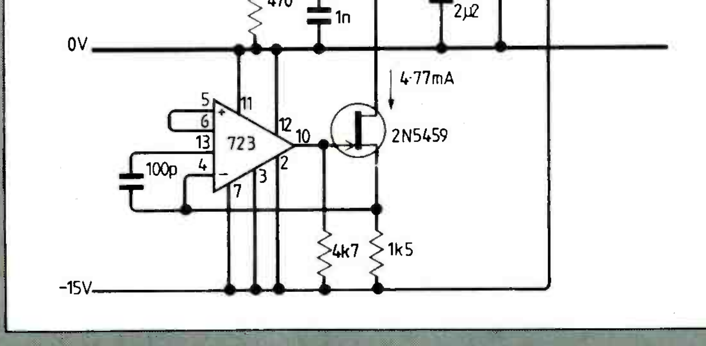
Pulse-width demodulator

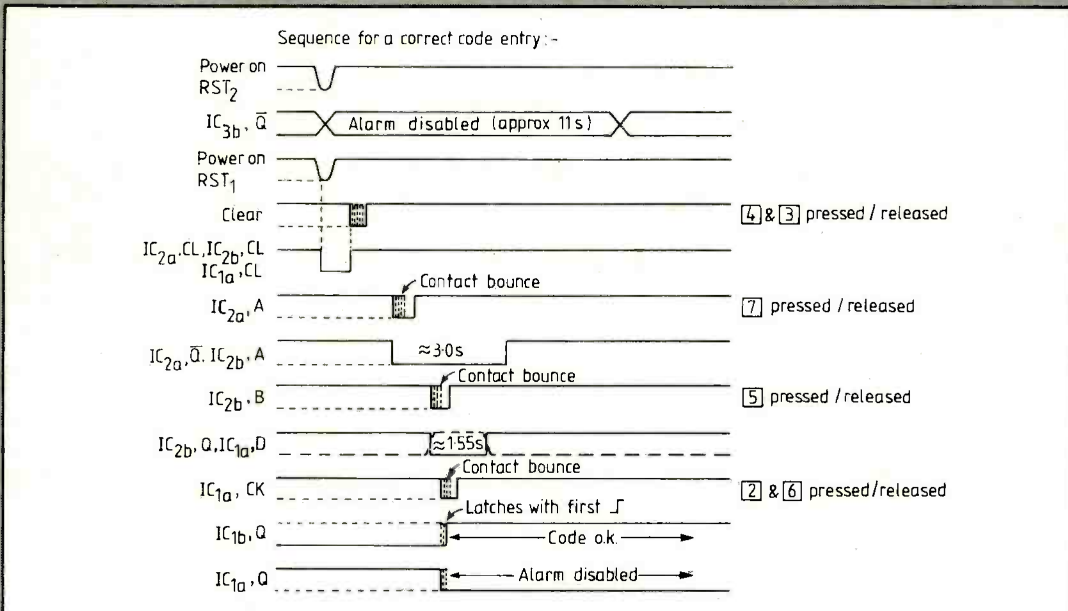
Designed as part of an optical-fibre interface between a computer and e.h.t. generator, this pulse-width demodulator uses a 723 voltage regulator and fet as a low-drift constant-current sink.

The 723 and fet provide a 4.77mA reference for a 10kHz pulse-width demodulator. When the t.t.l. input is low, all of the reference current is supplied from the 5V rail, but when the input is high, current has to be drawn through the diode from the inverting output stage. The diode and switching transistor must turn off quickly, but their on resistances do not greatly affect performance. Current-to-voltage conversion and two low-pass filter stages are provided by the output circuit. I have followed this arrangement by a 10kHz notch filter (parallel T) to remove modulation frequency break through.

When the 723 is driven from a stabilized supply, the only drift problems seem to be those due to temperature. After gluing a lump of aluminium to the device, drift was +0.02% in the first 15 minutes, +0.02% over the next hour and ±0.02% thereafter.

Jim Dawson
University of New South Wales
Sydney





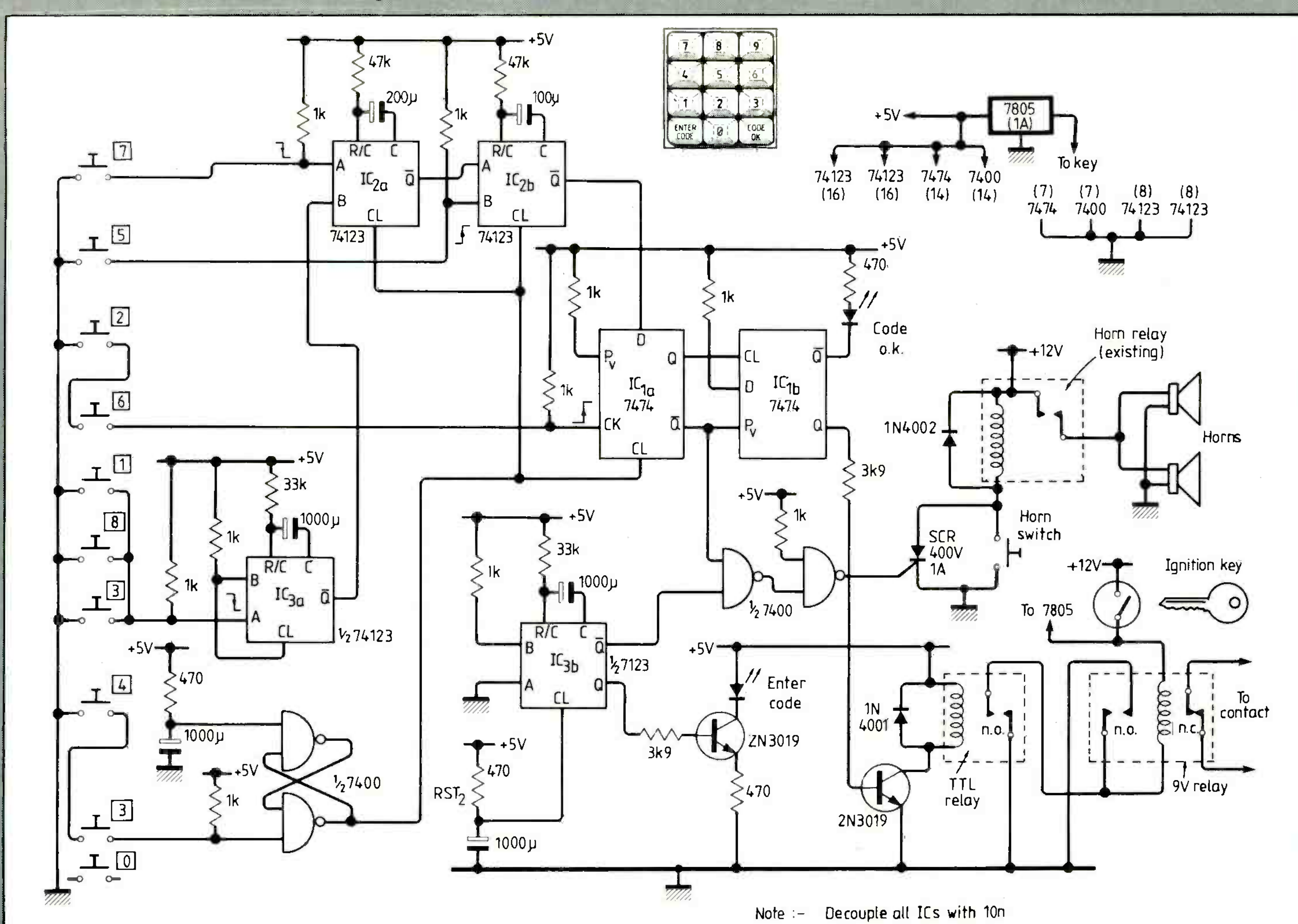
Electronic ignition key

Your car can be made burglar proof if it can only be started by entering a code on a keyboard. With this circuit, the code has to be entered within a time limit and the code cannot be corrected without setting off the alarm, thwarting even the shrewdest car thief.*

When the ignition is first switched on, latches $IC_{1a,b}$ and monostable circuits $IC_{2a,b}$ are cleared by RST_1 and reset signal RST_2 initiates an 11s period, during which the alarm is disabled. If any of the system-reset keys is pressed (1, 3 or 8) during this period, another 11s cycle is initiated by IC_{3a}. This inhibits further code entry and the alarm is activated at the end of the cycle. When the correct code is entered during the initial 11s period, reset keys three and four are pressed together to release monostables $IC2_{a,b}$ and latch IC_{1a}.

Pressing key seven, the first digit of the code, triggers the first monostable device, IC_{2a}. The $\bar{Q}$ output of IC_{3a} will be high, provided that it has not been triggered. As the $\bar{Q}$ output of IC_{2a} goes low the rising edge of IC_{2a}'s B input (switch bounce is accounted for), through pressing and releasing key five as the second digit of the code, triggers the second monostable, IC_{2b}. Output Q of this device feeds the D input of latch IC_{1a} and pressing and releasing keys two and six together (third and fourth digits of the code) latches IC_{1a} Q output high. Output $\bar{Q}$ of IC_{1a}, being low, inhibits firing of the s.c.r., even after 11s, and the critical phase is over.

The spare second half of IC_1 serves as an output latch, the Q output of which energises a t.t.l. relay on whose normally-open contacts switch a further higher power 9V relay with normally open and normally closed contacts. The normally-closed contact releases the



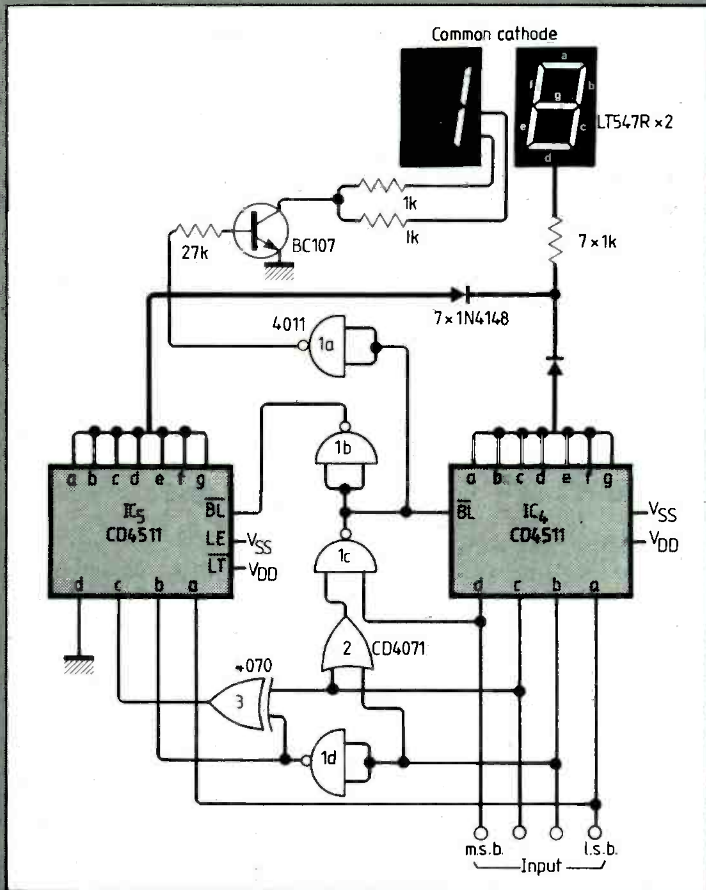
short across the ignition contact breaker and the normally-open contact offers a holding path for the 9V relay, even during reset.

If the correct code is not entered during the 11s period, the car horn is switched on. Turning off the ignition key does not stop the alarm but pressing the horn button will momentarily inhibit conduction of the s.c.r.

Use of the secondary 9V relay ensures reliability, even if the battery is not fully charged and during the voltage dip caused by starting the engine. Supply decoupling is not critical as the circuit only needs to operate properly while the car is stationary. Malfunctions occurring while the engine is running are of no consequence since the 9V relay only acts when the ignition key is switched off.

G. Varkey
Cochin Naval Base
Kerala
India

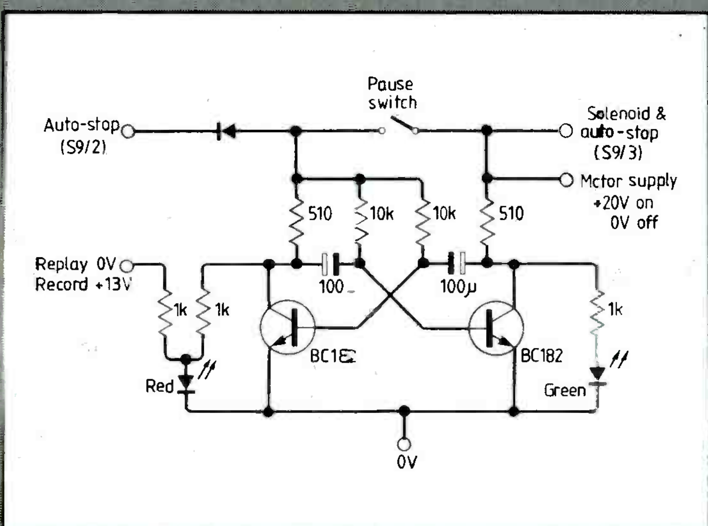
*Or a driver under the influence of alcohol — Ed.



Easy to read hexadecimal display

One seven-segment display made to display hexadecimal values is awkward to read. Devices for displaying binary-encoded decimal values don't respond to binary inputs above 1001 but this circuit display a hexadecimal value in decimal form and its most-significant decoder is capable of reading between zero and five.

Hr De Smet Willy Onlug
Zomergem
Belgium



One led shows six modes

In my application, this multivibrator driving a 'three-colour' led is used to indicate one of six modes of a cassette recorder but it can be applied to any situation where d.c. switching is used.

Supply to the multivibrator is split so that oscillation at about 1Hz only occurs when the pause switch is on. The six modes indicated are
- led off, deck disengaged
- green, running (play or wind) auto-stop effective
- red, record mode
- yellow, running (record) auto-stop effective
- red/yellow, pause (record)
- red/green, pause (play) if winding auto-stop ineffective

Connections shown are for the Hart Electronics VFL910 cassette deck. In other applications, green and yellow could be made to flash alternately.

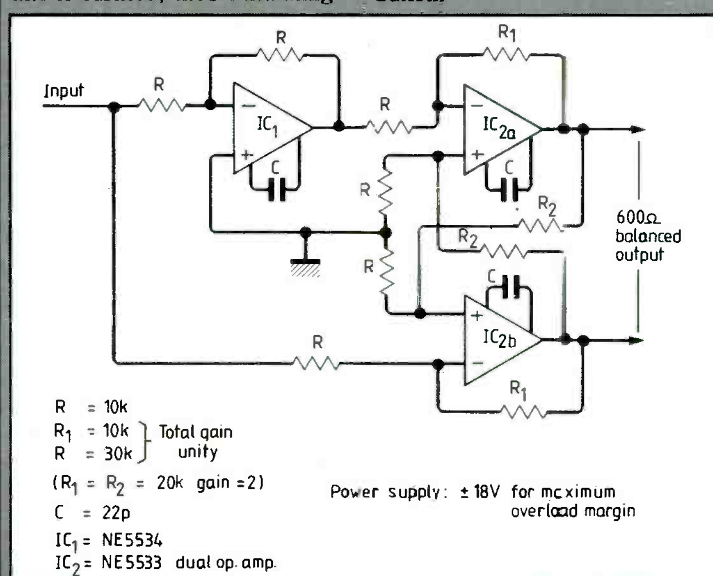
J.E. Wilson
Leicester

Differential line driver replaces transformer

There are many applications where balanced line driving is required, particularly in audio applications where noise is a problem. Transformers are expensive and suffer from limited bandwidth and stray magnetic fields so this circuit uses opamps.

Output maintains constant amplitude even if one balanced line is earthed, thus simulating true transformer action. Devices chosen have low noise figures and can drive 600Ω lines directly. The circuit has a 22dB overload margin when driving 0dBm into 600Ω, and greater than 60kHz full power bandwidth can be achieved by careful choice of resistos.

