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WIRELESS WORLD JANUARY 1981

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1st place for
quality and value

Front cover shows inset microprocessor trainer described in this issue with background of a Burr Brown thick film hybrid a-to-d converter photographed by Paul Brierley.

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ELECTRONICS / TELEVISION / RADIO / AUDIO

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Programmed in BASIC - the world's most popular language - the ZX80 is suitable for beginners and experts alike. And response from enthusiasts has been tremendous - over 20,000 ZX80s have been sold so far!

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This 4K BASIC ROM offers remarkable programming advantages:

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- Unique syntax check: a cursor identifies errors immediately.
- Excellent string-handling capability - takes up to 2655 variables of any length. Strings can undergo all relational tests (e.g. comparison).
- Up to 32 single dimension arrays.
- FOR/NEXT loops nest to up 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, condition expressions, etc.
- Programming function useful for games and secret codes, as well as more serious applications.
- Timer under program control.
- LED and POKE enable entry of machine code instructions.
- High-resolution graphics.
- Lines of unlimited length.
- Unique RAM

The ZX80's 16K BYTE RAM is the equivalent of up to 4K BYTES in a conventional computer - typically storing 100 lines of BASIC.

No other personal computer offers this unique combination of high capability and low price.

The Sinclair teaches itself

BASIC manual

If the specifications of the Sinclair ZX80 mean little to you - don't worry. They're all explained in the specially-written page book (free with every ZX80). The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming - from test principles to complex programs.

Kit or built? - it's up to you

In kit form, the ZX80 is pleasantly easy to assemble, using a fine-tipped soldering iron. And you may already have a suitable mains adaptor - 600 mA at 9VDC nominal unregulated. If not, see the coupon.

Both kit and built versions come complete with all necessary leads to connect to your TV (colour or black and white) and cassette recorder. Plug in and you're ready to go. (Built versions come with mains adaptor.)

Now available for the ZX80...

New 16K-BYTE RAM pack

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For example, you could write an interactive or 'conversation' program to show people what your ZX80 can do. With 16K BYTES of RAM, they could be talking to your computer for hours!

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And by linking a number of separate programs together into one giant, modular program, you can achieve the same effect as loading several programs at once. We're also confident that it won't be long before you can buy cassette-based software using the full 16K BYTE RAM. So keep an eye on the personal computer magazines - and brush up your chess perhaps!

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To: Science of Cambridge, FREEP0ST 7, Cambridge CB2 1YV

Remember: all prices shown include VAT, postage and packing. No hidden extras. Please send me:

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<thead>
<tr>
<th>Qty</th>
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<th>Code</th>
<th>Item price</th>
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<tr>
<td>02</td>
<td>Sinclair ZX80 Personal Computer kit: Price includes ZX80/BASIC manual, instructions and mains adaptor.</td>
<td>02</td>
<td>79.95</td>
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<td>Readily assembled Sinclair ZX80 Personal Computer kit: Price includes ZX80/BASIC manual and mains adaptor.</td>
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<td>ZX80/Mains adaptor. (Mains free with every ZX80 kit or ready made computer).</td>
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<td>Sinclair ZX80/Mains adaptor. (Mains free with every ZX80 kit or ready made computer).</td>
<td>06</td>
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## WIRELESS WORLD JANUARY 1981

### All equipment for sale is fully refurbished to manufacturers' original specifications

<table>
<thead>
<tr>
<th>Name &amp; Model</th>
<th>Price</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td><strong>Bigger stock investment greater equipment range means wider choice</strong></td>
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### OSCILLOSCOPES

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<tr>
<td><strong>AVANCE</strong></td>
<td>850</td>
<td>Includes 20 MHz scope</td>
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<tr>
<td><strong>KTELE</strong></td>
<td>3,755</td>
<td>Includes 60 MHz scope</td>
</tr>
<tr>
<td><strong>TELE</strong></td>
<td>2,755</td>
<td>Includes 100 MHz scope</td>
</tr>
<tr>
<td><strong>AVE</strong></td>
<td>3,925</td>
<td>Includes 100 MHz scope</td>
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<tr>
<td><strong>AVANCE</strong></td>
<td>850</td>
<td>Includes 20 MHz scope</td>
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</tr>
<tr>
<td><strong>AVE</strong></td>
<td>3,925</td>
<td>Includes 100 MHz scope</td>
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### Spectrum Analyzers

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<th>Notes</th>
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<tr>
<td><strong>Hewlett-Packard</strong></td>
<td>850</td>
<td>Includes 20 MHz spectrum analyzer</td>
</tr>
<tr>
<td><strong>ADCO</strong></td>
<td>3,925</td>
<td>Includes 100 MHz spectrum analyzer</td>
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### Power Supplies

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<td><strong>ADC</strong></td>
<td>3,755</td>
<td>Includes 60 MHz power supply</td>
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<td><strong>TELE</strong></td>
<td>2,755</td>
<td>Includes 100 MHz power supply</td>
</tr>
<tr>
<td><strong>AVE</strong></td>
<td>3,925</td>
<td>Includes 100 MHz power supply</td>
</tr>
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### Temperature Measuring Equipment