S. Whitt
Ipswich
Suffolk



by P.N.C. Hill

More on the XY plotter

Further constructional information and some software

Since the publication of the previous article on the construction of an X/Y plotter in the January edition of WW, I have received a number of enquiries requesting further information. Although the first article was intended only to introduce readers to the idea of constructing such a precision instrument, I hope that this will further encourage any would-be constructors.

The software required to drive the plotter has also been expanded and re-written in Pascal on a CP/M-based system similar to the SC84 computer described in this journal. An interactive control program has been developed to allow diagrams to be drawn from a stock of pre-defined shapes and then annotated with a wide selection of type sizes and founts*. A graph/histogram package also links a digital filter design program to the plotter so that frequency response and impulse plots can be drawn and labelled.

*The interactive control program can be obtained from this office. Please enclose a large, stamped and addressed envelope and mark your letter 'XY Plotter'.

Driver circuits

The driver circuit described originally might seem excessively complicated to those who wish only to experiment with stepper motors. As mentioned previously the aim was to achieve 400 step-per-revolution accuracy from the motors. To achieve this from the four-pole motors, the sequence of excitation must be as follows:

A,AB,B,BC,C,CD,D,DA,A...

The rom sequencer described previously performs this operation for both motors therefore keeping chip count and interconnections to a minimum. However, those constructors unable to gain access to a prom programmer may prefer a more traditional approach in generating the necessary control signals for either 200 or 400 steps.

400 step sequencer. The circuit in Fig. 1 may be used to drive a single stepper motor. The 74LS193 counter maintains the current position in the 8 stage sequence: only the top 3 bits are used for this, the fourth bit being left disconnected. The counter's up/down input serves as a motor direction control, so that pulsing the counter steps the motor forwards or backwards. The binary outputs from the counter are decoded by the Nand gates. The four final outputs marked A,B,C,D are connected to the power driver circuits, which in turn provide current to the stepper motor windings.

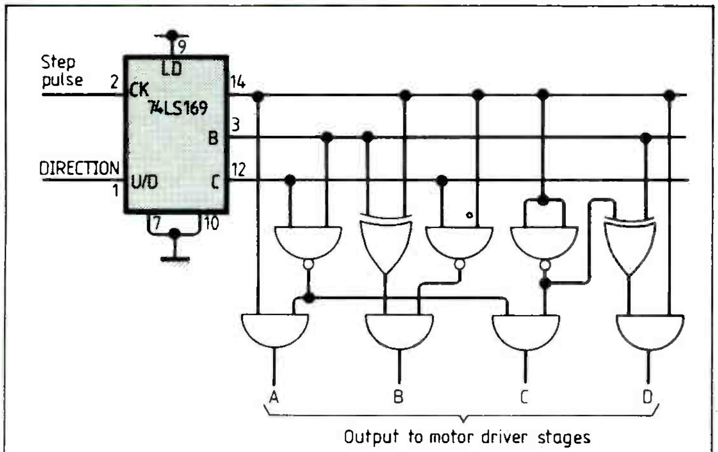


Fig.1. **Simplified 400 step sequencer for controlling stepper motors.**

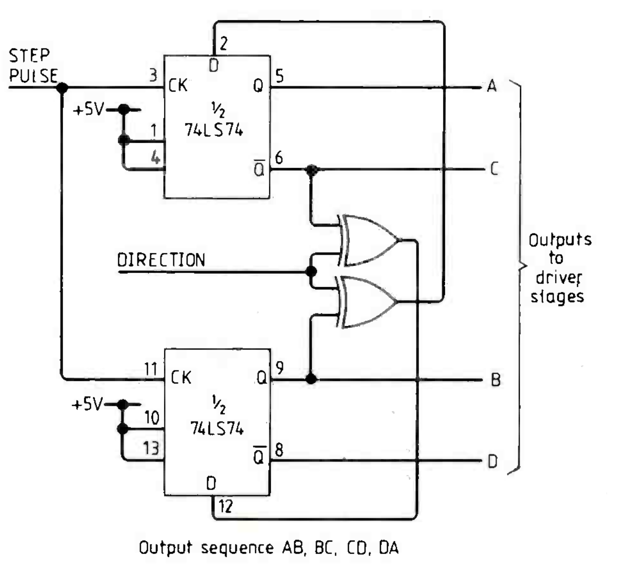
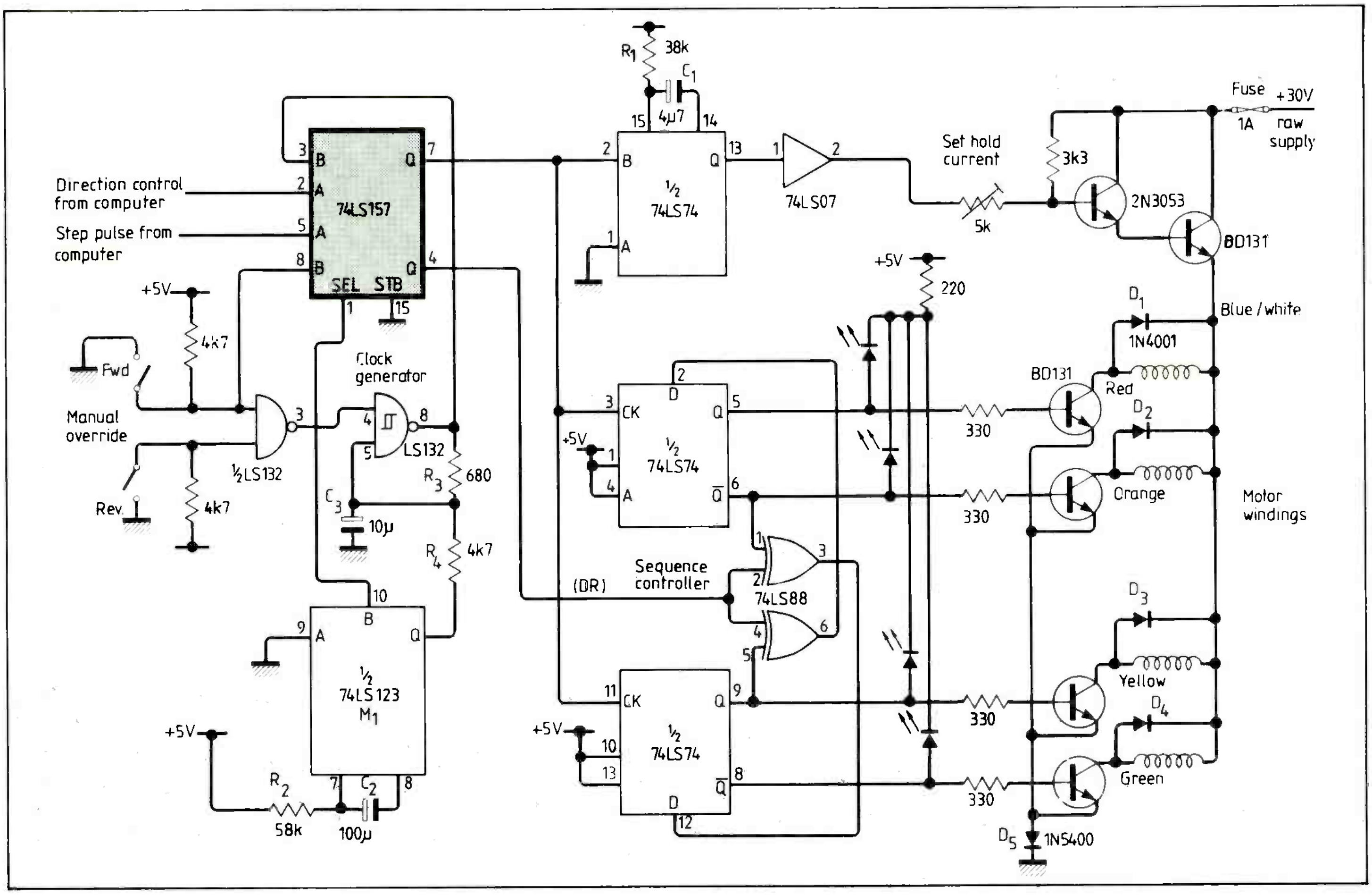


Fig.2. **200 step sequencer for controlling stepper motors with reduced resolution.**

200 step sequencer circuit. A much simpler circuit can be used to generate the sequence: AB,BC,CD,DA,AB... Although this halves the number of steps per revolution, useful results can still be obtained: the circuit is shown in Fig. 2. Only two D-type flip-flops and two ex-Or gates are required for each motor — the motor direction is controlled by the state of the external input to the ex-Or gates. This simply inverts the feedback around the counter formed from the two flip-flops. The step pulse to increment the motor position is applied simultaneously to both clock inputs on the 74LS74 flip-flop.

Either of the above methods can be used to generate the logic sequence used to drive the current in the motor windings. The power driving section simply hooks onto the output of the sequencer. The exact design of the driver naturally depends on the type of stepper motors used and also on the loading conditions of the motors.

Driver stages. Various factors must be considered when designing the driver stages. A typical scheme which might be used is as follows. The selected winding(s) is driven hard on as the sequencer output changes to the next state. The rotor accelerates towards its next position, drive current being then reduced to maintain the new rotor position and prevent overshoot. If the motor is driving a predominantly inertial load, then this maintenance current may be only slightly (if at all) lower than the main pulse current. However, if the load is frictional, then the holding current need be only very small; indeed, it may not be required at all, so reducing the power dissipation considerably. In the case of the plotter the motors drive a load which is part frictional and part inertial: a compromise is thus sought. A maximum of 200mA per phase for the pulse current with a holding cur-



rent of approx 40 mA is found suitable for the 12/24V motors obtained from Stewarts of Reading. These figures are not critical and optimum choice will depend on the mechanical construction of the plotter.

Motor controller circuit. The common-collector driver circuit originally proposed is ideal for providing the two levels of current in a controlled manner. The fact that the initial circuit was designed for use with several types of motor and transducer contributes to its relative complexity. An alternative (effective) method of driving the motor is shown in Fig. 3. If the discrete transistors are too bulky then transistor arrays can be used, provided the maximum current ratings are observed. Little or no heat sinking is required for the driver transistors if they are used only in the fully on or off states. However, the main regulating transistor will require a heat sink if an appreciable hold current is used.

It is also important to note that the actual measured current in the windings will not be exactly as first predicted due to the very high self inductance and impedance of the wire used in the motors. Large back e.m.fs will result during the current switching process, most of which the diodes (D_1-D_4 in Fig. 3) dissipate harmlessly. Failure to include the diodes will almost certainly lead to blown output transistors.

The on/off sequence is generated by a circuit similar to that in Fig. 2. In addition, logic for providing manual control from two push-buttons is included to allow movement of the pen independently of the computer. This is particularly useful when removing and re-loading paper. The movement rate is also increased after about one second of manual control to speed up the movement of the pen over longer distances whilst still allowing accurate positioning at a lower speed.

The circuit is self-contained (with the exception of the power supply) and so needs to be built once for each motor: Fig. 4 shows a photograph of the completed circuit. The component values shown are suitable for the SLO-SYN motors mentioned in the previous article. Resistor R_5 sets the maintenance or hold current, R_1 sets current-pulse length, supply voltage sets pulse current. Best results may be obtained with a supply voltage typically higher than the motor's rated voltage. Heating effects are not a problem as the current remains at the higher level only when the motor is stepped.

The circuit operation is basically straightforward with the possible exception of the modulation of the clock frequency by the output of the 74LS123 monostable via R_4. When either button is pressed the mono-stable (M_1) is triggered, so slowing the clock. After a short-period ($0.3 \times R_2 \times C_2$ seconds) the output returns high,

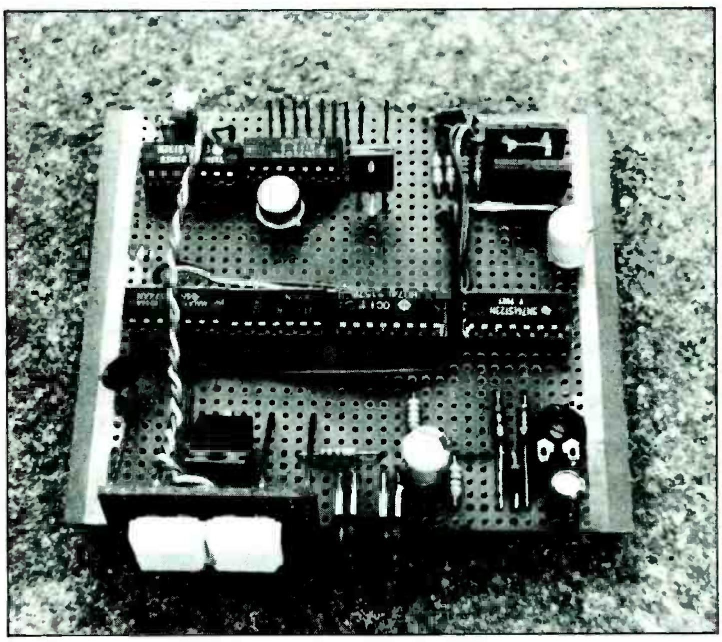


Fig.3. **200 step, stepper motor controller and driver.**

Fig.4. **Photograph of completed stepper motor control module. The manual control push buttons can be seen on the front of the board next to the led indicators. The leds turn off when the corresponding coil is being driven to avoid drawing excessive current from the logic.**

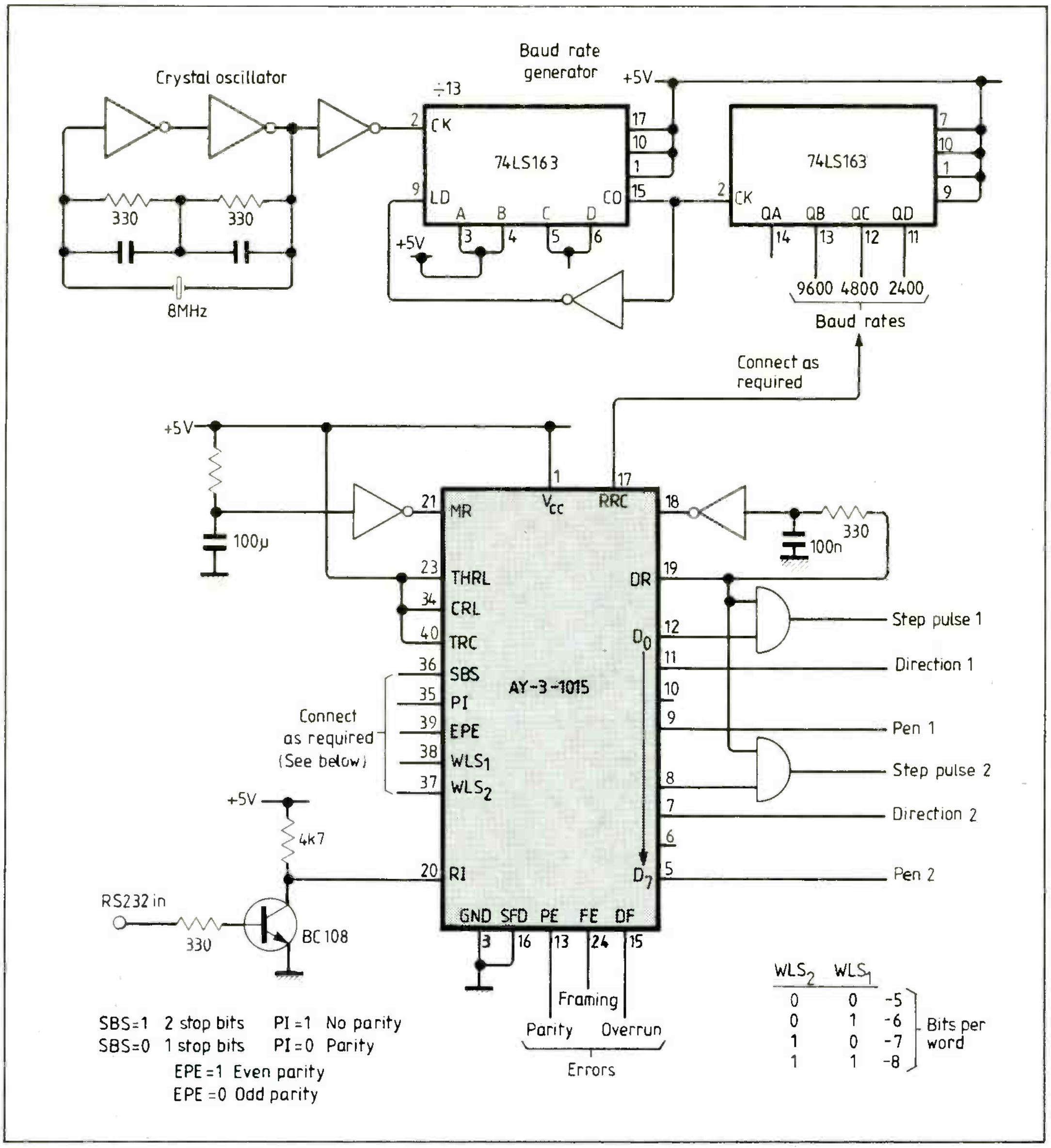


Fig.5. **Serial interface for graphics plotter.**

Fig.6. **Photographs showing the completed plotter in more detail. Both stepper motors can be seen attached to the pen carriage and the paper carriage.**

so increasing the clock frequency by an amount dependent on R_4. The clock base frequency is governed by R_3 and C_3 which, together with the Schmitt Nand gate, form a gated oscillator.

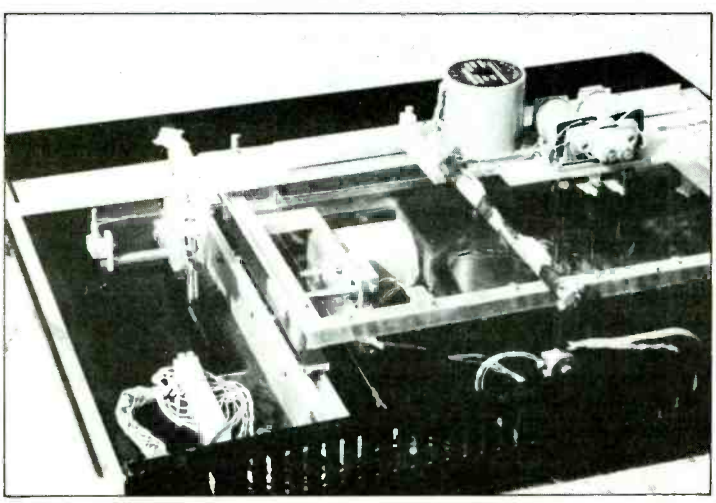
The 74LS74 flip-flop and the ex-Or gates provide the AB, BC, CD, DA sequence required for coil excitation, the direction being controlled by the state of the DR line.

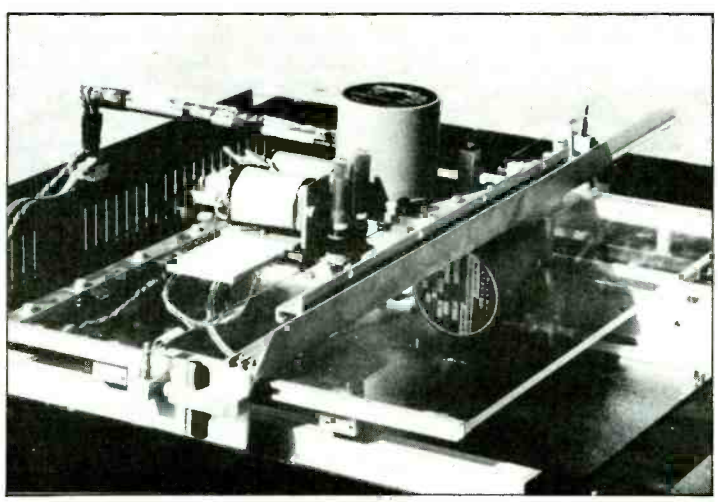
The 74LS157 is used to route the control signals from either the computer or the logic associated with the manual over-ride buttons to the sequence controller. Pressing either button over-rides the computer — necessary during software development!

Interfacing to the computer

Any home computer is capable of driving the plotter. Sadly, the interfacing facilities of most of the numerous hobby machines are far from being standard. If parallel outputs are available, then interfacing the plotter is a simple matter. Two wires are required for each motor: direction control and step pulse. One additional wire is required for each pen for the lift control, giving a total of six wires for a two-pen plotter, plus the common earth line (of which several are recommended for safety's sake). One standard eight-bit output port is thus sufficient. Additional input lines can be added for feedback for finding the paper origin etc.

This form of parallel interface requires a multi-core cable and cumbersome connectors, and offers no protection to the microprocessor from external nasties such as 25V lines etc. An alternative approach is to use a serial interface driven from the RS232/IEEE 425/426 output of the computer. This is portable and flexible and only requires two wires! Many uart chips are available which perform the basic shifting and timing operations necessary for an asynchronous receiver. The AY 3-1015-D is one such device particularly useful in this application as it can operate without a host microprocessor. It requires a stable clock at a frequency of 16 times the baud rate. This is generated from a crystal-controlled oscillator and divider circuit. Baud rates of above 4800 are advisable to allow a reasonable plotting speed to be achieved. Figure 5 shows a suitable interface circuit.





The incoming serial data is conditioned and buffered and fed into the RRD input of the device, the parallel output appearing on pins 26-33. The DR signal on pin 19 indicates a received byte of data and is reset by pulsing low the DRR input on pin 18.

Although the circuit has not been used with the plotter it has been successfully used with other projects. The gates connected to the outputs of the AY 3-1015-D simply route the received data strobe signal to either (or both) of the sequencer circuits used. If the corresponding output bit is set to one then the sequencer is stepped once. If the bit is left low then the sequencer remains in its previous state. eg: Sending 01H steps the X motor once in one direction whilst 03H steps it in the opposite direction.

Improvements to the mechanics

Some simple changes have been made to the mechanics which have improved the performance of the plotter. It was initially suggested that button-hole thread was suitable for the traction wires along which the motors run. This does work extremely well; however, plastic coated stranded wire produces better results as it can be tensioned to a greater extent. A source of suitable wire is a fishing tackle shop as it is sold for use in attaching to large hooks to prevent even larger fish from biting through the line. Various thicknesses are available but 40lb seems the most suitable.

A second improvement is to the pulleys that run along the wire. One pulley is fitted to each of the two motors which are in turn fitted to the pen carriage and to the plotter bed (or paper carriage). These should ideally be made of Brass rather than aluminium alloy, since the latter seems to promote excessive wear on the wire. The pulley diameter should be as small as possible to give the best resolution and smoothest performance of the plotter.

Finally and most importantly, the width of the flat area of the pulley on which the wire runs (see Fig.13 of original article) must be sufficiently great just to prevent the wire from winding to the ends. This is best done by calculating the number of pulley revolutions that must be made for the appropriate carriage to move from one end of its travel to the other. The pulley width must therefore be greater than this number times the thickness of the wire. In the case of the 40lb wire the outside diameter is approximately 0.8mm. A pulley of, say, 7.0mm diameter requires 14 revolutions to move the 21.2cm of a sheet of A4 paper, which means that a pulley width of 11.2mm is required. If the width is smaller than this then the plotter functions satisfactorily except for some long-term slippage.

The completed plotter is shown in the photographs in Fig. 6. Both stepper motors are clearly visible, as are the taut wires along which they run.

Controlling software

Once the plotter has been constructed and the electronics built and then interfaced to the computer, the software development can begin. This may, at first glance, appear to be a simple task, but there are a number of problems which can result if a few precautions are not taken.

The first rule is not to use floating-point arithmetic for the main line and curve drawing routines, since the inevitable truncation errors lead to inaccuracies which accumulate, as all pen positioning is naturally done relative to the previous pen position. If a positioning error occurs at any point the error remains from then on. These slight error may not be noticable on small diagrams but on larger, more complex drawings the end may not join up with the start.

For simplicity in the description of the software, the pen is assumed to move in both the X and Y direction over the paper. In practice this is not the case as the paper actually moves in the Y direction.

Straight lines. This is the most elementary routine (apart from pen up and pen down). We may specify the endpoint of the line on a cartesian coordinate system, the origin of which is previously defined at a suitable point on the paper. The X and Y coordinates of the endpoint are passed to the routine which then moves the pen from its current position (wherever that is) directly to the endpoint. If the pen is up then no line is actually drawn. If the pen is down then a straight line is drawn on the paper.

It is tempting to perform this function by calculating the gradient of the proposed line. A decimal number is obtained. For each step the pen is moved in the X direction it must be moved by this amount in the Y direction. Obviously the pen can only move in whole steps, so at each point one must calculate the exact position using floating point arithmetic and then move the pen to the nearest actual location. When the end of the line is reached any small error present must be corrected or else it will propagate. The problems mentioned are only the beginning, since we also have to cater for vertical line without a division by zero error in the calculation of the gradient. Doubtless it would be possible to devise routines to perform all these checks, but if they were written in anything such as Basic it would probably take serveral minutes to draw each line. Luckily, an alternative exists.

A glance at Fig. 7 highlights the problem. The central line shows the ideal (unobtainable) solution: The staircase route for the pen is the best approximation. At every point there are two possible directions in which the pen can next be moved: one step in the X direction or one step in the Y direction (the movement is either positive or negative on each axis but this is constant for any given line and so need not be determined at each step). We simply wish to determine which of the two options leads to the pen being positoned closest to the ideal line. If we calculate the distance that each of the two solutions would place the pen from the ideal line we can then choose the best of two.

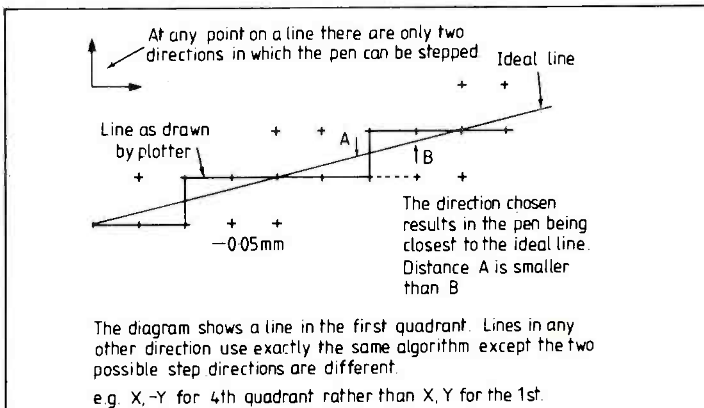


Fig.7. **Drawing straight lines.**

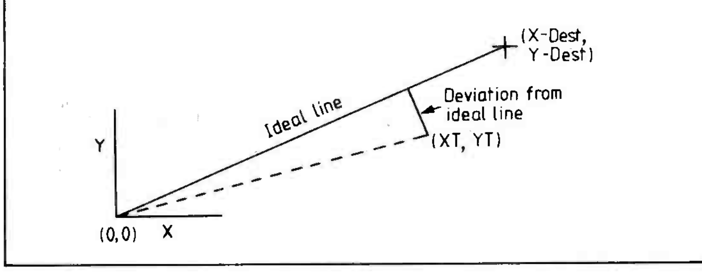


Fig.8. **Calculation of perpendicular distance of point from the required line.**

The calculation of the deviation from the ideal line is extremely simple, as Mr Griffiths pointed out in his letter published in the February edition of *E&WW*, and which is illustrated in Fig. 8. Thinking in terms of programming we may call coordinates of the endpoint of the line (X DEST, Y DEST) and the current pen position (XT, YT), both relative to the starting point of the line. The coordinates at which the pen would be positioned after the next step has been issued are calculated for each of the two possible next moves. These would be (XT+1, YT) and (XT, YT+1), the '1' referring to the one step moved in either of the two directions. We then compare deviations from the ideal line obtained by both solutions, adopting the solution with the smallest deviation. The implementation of this is further simplified as the value of '1' (the line length) is constant and so need not be included in the comparison. The test may be implemented as follows:

```
IF ABS[XT*Y_DEST
—(YT+1)*X_DEST]
< ABS[(XT+1)*Y_DEST]
—YT*X_DEST]
THEN MOVE IN Y DIRECTION
 ELSE MOVE IN X DIRECTION
```

ABS indicates absolute value.

To be continued.

by J. Rush*

Digital derivative feedback at l.f.

In a proportional-plus-derivative servo system in a model ship, a hybrid digital-analogue circuit gave better results in extracting the rate signal that the more usual lead/lag RC network.

*University College, London

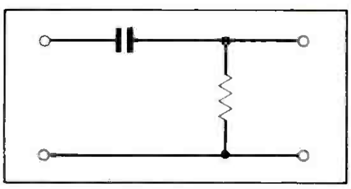


Fig.1. **Elemental CR circuit produces derivative action, used to obtain rate information.**

It is well known that a resistance capacitor network such as that shown in Fig. 1 will produce derivative action on any signal injected into it. This effect can be used to produce a 'rate' signal in servo mechanisms, but it has two serious defects. The first of these is that the degree of phase shift depends very much on the frequency being differentiated. The signal emerging from the network, will be a combination of a proportional signal and a derivative signal at +90° to it. The ratio of these two determines the phase advance, which unfortunately decreases with decreasing frequency. The second drawback is the size of capacity needed at low frequencies, say 1Hz, to produce moderate derivative action. The phase angle of the emerging signal depends upon the ratio of the impedances of the resistance and the capacity. The impedance of the resistance can be taken as the resistance; the impedance of the capacitance X_c, is

$$X_c = 1/2\pi fC \text{ ohms}$$

for a frequency in hertz and capacitance in farads. The phase angle is then

$$\tan^{-1} X_R/X_c \text{ for } X_R \text{ and } X_c \text{ in ohms.}$$

The difficulty with the system is the size and quality of the capacitance needed to produce a reasonable phase shift at low frequencies. In Fig. 1 the capacitance shown is assumed perfect, with no leakage resistance or self inductance, and this can only be approached in practice with very careful layout and high quality, expensive and bulky capacitors. Suppose, as in this case, we are working with a model ship, and wish to consider frequencies in the response region of yaw motion, say 0.5Hz. With careful shielding and f.e.t. amplifiers, X_r could be made as high as 10MΩ, so that to produce a lead angle of 85°, the capacitance need, assuming no loss, is 0.36 μF. This is obviously undesirable and a more reasonable value might be 0.01 μF, which gives a lead angle of only 17° and has an impedance of 32 MΩ at this frequency.

Direct rate measurement

It was felt that this problem could be more easily overcome by measuring the rate of change of the incoming gyroscope signal directly. This can be done with the gyro signal charging a capacitance which is discharged at a fixed

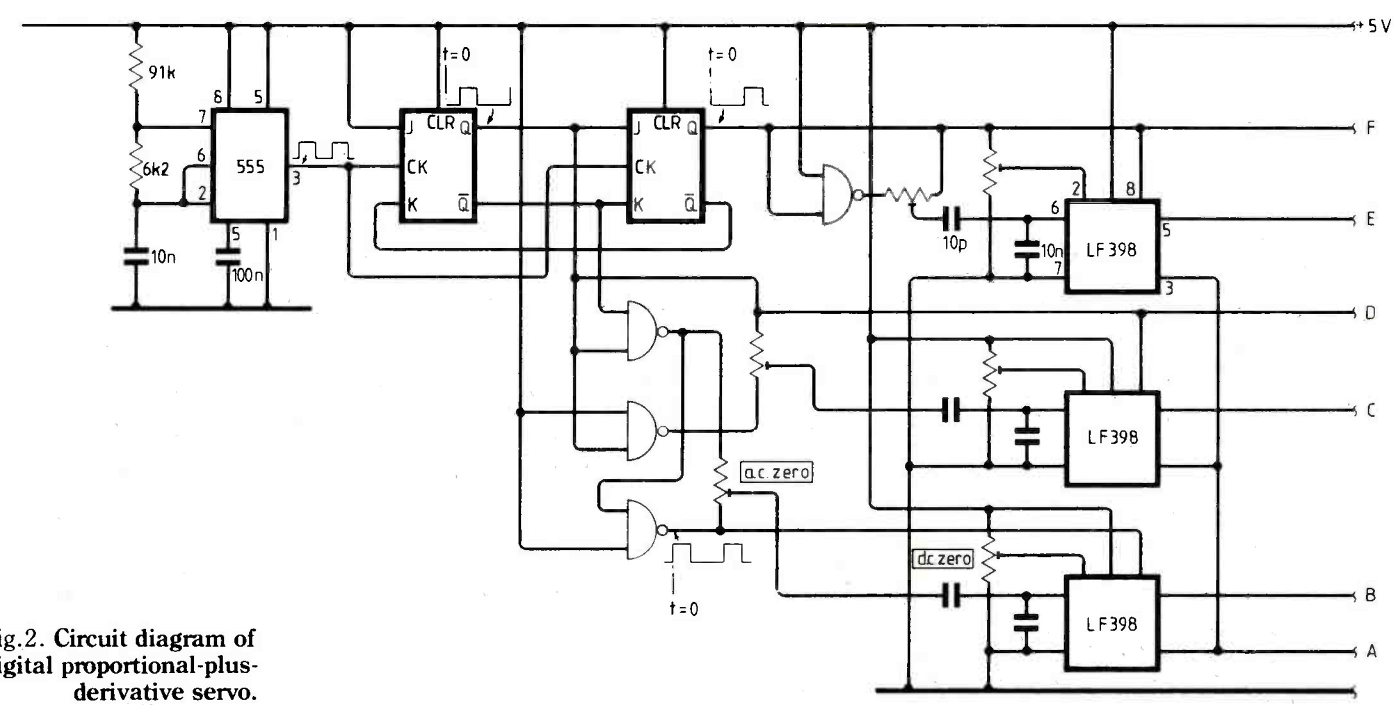


Fig.2. **Circuit diagram of digital proportional-plus-derivative servo.**

rate by resistance, but this is really the same as the phase lead network. The solution was to sample the incoming gyroscope signal at fixed small intervals and take the output derivative signal as the consecutive difference between two consecutive samples. This gives a derivative signal which easily works at low frequencies and within noise limits, improves with decreasing frequency.

The incoming gyro signal can be sampled with a 'sample and hold' circuit, which can be obtained as a single i.c., and one would need a minimum of two samples to produce a rate signal for a given time interval. The rate signal is obtained by making the two samples the input to a high gain differential amplifier.

In practice, sample and hold circuits suffer two distinct lags, hold settling time, and acquisition time. The first of these is the time required for the output to settle after a 'hold' has been given. When measuring small differences between consecutive samples this hold error could introduce magnified errors in the output, but for the sample and hold circuits used the hold settling time is of the order of 1 microsecond, and for the frequencies being considered the error can be ignored. The acquisition time is much longer, of the order of 20 microseconds for the capacitor needed at the sample holding times used in this instance, and prohibits the use of only two sample circuits. The electronics with two circuits is also less straightforward, since each sampling circuit must hold for one clock cycle, sample for sufficient time to acquire the new signal level, and then switch back to hold. During the sample period no rate output is available and one also has to switch both sample circuit outputs between the differential amplifier inputs every other clock cycle.

A better solution is to use three sample and hold circuits, switched so that whilst two are producing the required output the third is acquiring the new signal level prior to switching to the hold mode. For three holding circuits A B and C the required sequence of differences for a continuous positive rate output is:

B — A
C — B
A — C
B — A
etc.

With samples produced at the correct time from a clock signal, the above may be produced from a dual-channel, analogue demultiplexer driven at the same clock frequency. This would feed the two samples required from the hold circuits to the differential amplifier, and thus produce the rate signal. From the sequence above it can further be seen that each held sample is required for two thirds of the time, so that the sample and hold needs to be driven by a clock signal which is assymmetric. Furthermore, the clock signals to the three sample circuits should be 120° out of phase with each other.

The outcome of these requirements is the circuit diagram in Fig. 2. This was built from medium and low specification components with a clock rate of 75Hz, and will produce a derivative signal from a 2V source from 0.01Hz to 10Hz. The phase angle at 0.01Hz is approximately 89.4°, and the largest capacitors are 1μF, these being low voltage types in the smoothing/lead circuit.

The clock is a conventional 555 timer in a stable mode which produces the 75Hz square wave. This is then fed to the 74107, which is an assymmetric divide by three, producing two of the driving clocks needed directly. The third clocking signal is produced by 'anding' the comple-

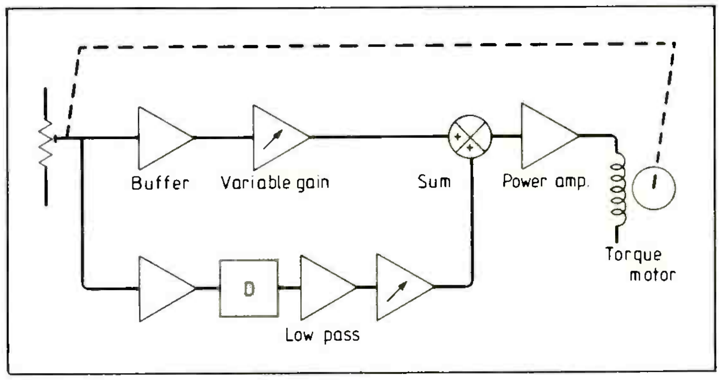
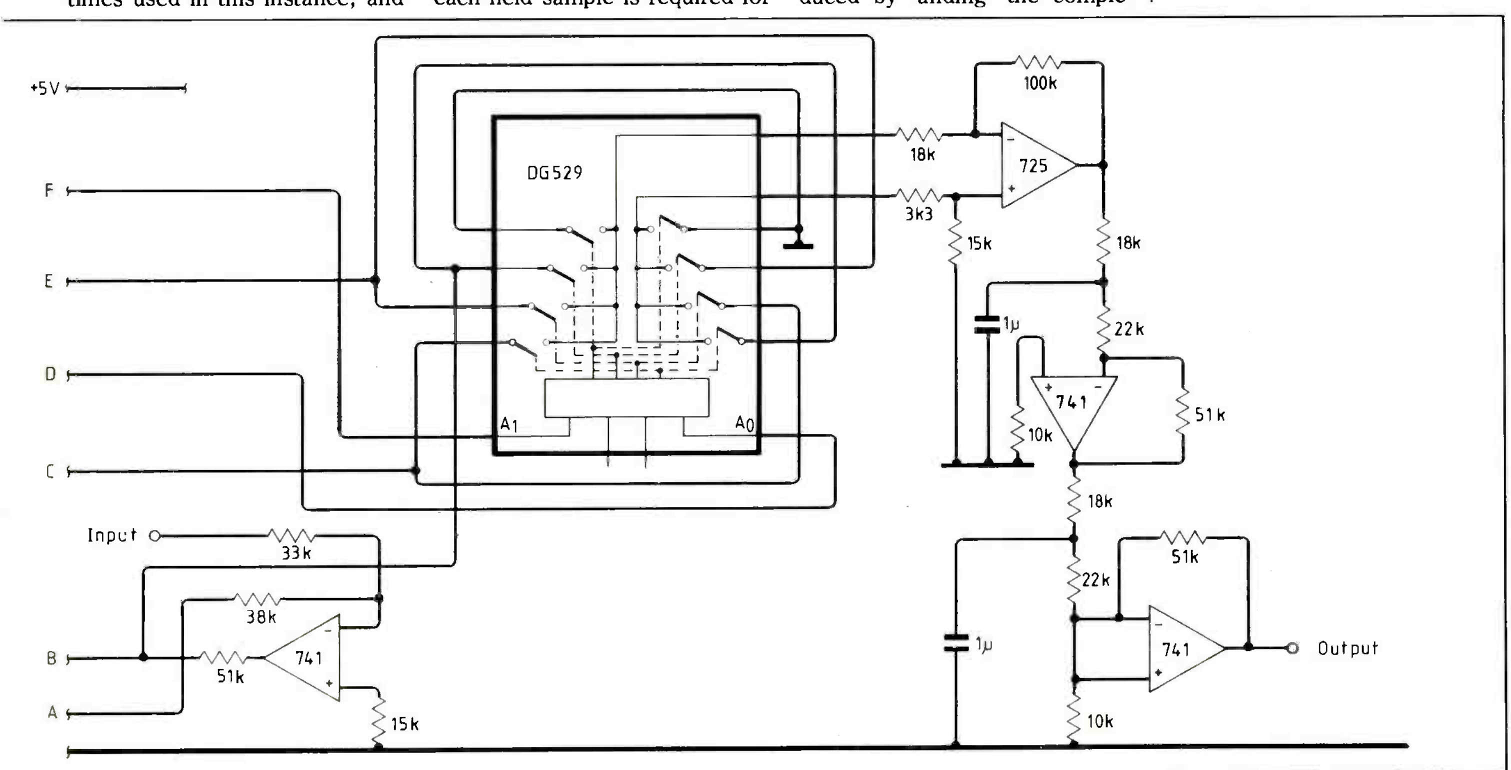


Fig.3. **System used to provide velocity feedback.**



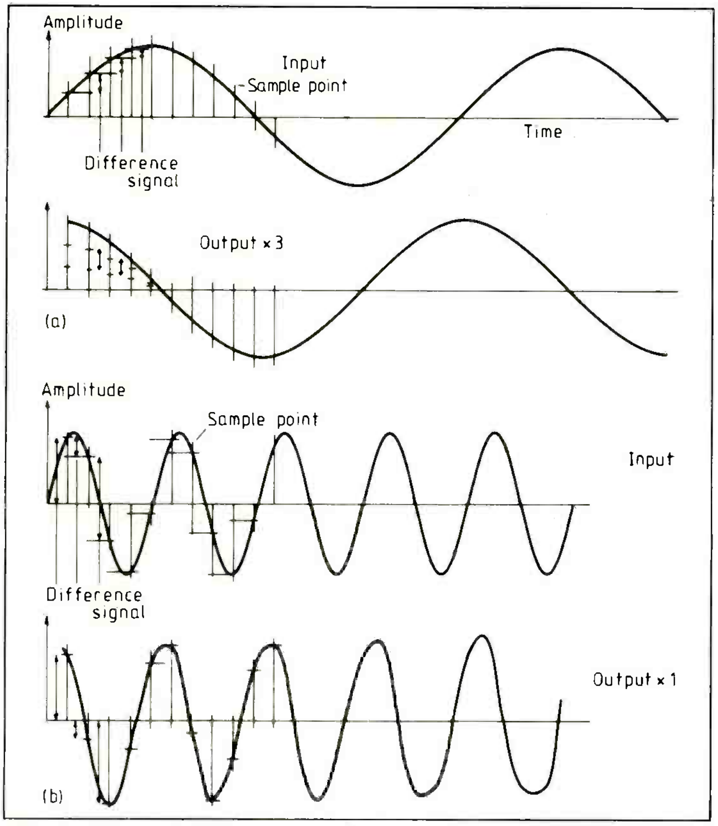


Fig.4. **Effect of differentiation network at higher input frequencies. At (a), input is one-twentieth of clock frequency, giving little distortion. Higher input frequency at (b) increases distortion.**

ments of the two flip-flop outputs in a 7400 Nand gate. The three other gates on the quad 7400 produce inversions of the clock signals, used to help produce the a.c. zeroing of the sample and hold circuits. The latter are LF398Ns, which have a comparatively low specification in terms of a.c. noise, d.c. offset, hold setting time, droop rate, and other important parameters of sample circuits. The signal to be sampled is buffered by an inverting 741, feeding a common signal line. The sampled outputs are fed to three pairs of gates of a DG529, which is a dual quad analogue multiplexer. This is a latching version, but this facility was not needed. The addressing of the 529 which goes 00, 10, 01, 00 etc. is taken directly from the clock signals driving the second and third sample and hold circuits, and the output feeds the two inputs of a 725N differential amplifier with a gain of 5.5. The output at this stage from a pure sinusoidal input will be a stepped sine wave leading in phase by approximately 90°. To reduce instability problems and provide a smoothed output to the autopilot summing function, the signal then passes through a high frequency lag network (with gain) which produces a 90° phase lag at 16Hz, thus cancelling the derivative feedback above this frequency. The only other item is the unity gain buffer amplifier and the autopilot summing function. The former prevents direct feedback around the differential circuit, and the high frequency oscillation that this would cause.

Circuit performance

The differential amplifier was tested in isolation and produced excellent results. At this stage the lag network of the final circuit was not used, and a four-pole Butterworth low-pass filter with a breakpoint of 16Hz was used to attenuate high frequencies and provide a smooth output.

Although not strictly necessary, the differential circuit was then used to provide velocity feedback in the closed-loop rudder circuit, as in Fig. 3. It was then found that at even moderate derivative gains the rudder circuit became unstable, and the rudder, which was driven by a low-inertia motor had a tendency to oscillate at about 16Hz. Various modifications were tried, including lowering the frequency first to 10Hz and then to 2Hz, and the use of Bessel rather than Butterworth filters, but none of these proved to be a solution to the problem. The reason for this is that although these active filters give a rapid attenuation of higher frequencies, they also produce large changes in phase in the region of the filter breakpoint, so that along with the differentiator an overall phase lead of 180° could easily be produced, adding to instability. At this point the active filters were discarded and the phase-lag network used in the final autopilot was introduced.

This network very largely eliminated the instability problem, since it had no inductive action, and produced only a phase lag. The derivative gain could be increased by a factor of about 8 before the onset of instability, compared to the active filter circuits. However, it was found impossible to prevent oscillation of the rudder servo at high derivative gains, despite adjustment of the phase lag network. The answer to this problem lies in the behaviour of the differentiating network as the frequency going through the circuit approaches the clock frequency of the circuit itself. The differentiating effect is shown in Fig. 4(a) and 4(b) for low and high frequencies. In 4(a) the input frequency is 1/20 of the clock frequency, and it can be seen that the resulting signal is a sine wave with very little distortion which leads by a phase angle of 90° minus half the switching time of the clock. The higher input frequency in 4(b) at about 1/5 of the clock frequency, shows considerable distortion and harmonic content, and the phase lead, although on average being 90° minus half the switching time, varies along the wave train.

From this it is apparent that the differentiality circuit will always produce some harmonic distortion. The constantly changing phase at higher frequencies made it impossible to prevent the oscillation with the simple RC lag described above, and the harmonics produced would maintain oscillation in the absence of sufficient attenuation.

Having examined these waveforms it was then found that the problem could be solved by increasing the clock frequency, thus decreasing the phase distortion and harmonic content of the rudder servo signals to an extent sufficient to prevent oscillation. The limit to which the clock frequency can be increased depends on the noise in the system. With increasing clock frequency, the differential amplifier is amplifying smaller differences in the incoming signals, and will reach a point where the noise in the circuit becomes comparable with the difference in voltage between two consecutive samples. The most important sources of noise in the circuit are d.c. voltage offset in the sample and hold circuits, a.c. feedthrough of the switching signal in the sample and hold circuits and in the multiplexing switch, and noise in the multiplexing switch differential amplifier. The upper limit on input frequency for a given clock frequency will be governed by the degree of frequency and phase distortion that can be accepted. The circuit is actually measuring input voltage slew rate so it must be remembered that for a real circuit there will be a maximum permissable sinusoidal input voltage, at a given frequency beyond which the circuit limits and 'chops' the output.

In practical terms, the results gained from a prototype were very good. This was built using low-cost components with relatively poor electrical characteristics compared with what can be obtained. The prototype was built without a specific printed circuit board and made as compact as possible, and in fact is contained on a single board 10cm by 10cm. It will, however, deliver a usable rate output for input frequencies from 0.01 Hz to 10Hz, i.e. over a frequency range of 1000: 1; which is far better than would be achieved with an RC phase lead network. For nonsinusoidal input signals there are further advantages because the circuit does not contain any fixed time constants that are comparable to the frequency that is being differentiated. This is particularly so for a square wave input for which the convention RC circuit gives very poor performance.

If the square wave shown in Fig. 5(a) is put through an RC lead network the output will have the form shown in 5(b), in which the initial spike decays exponentially. The rate of decay depends on the time constant of the circuit and can be increased by making the product of R and C in the lead network smaller. Unfortunately the impedance of the capacitance increases as capacitance decreases, so that this also leads to greater attenuation of the output and a higher proportion of noise in the amplified output. Decreasing the value of R has the same effect. Figure 5(c) shows the output that is obtained taken before the high frequency attenuator in this case, consist of short alternating pulses of 13 milliseconds duration with no tail off. Because there is no synchronization it will sometimes occur that the circuit samples the input during a transition, in which case the pulse will be slightly longer.

A further benefit of this principle of operation is that there is no lower frequency limit, although a change in technique would be called for for frequencies in and below the cycles per hour range. This is because the sample and hold circuits suffer from voltage droop. The sampled voltage in the sample and hold circuit is held as charge in the holding capacity, and the voltage on it monitored by a buffer amplifier to produce the 'hold' output. The buffer amplifier has a high, but still finite, input impedance, so that the charge in the holdiing capacity will gradually drain away, resulting in a decay or 'droop' of the buffer output. The decay rate obviously depends upon the buffer input impedance and the capacitance size, so that the latter, which is external to the i.c., is chosen according to the sample frequency and hold time expected. The present prototype uses 0.01μF polycarbonate capacities rated at 250 volt and has a hold time of 26 milliseconds, so there is scope with this analogue system for extending the frequency range downwards by increasing the size of the holding capacitances.

However, a point would be reached where this became impractical, and the solution then is to change over to a latching digital holding circuit. The incoming signal is still sampled with a sample and hold circuit, but the output of this is then fed to an a-to-d convertor. The hold time is thus reduced to the conversion time of the a-to-d which can be very short. Each output line of the converter then feeds a binary latch, thus holding the digital signal indefinitely. The latch is sampled by d-to-a convertors to reproduce the original analogue voltage, and the remainder of the circuit would be unchanged. System clocking frequencies may also be extended downwards by frequency division, and there is thus no lower limit to the frequency that may be differentiated.

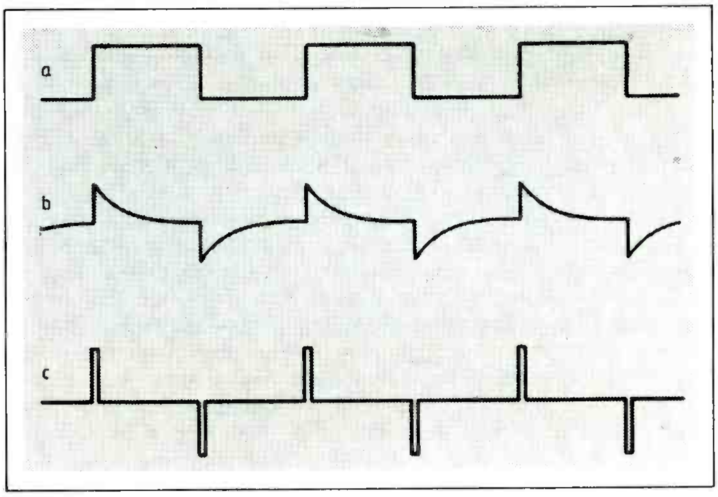


Fig.5. **Ouput of circuit (c) compared with simple CR network.**

In the this low-frequency range the system may be compared to differentiation using microprocessors. The results should be very similar in terms of quality of the output signal, and in fact the digital form of this circuit described above is actually a microprocessor with a single programme 'hardwired' into it. A conventional microprocessor, Z80 for example, would be more easily adapted to changing requirements, but would be considerably more expensive. For the frequency range in which the prototype operates, similar considerations apply, with the added provison that the analogue solution will inevitably give a more accurate signal with less noise, then a microprocessor equivalent. The added complexity of the microprocessor and the act that the input and output circuits operate with discrete voltage levels can only degrade the quality of the final output signal.

Continued from page 57

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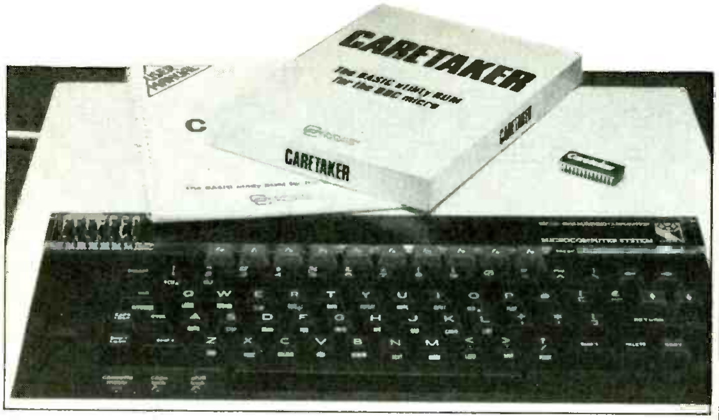


CARETAKER FOR THE BBC

The Caretaker rom for the BBC Micro is a collection of utilities for Basic programmers. Among these are a search-and-replace facility for editing programs, commands for merging programs and for loading or saving individual sections, a 'bad program' recovery routine and a very comprehensive compactor for saving memory space.

One novel feature offered by the package is single-key is not a strictly accurate description of the process since you have to press the tab key at the same time. A set of stickers is supplied to indicate which key does what. This facility (which can be switched off) may not save much typing time, but should certainly prove an attraction to refugees from the ZX Spectrum.

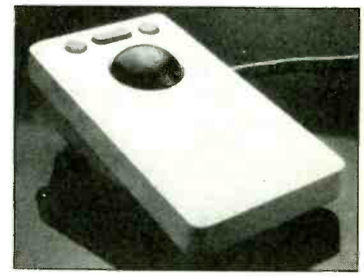
Several routines in Caretaker parallel those of Beebugsoft's excellent Toolkit rom: some of them are less easy to use, though they allow rather more flexibility. A useful 'help' page is available to remind the user of the commands and their syntax.

Caretaker comes in an 8K eprom and costs £133·35 Computer Concepts, Gaddesden Place, Hemel Hempstead, Hertfordshire HP2 6EX, tel. 0442-63933. EWW 205

MICRO TRACKER BALL

Developed from their tracker balls used in military and air-traffic control applications, Marconi have produced a tracker ball control for use with microcomputers. There are advantages of such a device compared with joysticks or 'mice'; they offer more accurate positioning of the cursor than joysticks and do not require the table-top space needed for mice.

The two-inch diameter ball is in non-slip contact with two shafts accurately positioned at 90° to each other. Each shaft is fitted with a slotted disc; light source and photodetectors measure the rotation of the disc and electronic circuitry translates these into X and Y coordinates. The resin ball rotates freely in any direction and its ease of use makes it suitable for long sessions. With the appropriate software the RB2, as it is called, is capable of moving a cursor one pixel at a time on a computer graphics screen while also being able to



move and change direction very rapidly.

The first issue of the tracker ball has been aimed at users of the BBC micro and is supplied with utilities software. This allows it to replace the cursor keys or be used instead of a joystick. The software allows the user to define the function of the three keys built into the tracker ball housing. Further software in preparation include c.a.d. and graphics programs. Computers with an RS232 input can also use the RB2 by the addition of an interface card fitted inside the control's housing at extra cost. Prices vary according to the distributor but are about £50. MEDL Power Division, Carholme Road, Lincoln LN1 1SG.
EWW 206

FALSE COLOUR SATELLITE WEATHER MAPS

A complete system for receiving Meteosat pictures, which includes everything from the antenna to a colour monitor, is produced by Microwave Modules. The processed image as displayed by the MMS 1690 system is received in segments; 24 in the case of visible pictures and 9 for infra-red. Each image is provided with a caption which gives date, time (GMT), type of image and segment code. Meteosat transmissions include outlines of the countries, which may be concealed by clouds, and coordinate points at 10-degree spacings. Although Meteosat is stationed above the equator and can monitor about one third of the Earth's surface, as a European satellite it gives performance to the images covering Europe which are updated at least twice an hour.

The receiver is equally suitable for other geosynchronous weather satellites spaced around the World. With the addition of a suitable antenna, the NOAA and Meteor satellite signals at 137MHz may be received. However the images may only be captured during their brief fly-past periods unlike Meteosat, which provides continuous data.

The system consists of an easy-to-assemble antenna kit, suitable for mounting on a vertical mast; a 1691MHz GaAs fet preamplifier which is weather-tight and may be mounted close to the antenna ensuring the optimum signal strength and picture quality; an s.h.f. down-converter to 137.5MHz; the main six-channel receiver which incorporates the power supply; and a digital scan converter which translates the signals into pictures and can also convert the monochrome images into colour by assigning colour values to different bands of the 64 grey levels obtained. Sequences of weather images can be retained inexpensively by recording the signal onto a good quality cassette recorder. A library of images can be built and replayed through the scan converter to simulate a time-lapsed sequence. The system is completed by a colour monitor. Component parts may be purchased separately. The complete system costs £1738, excluding tax, claimed to be 50% cheaper than any similar system. Microwave Modules Ltd, Brookfield Drive, Aintree, Liverpool L9 7AN.
EWW 207

★ ★ NI-CAD BARGAINS ★ ★

Re-chargeable Nickel-cadmium batteries in stock. Ex-equipment but very little used condition. DEAC 1000DK Button Stacks 6 cells — 7.2V. Size 2¼ × 2" diam. Capacity 1AH. £4 inc. VAT (p&p 25p). DEAC 600 DKZ Button stacks 3 cells — 3.6V. Size 1¼ × 1¼" diam. Capacity 0.6AH £1.50 inc. (p&p 20p).

Also available — PCB's from which these batteries have been removed containing Transformer, Diode rectifiers, smoothing capacitors, DPDT Relay, fuses etc., easily adapted to charge either of the above stacks. DNLY £1.50 each inc. VAT (p&p 75p).

★★ STEPPER MOTORS ★★

Brand new stock of 'ASTROSYN' Type 20PM-A055 stepper motors. 28V DC. 24 steps per rev. 15 oz-in torque @ 100PPS. Body length 2½", diameter 2", shaft ¼" diam × 4¼" spirally threaded. Weight 16oz. Price each £11.50 (p&p 50p). Connections supplied. INC. VAT.

★ ★ STEPPER MOTORS ★ ★

In stock — used, but excellent condition, 4-phase steppers. 50 steps/rev motor with (removable) gearbox giving a 300:1 reduction. 6V DC operated. Complete with a driver board requiring just a single 6V rail and pulse input. Motor measures 1" × 2" diameter, gearbox ¾" × 2¾" output shaft 3/16". Sold complete with connections, CCT diagram of motor, CCT details of half-stepping etc. All for just **£8 inc. VAT** (p&p 50p).

OPTICAL ISOLATORS

SPERRY UNIVAC M4000 opto-isolator units providing 2KV of insulation between Modems and Terminals. 25 way 'D' connectors (RS232C Interface) in and out. Measures 9×5×7". Complete with handbook .... **£16.50** inc vat & pp.

BECKMAN TURNS COUNTER DIALS

Miniature type (22mm diam.). Counting up to 15 turn "Helipots". Brand new with mounting instructions. Only **£2.50** each Inc VAT & pp.

'TELEVISION SERVICE KIT'

We have managed to obtain a stock of Labgear T.V. Service equipment affording vast savings on new price. All items are sold in full working condition and guaranteed.

LABGEAR COLOURMATCH CM6004PG. UHF TV Pattern generators. Grey scale, variable level cross-hatch & dot patterns. £35. inc

LABGEAR COLOURMATCH CM6010RG Gated Rainbow colour pattern generators. Cross-Hatch/dot & gated rainbow (RGB) colour bar patterns.. £65 inc.

UNAOHM EO684 PAL Colour-bar & pattern gen. £275+
KORTING 82512 PAL/NTSC Colour & pattern gen £275+

Mail Order customers please add £2.50 postage ea. item

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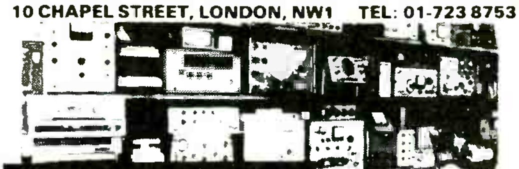
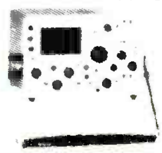


'OSCILLOSCOPES'

HEWLETT—PACKARD 141A Storage Oscilloscope.
HEWLETT—PACKARD 1707A dual trace 75MHz £750
TEKTRONIX 454A dual trace 150MHz sweep delay £950
TEKTRONIX 453 dual trace 50 MHz sweep delay £600
TELEQUIPMENT S61 — see display below
TELEQUIPMENT D67 dual trace 25MHz sweep delay £350
TELEQUIPMENT D75 dual trace 50 MHz sweep delay £450
TELEQUIPMENT D63 c/w dual-trace & differential units £375

All these units are sold in full operational condition and calibrated to spec. All prices are subject to additional VAT & carriage (Securicor) + £10

★★ TEST EQUIPMENT ★★



SONY/TEKTRONIX 335 SCOPE ½ list price.
REGUVOLT 2KVA CVT's Sine wave 230V, AC **£100**.
MARCONI TF868 LCR Bridge
MARCONI TF2604 Electronic Multi-Meter
MARCONI TF893A Audio Power Meters **£85**.
MARCONI TF2502 RF Power Meters. DC-1GHz. 10w fsd **£350**.
MARCONI TF2701 In-Situ Universal Component Bridge **£250**.
ROHDE & SCHWARZ 'SDR' AM Signal Generator 0.3-1GHz.
TEKTRONIX 2901 Time-mark Generator
ROHDE & SCHWARZ Resonance Frequency Meter 470MHz-2.5GHz.
ROHDE & SCHWARZ Polyscop SWOB II.
BRUEL & KJAER Heterodyne Voltmeter 0.5-240MHz.
AIRMEC Display Oscilloscope 279. 4-trace, 14x10" CRT **£195**.
RIKADENKI 3-channel Chart Recorder, Model B-341.

TELEQUIPMENT 561 SCOPES

A bulk purchase of these quality oscilloscopes enables us to offer them for sale for just £100 + vat. Specification as follows: Bandwidth DC-5MHz Sensitivity 5mV/div. Sweep speeds from 500ms/div to 1us. 8×10cm CRT External X & Z-mod inputs. £115 inc vat & inc handbook Zerox (Carriage £10)

POWER CUTS ???

—we all hope not, but be prepared in case. We have a stock of Transistorised Flourescent light inverters for emergency use. These are top quality units in polyprop transluscent cases with black base. 12V Battery input 8W tube (supplied) output. Circuitry has solid state change over to charge Ni-cad cells when mains supply is on (batts not supplied). size 12×4×5in Buy now before its too late! £22 — ea inc VAT & pp
Also available 12VDC-Mains 50Hz inverters from 100W.

★ SWEEPERS ★

TELONIC 2003 System 800-1500MHz **£325**
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KNIGHT KG-687 3-220MHz. **£150**

★ TEKTRONIX ★

FILE MANAGER SYSTEM MODEL 4907 Option 31 (Third disc drive). 4051 Graphic System compatible. GPIB (IEEE 488-1975) compatible.

PLEASE NOTE. All the pre-owned equipment shown has been carefully tested in our workshop and reconditioned where necessary. It is sold in first-class operational condition and most items carry a three months' guarantee. For our mail order customers we have a money-back scheme. Repairs and servicing to all equipment at very reasonable rates. PLEASE ADD 15% VAT TO ALL PRICES. EQUIPMENT WANTED. PLEASE WRITE OR PHONE.

★ COMPUTER PERIPHERALS ★

1.6MB 8" FLOPPY DISC DRIVES — New Stock

After our recent sell-out of the DRE7100 FDDs. we are pleased to offer another bargain package as follows: BRAND NEW American 'MFE Corp' model M-700 **DOUBLE-SIDED** 8" Disc Drives. Massive storage capability up to 1.6MBytes. Full IBM compatability. External power requirements are ±5V at 1.2A and +24V at 1.1A. Full spares/back-up available U.K. (Elcomatic's). Current list is over £315.

" NOW LOWEST PRICE EVER £160 — INCLUDING MANUAL INC CARRIAGE & INC VAT "

8in SHUGART type SA800

Floppy disk drives. We are pleased to say that we have these in stock now after our sell-out a few months ago. Used but excellent condition single-sided drives to 800KB. Few only at the same price £90 inc VAT & carriage & Zerox of user handbook. Also to those too late for our last stock of 19Mbyte Winchester — we now have some coming in ca. £125, please call.

★ SWITCHING POWER SUPPLIES ★

The following DC power supplies are available now from stock in limited quantities. All fully tested and guaranteed.

5V @ 10 Amps	£18	12V16A(110V.In)	£20
5V @ 20 Amps	£20	5V @ 40 Amps	£30
5V @ 60 Amps	£40	19V @ 30 Amps	£40
+15V, −12V & +5V @ 11A, 4A and 40A			£50

ALL PRICES NOW INCLUDE VAT. CARRIAGE + £2 EACH.

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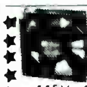
'TORIN' Type U62B1. 230V Cap'Start (supplied), very powerful (200W. 3,000rpm) centrifugal fans for large rack cooling or enclosure extraction applications. Overall dimensions 20x12 cms, outlet 6x4 cms. BRAND NEW. Surplus stock. **£15 each** inc. VAT, pp **£1.50**. ALSO SEE LEFT HAND COLUMN



ROTRON INSTRUMENT COOLING FANS

Supplied in fully tested excellent condition, as follows:
115V, 4½×4½×1½" **£5.** 230V same size **£5.50.** 115V 3×3×1½" **£4.** 230V 3" size, brand new **£6.** Also small quantity 115V 4½" size, brand new **£6.** Postage each + 50p please. WW10

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B & T with 128K Bytes of RAM	£599.00
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Full range of PC compatible boards available.

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smARTWORK lets you create and revise PCB artwork on your IBM. Requires 192K RAM, colour/graphics adapter, Epson printer and Microsoft Mouse (optional). ONLY £995.00

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Analogue and power control I/0 in a single board computer. 6801 Micro Control System designed for distributed control or standalone use: 6801 or 68701 MPU with 2K ROM, 128 RAM, timer, 8 12-bit analogue I/Ps, 8-bit analogue O/P, 8 AC or DC inputs or outputs. Typical Systems from £250.00

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CIRCLE 75 FOR FURTHER DETAILS.

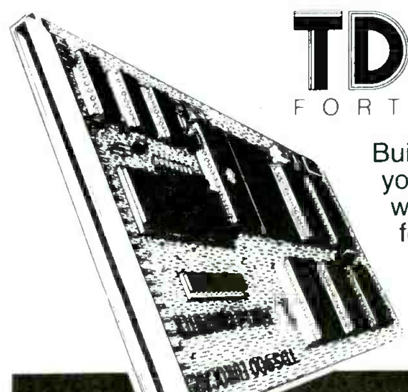
EDR editor for DEC

- **Keypad editor similar to KED an EDT**
- **Uses no host time or memory when editing**
- **Fast Response**
- **Edits PDP-11, LSI-11, and VAX files**

Why burden your overworked DEC computer with the task of editing files? use the new EDR front end processor to do your editing — for a mere £350. EDR intercepts the serial line between your terminal and DEC computer, and provides a powerful keypad editor with fast response. DEC users familiar with KED or EDT will be instantly at home with with EDR. For more details of this unique device contact:

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

CIRCLE 61 FOR FURTHER DETAILS.



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FORTH COMPUTER

Build the TDS 900 into your products, program it with a VDU and your forecasts become fact.

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REQUIREMENT: AMPLIFICATION SOLUTION: CRIMSON!

More than ever, Engineers, Enthusiasts, & Professionals require a reliable source of quality amplification, crimson continue to meet this demand with a comprehensive range to suit virtually every application and support this with friendly advice and back-up. Our prices have remained stable for 18 months and with two regional distributors and our own mail order system, there has never been a better time to choose the best.

MODULES

Power amplifiers bipolar type. Incorporating full electronic protection, integral heatsink bracket, high slew/low distortion circuitry (<0.01% THD TYPICAL)

TYPE	MAX O/P	SUPPLY (DC)	PRICE
CE608	60W/8R	+/—35V	£21.50
CE1004	100W/4R	+/—35V	£25.00
CE1008	120W/8R	+/—45V	£28.00
CE1704	200W/4R	+/—45V	£35.50
CE1708	180W/8R	+/—60V	£35.50
CE3004	320W/4R	+/—60V	£49.50

NEW LOW POWER

CE308	30W/8R	+/—25V	£15.90

Power amplifiers Mosfet type. Ideal for heavy duty use — i.e. disco's or driving line transformers, itegral heatsink bracket, (<0.02% THD TYPICAL)

FE908	90W/8R	+/—45V	£30.00
FE1704	170W/4R	+/—45V	£39.00

Pre-amplifiers stereo modules with R.I.A.A. eq. M.M. & line input, needs vol and bal pots and input switching. Can be used with MC2 module to allow use of low O/P MC cartridges.

CPR1X	STEREO	+/—12V/20mA	£33.90
MC2	STEREO	+/—12V	£23.00

NEW SUPER CPR

CPR2	STEREO	+/—12V/20	£47.95

Full details of our complete range including heatsins, toroidal power supplies, active crossovers etc. available on S.A.E.

HIFI KITS

Still the reference kit amplifier! for less than £250 you can own an esoteric pre-power combination with the added pleasure of building it yourself. Write for our full brochure and review reprints.

CK10 10	Stereo pre-amplifier	£92.00
CK1040	Stereo P/A 40+40 WPC	£121.00
CK10 0	Stereo P/A 80+80 WPC	£134.00
CK1100	Stereo P/A 100+100 WPC	£151.00
MC2K	M/C kit for CK1010	£25.00
P.S.K.	Pre-amp power supply	£20.00

PRO POWER

A new range of 19" rack mounting power amplifiers are undergoing field trials for launch later this year. Please contact us if you have a particular requirement for this type of amplifier as the final design will depend on your needs!

TO ORDER

Send cash with order or quote Acces/Mastercharge card no. All prices include VAT, P&P.

DISTRIBUTORS

London: Bradley Marshall Ltd., 325 Edgware Road.
North: Wilmslow Audio, 35/39 Church Street Wilmslow.

EXPORT

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BERG LOW PROFILE 14 PIN DUAL IN LINE I.C. SOCKET manufactured from glass filled polyester to UL94V-0. £7 for 100, £31 for 500, £56 for 1000, £256 for 5000, £460 for 10,000, £2100 for 50,000, £2,700 for 100,000. Sample 10 sent for £1.20 + 30p p&p (£1.73 inc VAT)
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WIRE CUTTER AND STRIPPER Tempered steel blades spring loaded with moulded red P.V.C. handles. Cutting and stripping adjustable up to 6.0mm². Overall length 135mm, weight 64 grms, 10 for £15, 25 for £34, 50 for £63 100 for £116, 500 for £525, 1000 for £1000. Sample pair sent for £1.75 + 25p p&p (£2.5 inc VAT)

METAL FILM RESISTORS FZ4 manufactured by C.G.S. semi-precision with a standard tolerance of +−2% and a temperature co-efficient of better than 100 ppm/oc. We have a full range in stock from 100R to 1MO. All bandoliered. £2.50 per 1000 any one value.
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3 watt series £3.50 per 100 any one value + £1 p&p (£5.17 inc VAT)
6 watt series £6.50 per 100 any one value + £ p&p (£8.63 inc VAT)
10 watt series £10.50 per any one value + £1 p&p (£13.23 inc VAT)
ALUMINIUM FOIL CAPACITORS manufactured by Iskra 2.25 MFD 385V A.C. WKG axial tupe. Body length 40mm × 23mm £25 per 100 pcs, £115 per 500 pcs. £212 per 100 pcs, £980 per 5000 pcs, £1800 per 10,000 pcs, £4,165 per 25,000 pcs. Sample 10 sent for £3.00 + £1 p&p (£4.60 inc VAT)
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PAIR OF MATCHED SPEAKERS 4 ohm 3 watts in teak finish cabinets with black/chrome facia 7 1/2" × 12" × 5" depth — 1 sample pack (2 spks) £10.00 + £2 p&p (£13.80 inc VAT) 10 packs £9.00 each + £2 p&p (£12.65 inc VAT)
12" VIDEO DISPLAY UNIT (green) complete with frame and P.C.B. incorporating time bases/EHT, etc but minus case and simple power supply unit. Originally designed to be basically compatible with BBC Micro and Commodore computers. Circuit diagram supplied. Price per sample unit £60.00 + £3 p&p (£72.45 inc VAT) Quantity prices on application.
OPEN FRAME AND SHADED POLE MOTORS by well known manufacturers, 240 volt a/c — many uses — Price per sample £1.50 + 75p p&p (£2.59 inc VAT). Price per 10 motors £1.25 + 75p p&p (£2.30 inc VAT) each.
ULTRASONIC BURGLAR ALAM — portable — wooden finish with internal alarm — easily installed — mains/battery option — provision for window contacts and pressure mat — extended horn and bell unit.
Sample units £39.00 + £2 p&p = £47.15 inc VAT each, 5 units £35.00 + £2 p&p = £42.55 inc VAT each, 10 units £33.00 + £2 p&p = £40.25 inc VAT each.
EXTERNAL HORN Sample £7.50 + £1 p&p = £10.35 inc VAT each, 5 units £6.75 + £1.50 p&p = £9.49 inc VAT each, 10 units £6.37 + £1.50 p&p = £9.05 inc VAT each.

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

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SINGLE SIDED DOUBLE DENSITY £100
DOUBLE SIDED DOUBLE DENSITY £130
BRAND NEW

DON'T DELAY— ORDER TODAY!

H.P. SPECTRUM ANALYSER 8551A 10MHZ - 12.4GHZ P.O.A. with 851B Display
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OSCILLOSCOPES

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109 Wayne Kerr Autobalance Component Bridge 8421 .... £250
114 Wayne Kerr Component Bridge B521 (CT375) L 100uH-500kH; C1pF-5F; R1 milliohm-1000Mohm £35
117 Wayne Kerr VHF Admittance Bridge B801 with Source S161 & Detector R161 .... £400
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161 FARNELL STAB PSU TSV30/2 0-30V 2A Current limiting metered £50
163 ROBAND VARECD PSU type 33-2 0-33V 2A Current limiting metered (in current production) £100
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190 VOLTEX PSU Model 82-635 +/− 5V; +12V; +24V High current un-used £15
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206 B&K LEVEL RECORDER 2305 .... £400
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211 B&K DIGITAL EVENT RECORDER 7502 .... £1,500
225 DAWE OCTAVE BAND SOUND LEVEL METER type 6419c £150
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Also in stock **NEW OSCILLOSCOPES, MULTIMETERS** etc.

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Callers welcome 9 a.m. to 5.30 p.m. Monday to Saturday inclusive

CIRCLE 52 FOR FURTHER DETAILS.

PERSONAL LOGIC ANALYSER

Facilities for the troubleshooting of microprocessor systems are incorporated into the PM3626 logic analyser from Philips. It is used to locate faults in a microprocessor system, both hardware and software. The 32-channel instrument can be used for logic state analysis, or up to 12 channels can be used for timing analysis while the rest are used for state. Maximum sampling speed for accurate timing can be set at up to 100MHz.

For software bug-hunting, the analyser may be fitted with a disassembler for any of the twelve most popular microprocessors. Interactive software de-bugging is also possible by the use of a rom emulation module, plugged into the rom socket of the system under test. Programs may be patched to the target system by use of front panel controls. Specific areas of a program may be explored by the four-level triggering system and the timing delays which can count up to 50 thousand clock cycles to pinpoint a specific action. The instrument is operated through menu selection on the screen and multi-function keys. For example it is even possible to recall the colour coding of the probe leads and thus save a lot of time referring to the instrument's manual. State displays may be chosen to give the information in binary, decimal, octal, hexadecimal or ASCII.

The analyser may be extended by adding a non-volatile setting module which retains up to eight preset configurations for the instrument. Another non-volatile memory option can hold

reference data and compare with incoming data on the instrument. Each of the 32 channels may be examined to a depth of 1000 samples or four channel to a depth of 8000. A further option is an RS232C interface card.
The instrument costs £3285 which, according to Philips, is well below the cost of rival instruments. It is also available for hire from Livingstone Hire and from Instrumental Rentals. Pye Unicam Ltd, York Street, Cambridge CB1 2PX.

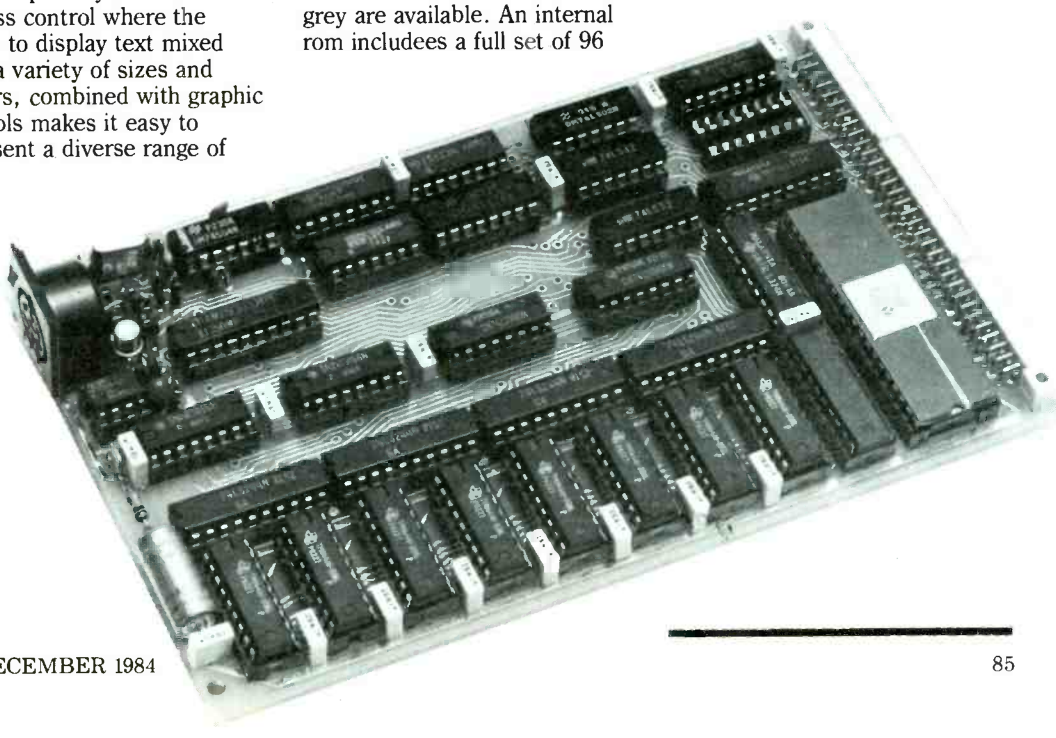
EWW 208

MONOLITHIC PREAMPLIFIER

An ultra-low-noise monolithic preamplifier circuit is particularly suited to microphone signal processing, says CMS who are marketing the SSM 2015 from Solid State Micro Technology. The very low voltage noise performance is enhanced by a programmable input stage which allows overall noise to be optimized for source impedances up to 4kΩ. The circuit has a bandwidth of 700kHz at a gain of 100 with symmetical slew rates of 6V/us and distortion of 0.007%. True differential inputs and a high common-mode rejection of 100dB provide easy interfacing to balanced micropphone outputs, tape heads and single-ended devices. The SSM2015 is specified for commercial temperature ranges only and has a one-off price of £9.48. CMS (Distribution) Ltd, 26 Pamber Heath Road, Pamber Heath, Basingstoke, Hants RG26 6TG.
EWW 209

COLOUR GRAPHICS

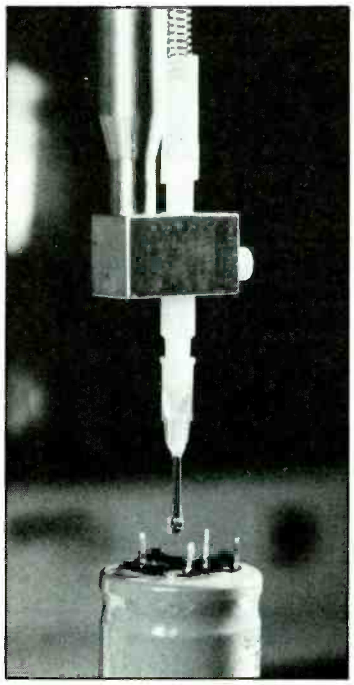
A high resolution graphics controller combines many of the features usually found on much larger systems into a single Eurocard. It has been specifically designed for industrial environments where the engineer needs reliability, speed, and easy software implementation. The board is based around the Thompson EF9366 grraphics processor i.c. and is especially suitable for process control where the ability to display text mixed from a variety of sizes and colours, combined with graphic symbols makes it easy to represent a diverse range of industrial processes. The board is compatible with the Acorn bus and includes full address decoding so that it occupies only 32 bytes of the host computer's memory. It includes 64K of onboard graphic memory. Eight colours with inverse and flashing are available on a screen image 512 by 256 elements with a resolution of 5 to 8 dots. In black and white, 16 levels of grey are available. An internal rom includees a full set of 96 ASCII characters and the high-density text mode enables the use of 32 rows of 85 characters. Character size and style, including italics are all fully user programmable and characters may be scaled independantly in X and Y directions by up to 16 times. Price? £299. Cambridge Microprocessor Systems Ltd, 44a Hobson Street, Cambridge, CB1 1NL..
EWW 210



POTTING BY ULTRA-VIOLET

Rapid curing is claimed for the structrual adhesives developed by Loctite for the encapsulation of electronic components. The one-part adhesives are cured by exposure to medium or high intensity u.v. light in a matter of seconds. Loctite estimate that in such operations as potting relay switches there is a saying of 26% when compared with epoxy compounds. In addition the u.v. adhesives use no solvents and have an indefinite pot life, making them highly suitable for automation.

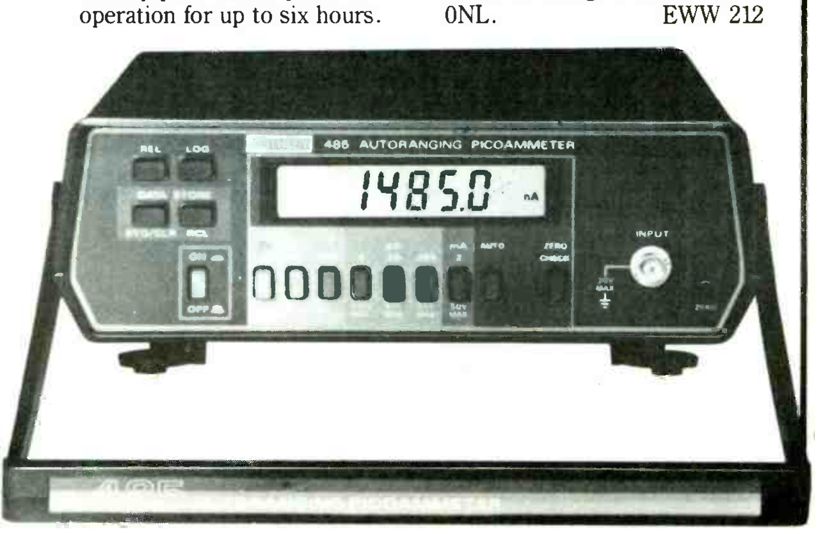
A secondary system for curing ensures that even the parts that the u.v. light does not reach are cured by the anaerobic action of the adhesive. Different formulations of the adhesive are suitable for different applications: for example UV365 is recommended for smaller component potting, sealing and encapsulation. It has a medium viscosity and when cured can withstand temperatures from −55 to 175°C, and is resistant to most kinds of chemical enviroments, retaining full strength under the most stringent of tests. Other adhesives in the series vary chiefly in their viscosities, making them more suitable for different applications. The low-viscosity UV371 has good penetration properties and is therefore good for coating and shallow potting. Loctite UK, Watchmead, Welwyn Garden City, Herts AL7 1JB.
EWW 211



PICOAMMETER

Model 485 picoammeter has been upgraded over pevious models by the addition of a decade of sensitivity and resolution. A GPIB version is available to interface with instrument controllers. All front panel controls can be programmed through the interface bus. An optional battery pack allows partable operation for up to six hours.

Additional feature include fast autoranging, relative, differential, measurement, 100 data point storage with minimum/maximum readings held, and the ability to log the current display. Digital calibration can be performed over the bus. Keighley Instruments Ltd, 1 Boulton Road, Reading, Berks RG2 0NL.
EWW 212



MULTI—TASKING MICRO

The addition of one rom to a BBC microcomputer can change it into quite a different computer; one that runs Forth and is capable of executing several different Forth applications at the same time. Multi-Forth 83 is a 16K eprom which may be plugged into a spare 'sideways' rom socket within the computer. Depending on its position, it can be given a higher priority than the Basic rom and thus be controlled from Forth with Basic as an addition. The latest version of Forth, Forth 83, is used. This is an improved version of Forth 79 with many additions to the resident dictionary of command words*. In addition, Multi-Forth has been tailored to suit the BBC and has therefore translated many of the Basic commands, for example the graphics and sound commands, into Forth. Many of the operating system commands have been incorporated and all the 'star' commands may be used from within Forth.

Especially suited for control and monitoring applications, multi-tasking enables the user to run a number of programs simultaneously, transparent to each other. Each task is placed in a queue and the total length of the queue can be up to 28 programs. A task has its own 32-bit clock and can be scheduled to execute at a pre-determined time, controlled directly by the user, or controlled from within other tasks, forming an interactive interdependant suite of programs for such applications as robotics. At the simple level, printer output can be defined as a task which, when run leaves the computer free for normal use. Disc and tape can be run at the same time on different files; very useful in data logging. Up to four files may be open to access at a time and block files greater than 32K can be maintained on disc.

The system is vectored and features may be redefined or the whole system may be re-configured by redirecting the vectors. In addition, there is a standard 6502 assembler for machine-code definitions and a standard Forth screen editor which is enhanced to allow the use of the cursor keys for full-screen editing.

As it stands, the Multi-Forth rom, along with full fitting instructions and an impressive 170-page manual costs £40. Despite using the 16K rom as economically as possible, David Husband, who developed the system, had to leave some of the refinements out.
A £40 disc added to the rom program provides a de-luxe version which contains many more source-code definitions and a large number of colour and graphics commands. The de-luxe version improves on the already impressive tasking facilities, although the full system is not yet finalized — David Husband keeps adding to it. The disc includes a demonstration program which divides the screen in five windows; two are scrolling text independantly, one displays a real-time clock, another an oscilloscope-type display and these all leave the larger window free to enter and run programs exactly as if there were not four other programs running at the same time.

Versions of Forth on rom with multi-tasking facilities are also available for the Electron, The ZX Spectrum, The ZX81 and other computers. Skywave Software, 73 Curzon Street, Boscombe, Bournemouth, BH1 4PW.
EWW 213

* a full description of the differences between Forth-79 and Forth-83 is in the August edition of *Byte*.

MOTOR SPEED CONTROLLER

Designed for the control of electric drills, the ZN411E from Ferranti is equally suitable for the control of a number of a.c. motors including other power tools, and domestic equipment. The controller offers 'soft start' capability, precise control and can work in reverse complete with a built-in shunt regulator, the i.c. comes in an 18-lead dual in-line package and will operate from the a.c. mains supply, though it can be operated on d.c. power as well. Stocked by Celdis Ltd, 37 Loverock Road, Reading, Berks RG3 1ED.
EWW 214

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NEW Helper PML-1 SINADDER with psophometric weighting filter — the ideal instrument for cellular radio SINAD measurement and alignment. Includes all the features of the SINADDER Linear 5 automatic SINAD meter:

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2732 450ns Intel type	4.75	4.25	4.10
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CIRCLE 29 FOR FURTHER DETAILS.

BBC BASIC EXTENSION

Other utility and language roms for the BBC Micro provide their special facilities through 'star' commands. But Vine Micros' Addcomm rom is different. The new commands it offers are in the form of additional Basic keywords.

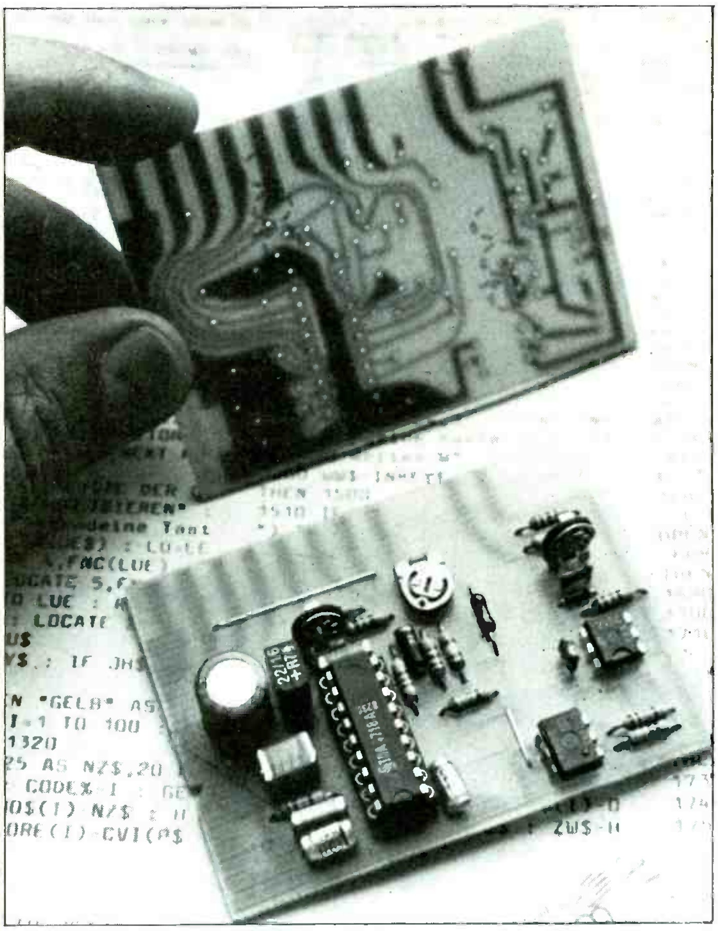
Unlike standard Basic words these are not converted into single-byte tokens by the computer, so some care must be taken in using them. But they give many new facilities, notably in the graphics department: there are commands for drawing circles and ellipses, for filling areas with colour and for scaling the screen co-ordinates. In addition there is a selection of Logo graphics commands.

Addcomm also incorporates some Basic editing aids, including a 'bad program' rescuer, a compacter, a character definer and a search-and-replace utility. Other commands give the user a string sorting routine, easier handling of text and graphics windows and (though not for purists) the freedom to jump out of For-Next loops without the usual consequences.

The Addcom rom is competitively priced at £28 including v.a.t. and carriage; it is also available for the Acorn Electron. Vince Micros, Marshborough, Sandwich, Kent CT13 0PG, tel. 0304 812276.
EWW 215

RS232 TO CURRENT-LOOP CONVERTER

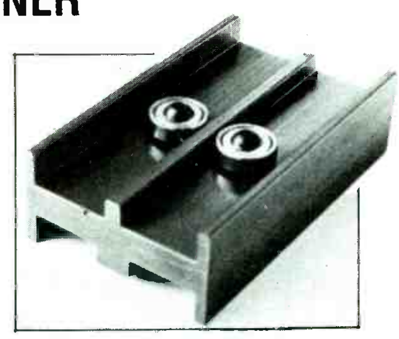
A converter to enable noise-immune communication over long distances with full protocol is available to connect to RS232 parts. It can convert in either direction and so can be used at either or both ends of a communications link. It may be used in half of full duplex and may be operated in passive or active mode; when 'active' the converter supplies the loop current. The Remark model 65 provides for 20 or 60mA current loops and can transmit or receive at uup to 9600bit/s. Supplied with a reference manual the unit costs £100 or less for bulk buyers. Advanced Technology Maintenance Ltd, 2 Norwich Road, Metropolitan Centre, Greenford, Middlesex UB6 8UB.
EWW 216



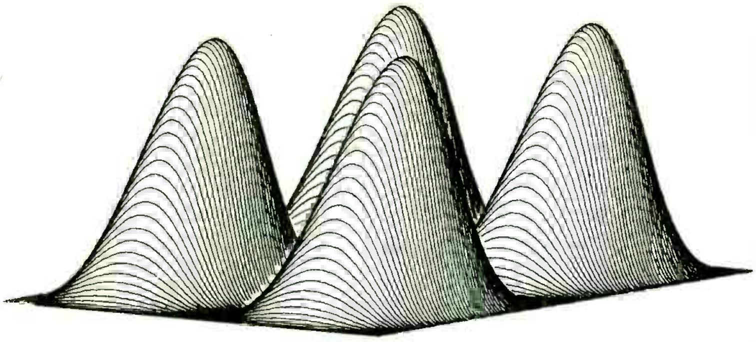
SWITCHER I.C.S AND LAYOUTS

Switching power supplies operating at high frequencies can be easily adapted to provide power at specific current and voltage values. Siemens produce four control i.cs for such supplies and have now made it even easier to design them by the provision of card layouts with the position of all components marked. The four circuits, TDA4700/14/16/18, provide power line-hum suppression, dynamic current-limiting, over and under-voltage protection, soft start for the supply itself, double-pulse suppression, reference overload protection and the facility for external synchronization. Siemens Ltd, Windmill Road, Sunbury-on-Thames, Middlesex TW16 7HS.
EWW 217

IC LEG STRAIGHTENER



Simply push the integrated circuit through this device and the rollers will position the legs so that they fit i.c. holders or p.c.b. hole patterns. The machine is adjustable and can cater for different leg thicknesses. This particular model can cope with 0.3 and 0.6in pitch dual in-line devices but others are available for 0.4 and 0.9in pitches. Low cost and handy for small batches or for those who do not have automatic insertion machinery. Other methods of bending the pins on i.cs are fraught with dangers and difficulties. Hionics Ltd, Lower Quemerford Mill, Calne, Wilts SN11 8JS.
EWW 218



XY PLOTTER

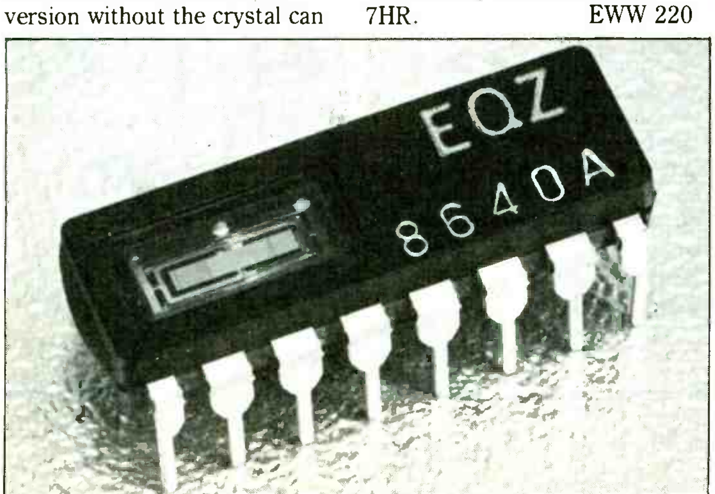
A flat-bed xy plotter has a number of add-on options to make it a versatile instrument. The Parfitt plotter is basically a three-pen plotter that can be instructed by a computer to draw anything from from complex geometric shapes and patterns to graphs and electronic circuit diagrams. It can use any of the three pens during its drawing program to produce colour drawings. The pens can be replaced by a scriber and the plotter can then be used to make scraper board pictures on scribe copper for etching. This in turn can be replaced by a light sensor and the instrument can scan a picture to be displayed on a tv screen. A picture scanned in this way can be reproduced by the plotter. The light sensor can also be used to negotiate mazes. On top of all this a drill or router can be fitted and used to machine soft materials and drill (e.g.) p.c.bs. These add-ons come as extras on top of the basic price of £270, the full kit of plotter, power supply, drill/router,, optosensor, scriber and software on disc is £490. Software on cassette is provided in the basic package. Aimed at schools and colleges,it plugs directly into the user port of a BBC micro and an optional conversion makes it suitagle for the other widely used educational computers, RML 380Zs. Parfitt Electronics Ld, 6 View Road, London N6 4DA.
EWW 219

LOGIC PROBE

A pen-sized, digital logic probe that may be used on d.t.l, t.t.l. and mos circuitry comes from OK Industries. The instrument detects high or low logic levels and can indicate if the level is correct or incorrect. It can also detect open circuit. Such a probe can often be used for testing when the only alternative would be an oscilloscope and/or other bulky test equipment. The probe has a frequency range from d.c. to 50MHz. The PRB-1 can also catch 10ns pulses and automatically stretch them to 50ms. It sets its threshold level automatically as a function of the voltage found at the tip and operates from the supply voltage of the circuit being tested, from 4 to 15V. Optionally an additional adaptor allows the probe to be used from a supply up to 25V. OK Industries UK Ltd, Dutton Lane, Eastleigh, Hants SO5 4AA.
EWW 221

CRYSTAL CLOCKS

A quartz oscillator is combined with a programmable on-chip c.mos divider chain to produce up to 57 different output frequencies up to the crystal's own frequency. A specific frequency is selected by applying logic levels to the six control pins of the 16-pin d.i.l. package. A selection of oscillators with crystal frequencies in the range 32.768kHz to 1MHz are available as standard and a version without the crystal can be supplied. For applications requiring a data-rate generator, two versions can be provided with base frequencies of 768 and 96kHz which can produce rates between 50 and 48 000 baud. Low power consumption and small size combine with the elimination of much external circuitry make these oscillator/dividers suitable for many applications. Euroquartz Ltd, 5 Church Street, Crewkerne, Somerset TA18 7HR.
EWW 220



PSEUDOSTATIC RAM

Low-cost dynamic ram chips can emulate static devices by incorporating refresh counters and multiplexers within the package. The NEC uPD4168, a 64K ram arranged as an 8Kbyte memory, uses the standard 28-pin package and is pin-compatible with static rams, while internally it refreshes memory at a rate of 128 cycles/2ms. Access time is 200ns with a cycle time of 330ns. Operating from a single supply rail of 5V, it consumes 330nW while active and 28mW on standby. The price is claimed to be 40% cheaper than the equivalent static ram. Available through Impulse Electronics Ltd, Hammond House, Caterham, Surrey CR3 6XG.
EWW 222

GAS-FIRED SOLDERING IRON

A Christmas present for the engineer who has everything is this butane-powered portable soldering iron. The Oryx Portasol works on a different principle from other gas-powered irons. There is no flame during operation, the chemical energy in the gas being converted directly into heat by means of a patented catalytic converter in the iron's tip. The rate of conversion is adjustable up to the maximum setting which gives the equivalent power to a 60W electric soldering iron. Tip temperature is adjusted to between 250 and 450°C. The gas resevoir is filled in much the same way as a gas cigarette lighter, and the pen-sized tool has an igniter (i.e. flint) incorporated in its cap. Apart from its portability the iron offers the elimination of electrical damage to sensitive devices. Costs £17.90 inclusive. Replacement tips are readily available. Greenwood Electronics, Portman Road, Reading, Berks RG3 1NE.
EWW 223

ERS — PRINTERS — PRINTERS — PRINTERS
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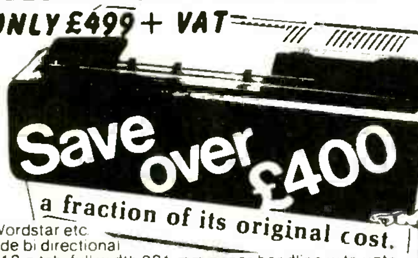

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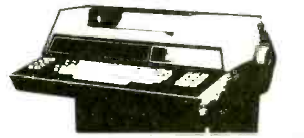
GE MODEL 30



A large purchase of these stand alone terminal units offers an EXTREMELY LOW PRICE for a professional printer for direct connection to your micro. The printer has a standard RS232 serial interface with switchable rates of 110, 200 and 300 baud. Upper and lower case characters are printed by a matrix head with character widths up to 132 columns. Unit accepts standard fan fold sprocket fed paper from 4" to 9.5". Many other features such as numeric keypad, electronic keyboard, auto motor on/off and FREE floor stand.
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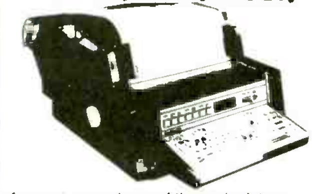

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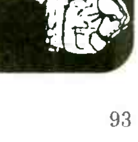

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Appointments

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For further information contact: Sarah Kennedy, Dolby Laboratories Inc. 346 Clapham Road, London SW9 9AP. 01-720 1111

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Telephone Nigel Fielden on 01.833 4737 for an interview.

(2768)

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(University of London)

ELECTRONICS TECHNICIAN—

The post is available with the Particle Physics Research Group, and is funded by an SERC rolling grant for an initial period of 3 years. The group is carrying out experiments within international collaborations at CERN, Geneva, Switzerland.

The person appointed should posses at least an HNC and have had previous practical experience in Electronics. He will be based at Queen Mary College, but will be expected to spend time both at CERN and at the Rutherford Appleton Laboratory, Oxfordshire. The work will be closely associated with the development of new fast time-digitising and charge sensitive analogue techniques for particle detectors. The data acquisition system is computer controlled. Novel techniques using UV lasers and fibre optics will also be implemented. The successful candidate will be encouraged to pursue original ideas. The initial salary will be within the range £6581 to £9871 per annum depending on age and experience plus £1250 London Weighting.

Letters of application giving age, experience and qualifications and the names of two referees should be sent as soon as possible to Mr D.R. Stone, Physics Department, Queen Mary College, Mile End Road, London, E1 4NS.

Closing date: 7 December 1984

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COMMUNICATIONS DIVISION

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microwave communications systems

Wells, Somerset

If you have a thorough knowledge of functional testing of microwave electronics sub-assemblies, units and systems, then we can offer attractive career opportunities at Wells in Somerset.

We are the Communications Division of Thorn EMI Electronics Limited and have played a leading role in developing the technologies on which modern communications systems depend.

Working in a development and production environment, you will be involved with microwave systems for civil applications, currently covering frequencies up to 20 GHz.

These opportunities would suit electronics technicians with experience in microwave testing, although college leavers who have received training in microwave systems as part of their course could also be considered for some of the more junior posts.

As a leading high technology company, career development opportunities are excellent with the potential of further developing your knowledge and experience.

Attractive salaries and benefits include an active sports and social club and free life assurance.

Please 'phone or write for an application form quoting Ref. EWW/385 to Mr. F. M. Taylor, Assistant Personnel Manager, Thorn EMI Electronics Limited, Communications Division, Wookey Hole Road, Wells, Somerset BA5 1AA. Tel. Wells (0749) 72081. Ext. 227.

THORN EMI

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(2776)

I.L.E.A.

Learning Resources Branch
Television and Publishing Centre,
Thackeray Rd, London SW8

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Salary range £7470—£9432 plus £1347 London Weighting Allowance, and an irregular hours allowance of £228.

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Film Camera Assistant (ST1/2)

Slary Range £5,568—£8,451 plus £1347 London Weighting Allowance.

The Centre's Broadcast quality colour programmes use 16mm sound film and video insert provided by the film camera section in which this vacancy has arisen.

Applicants should have relevant training and experience in servicing the requirements of film and video cameras together with the associated location lighting equipment, in television or documentary film environment.

PRODUCTION DIVISION

Television Maintenance Engineer

(ST1/2) [Re-advertised9

Salary Range £7470—£8451 + £1347 London Weighting Allowance. Plus £192 shift allowance

A maintenance engineer is required to work at the Television and Production Centre which is equipped to professional colour TV broadcasting standards. The engineer will work in a section of four which is responsible for maintaining a high level of performance of a wide range of sound and vision equipmen.

Full job description and application forms for all the above posts are available from EO/ Estab 1B, Room 366, The County Hall, London SE1 7PB. Please S.A.E.
The closing date for completed application forms is the **2nd January 1985**
These post are suitable for Job-share.
ILEA is an Equal Opportunities Employer.

(2769)

Marshall

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DUE TO EXPANSION, A VACANCY EXISTS IN OUR DEVELOPMENT DEPARTMENT, WHICH WILL INVOLVE ALL ASPECTS OF DESIGN FROM CONCEPT TO PRODUCTION. THE APPLICANT SHOULD BE QUALIFIED TO DEGREE LEVEL, AGED 21-25 AND HAVE A KEEN INTEREST IN MUSIC

Phone in first instance to Mr. Mike Hill.

Jim Marshall (Products) Limited, Denbigh Road, Bletchley, Milton Keynes MK1 1DQ.
Telephone: Milton Keynes (0908) 75411.

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Required in the electronics workshop. The workshop staff are responsible for the maintenance of electronic instruments and for the development and construction of electronic equipment for both teaching and research. Applicants should have an appropriate qualification (minimum ONC or equivalent) and considerable experience in electronic engineering, preferably including computers.

Salary will be grade 5 **£6,581—£7,684 p.a.**
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(2789)

Philips Drake Electronics is an expanding company specialising specialising in the design and manufacture of equipment for the Broadcasting Industry. We now require engineers for the following positions:

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A vacancy exists in our Projects department for an enthusiastic and self motivated engineer. The department deals primarily with the system design of broadcast communications equipment to customers' requirements and is responsible for the preparation of production and handbook documentation in addition to providing technical support for our sales, manufacturing and test department.

A suitable engineering qualification together with some experience in broadcast or the professional audio industry is essential.

ANALOGUE DESIGN ENGINEER

We are looking for an experienced engineer to join our development team. The successful candidate will be involved in all aspects of design from concept to production. He/She will most likely have a relevant degree and must be capable of producing innovative but practical designs with minimum supervision. Experience of the professional audio industry would be an advantage.

TEST ENGINEER

We require a test engineer with experience in testing analogue (preferably audio) circuits and fault finding to component level. He/She will become involved in varied testing from small batch produced units to complete studio communications systems and will be required to adapt to digital technology as this is introduced.

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A new position of microprocessor software engineer has been created and we seek a suitable candidate to design software in PASCAL and ASSEMBLER for the MC6800 family. The ability to work on your own initiative and communicate your ideas clearly is essential.

Attractive salaries will be offered to the right people.

If any of the above positions appeal to you please apply in writing including your current CV or phone Jill Humphreys on Welwyn Garden City (07073) 33866 for an application form.
Philip Drake Electronics Ltd., 37 Broadwater Road, Welwyn Garden City, Herts Al7 2AX.

drake

(2782)

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What you want, where you want!

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If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you. All applications are treated in strict confidence and there is no danger of your present employer (or other companies you specify) being made aware of your application.

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Address . . . .

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Electronics technician (Medical Physics Technician IV) required to join small team responsible for servicing, maintenance and electronic development of radiotherapy units. Principal units are a linear accelerator, two cobalt units (one performing three-dimensional treatments) and a treatment simulator. Training will be given in the specialist techniques required; study for further qualifications is encourged. The post gives an opportunity for gaining familiarity with a wide range of radiotherapy and physics equipment and for participating in development projects.
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Further details are available from Martin Welch **(01) 794 0500 ext 3209**
Job description and application form available from the Personnel Department Royal Free Hospital, Pond Street, Hampstead, London NW3 2QG
Please quote reference no: 1499

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To £16k **Thames Valley**

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This represents an ideal opportunity to become part of a team pioneering the development of VDU's and intelligent terminals. Candidates will therefore need to be able to demonstrate strong innovative flair backed by solid experience in the design of VDU's or TV drive circuits and PSU's. An appropriate qualification, preferably a degree, is essential.

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Please write, enclosing a full C.V. and quoting reference number WW/824 to The Chief Executive, DCM Appointments, 66 Frith Street, London W1.

DCM APPOINTMENTS

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TECHNICAL PROJECTS LIMITED

is a young and rapidly growing company specialising in the development, manufacture and marketing of audio products for the professional entertainments industry worldwide. Our customers include the BBC, independent television companies, local radio, hire and production houses, manufacturers, education and MOD etc. We are noted for product quality and customer service. Due to expanding business opportunities the following two vacancies have arisen:

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1. Wales, Midlands & East Anglia
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Applications are invited from sales engineers ideally in the field of professional audio/acoustic measurement and its related test products, possibly working in a large company and wishing to make an impact in a smaller one using their expertise and experience in field sales to promote the company's growth.
A combined five figure salary and commission of circa £19.000 is envisaged in the first year with every opportunity for increase and advancement into management. Company car provided plus normal benefits.
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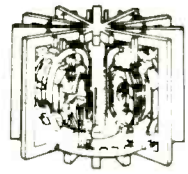

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The successful applicant will be involved in the procurement, installation, operation, maintenance and modification of high power radio frequency amplifiers, transmission line equipment and associated control circuitry.

A degree in electrical/electronic engineering or an equivalent qualification is required and several years' relevant experience of RF equipment in broadcast, industrial and scientific use, would be an advantage.

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For an application form and further details please write to Mr. M. Taylor, The Personnel Department, UKAEA, Culham Laboratory, Abingdon, Oxon OX14 3DB, quoting reference J3225. Closing date for applications is two weeks from the publication of the advertisement.

(2787)

HIGHLAND HEALTH BOARD
Department of Medical Physics and Bio-Engineering, Raigmore Hospital, Inverness

SENIOR TECHNICIAN/ TECHNICIAN — Electronics Section

A vacancy exists for a Senior Technician/Technician with ONC or high qualifications. The work involves design, construction, repair and maintenance, as well as clinical involvement.

Salary is — Grade III £6408-£8283
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Job description and application form from Area Personnel Officer, Highland Health Board, 17 Old Edinburgh Road, Inverness.
(Tel. 0463 239851)

For additional information contact Mr A R Bowley, Deputy Director.
(Tel. 0463 234151 ext 276 or 277)

(2786)

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Contact: Brandon McHale or Nicholas Martin on
01-387 1262

(2775)

ELECTRONIC TECHNICIAN

Stage Lighting Control
Manufacturing Company require bright Technician for testing/servicing desks and dimmer systems. An/Dig experience necessary; microprocessor experience an advantage; formal qualification not essential.
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Two levels of entry providing two salary scales:
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Radio Technicians – £5485-£7818

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For further information and your application form, please telephone Cheltenham (0242) 32912/3 or write to:

GCHQ

Recruitment Office, Government Communications Headquarters,
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Require a
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For general duties in the Engineering Department. The successful applicant will have a HND/Degree qualification or equivalent training in a relevant subject.
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ST4 2SR (2680)

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The position is well rewarded.
Contact
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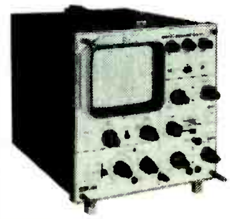

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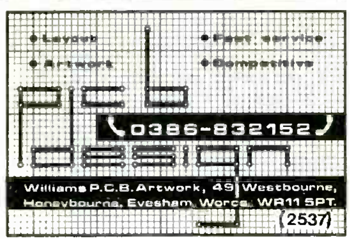

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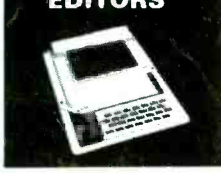

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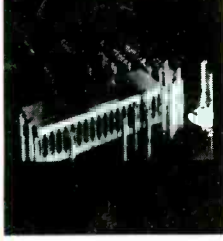

I.C.T. (Intelligent Connectivity Tester) is the project name for a 40 pin dual-in-line CUSTOM-CHIP developed by DATAMAN.
The chip is called the MT72017 and it will appear soon in BARE-BOARD TESTERS, IDC CABLE TESTERS and LOOM ASSEMBLY EQUIPMENT all over the world. An EVALUATION-SYSTEM/CONTROLLER for the MT72017 is available on a EUROCARD and you can BUILD YOUR OWN custom connection-pattern tester for **£295**
The controller has full documentation, source-code, circuit diagram, parts-list and a description of operation. Each MT72017 tests 26 points and a single controller will handle hundreds of 'em — thousands of test-points.
MT72017 chip prices: **£12.50** (1 to 99) **£11.25** (100-999) **£10.25** (1000 up). **We do not sell samples of the MT72017 without a controller.**

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CIRCLE 3 FOR FURTHER INFORMATION