<table>
<thead>
<tr>
<th>Name &amp; Model</th>
<th>Price</th>
<th>Notes</th>
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<tbody>
<tr>
<td>** ניוקהול **</td>
<td>850</td>
<td>Includes 20 MHz temperature measuring equipment</td>
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<tr>
<td><strong>ADCO</strong></td>
<td>3,925</td>
<td>Includes 100 MHz temperature measuring equipment</td>
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### Redundant Test Equipment

<table>
<thead>
<tr>
<th>Name &amp; Model</th>
<th>Price</th>
<th>Notes</th>
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<tbody>
<tr>
<td><strong>Cartron Prime Equipment</strong></td>
<td>850</td>
<td>Includes 20 MHz redundant test equipment</td>
</tr>
</tbody>
</table>

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<tr>
<th>Product Code</th>
<th>Price</th>
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<tbody>
<tr>
<td>S100-01-001</td>
<td>£120</td>
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<tr>
<td>S100-02-001</td>
<td>£110</td>
</tr>
<tr>
<td>S100-03-001</td>
<td>£100</td>
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S100-05-001  | £80  |
S100-06-001  | £70  |
S100-07-001  | £60  |
S100-08-001  | £50  |
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A testing time for electronics

Why would a British nationalized industry not wish to associate itself publicly with the work of one of its engineers in using microprocessors, quite properly, to improve its industrial performance? This is what happened with an article we published recently. The engineer was quite free to publish the work, but his employer, the nationalized industry, specifically asked for their name not to be revealed in the article. You would think they would be proud to show their owners, you and me, what they were doing in this up-and-coming technology. Could it be that, with a national background of economic recession and high unemployment, they felt it was not exactly the right time to admit responsibility for "new technology" which might mean a permanent reduction in their work force?

A few years ago the argument that the use of electronics in new products and manufacturing processes would create more jobs than it displaced was readily accepted because of the confidence engendered by the rapid expansion of the free-market economies in the 1950s and '60s and the resulting high level of employment. Today, although the argument could still be valid — because we can point to actual new jobs that have been created — it is beginning to look somewhat feeble against the scale of current events. In Britain we now have over two million unemployed. This fact has come to some people as a sudden shock. Even so they dismiss it as a temporary, though severe, effect of yet another of those swings in the recurring trade cycles we have become used to over a century or more. It must end, they say. But other, perhaps more discerning, observers see the present figure of two million unemployed as not merely a temporary freak, but as part of a longer term "structural" change, as the economists call it. Up to about 1967 unemployment in the UK, running at about 300,000, was roughly matched by the number of job vacancies available. But after 1967 this situation no longer obtained. The unemployment curve began to "take off" upwards, leaving the "vacancies" curve much as it had been before. This trend has continued unabatedly for a decade. If these analysts are right and there is in fact a long-term structural increase in unemployment, then electronics and any other technologies being used to improve labour productivity will be scrutinized and tested as never before in the full glare of the public arena. If the higher labour productivity indicates a loss of jobs, rather than an increase of output with the existing level of employment, then the new technology will be opposed far more strenuously than if we were living in an expanding economy. Those who introduce it will have to prove, under the most searching examination, that they are not bringing social disruption in its wake by adding even more people to that sad group which always bears the brunt of industrial change — the poor, the unemployed, the unskilled, the handicapped, the chronically ill and the inadunate. One can only be glad that these new conditions are clearly understood by the central economic organization of the Western capitalist countries, the OECD. In a recent report "Technical change and economic policy" (written by a group including two men with an electronics background) this influential body states firmly that technical change can never be a goal in itself. It must be politically supported by the populations of these countries, and this social sanction "will be forthcoming only if there is a satisfactory balance between the generation of new employment and the loss of old jobs if technical change is perceived to improve the quality of life."
Two problems which prevent many electronic engineers from learning to use microprocessors are the complexity and cost of taking the first step. Constructing a unit can reduce the cost but may require some troubleshooting if it doesn't work. A simple unit that can be built easily may have limitations which restrict its use.

With these points in mind, a microprocessor trainer has been designed which is suitable for a novice but provides sufficient facilities for use as a tool.

A block diagram of the design is shown in Fig. 1. Only 9 Ics are used, which makes construction quite easy for anyone with the minimum of experience. The central processing unit is a Motorola 6802. Although not a particularly well known microprocessor, it is based on the popular 6800 device and includes clock generation and 128bytes of r.a.m. This reduces the cost and simplifies construction because only one crystal is required to complete the clock generation circuit. For programming, the 6802 is identical to the 6800 and is therefore well supported with software. Apart from the c.p.u. r.a.m., there are two other blocks of memory available. An e.p.r.o.m. permanently stores the monitor program, which takes care of the general "housekeeping" duties such as scanning the keypad, refreshing the display and providing debugging facilities to help with program development. The monitor occupies about 850bytes of the e.p.r.o.m. To improve flexibility, the unit has been designed to accept 1K, 2K and 4K e.p.r.o.m.s so that the user can write programs and have them permanently stored for application such as a dedicated controller. The second memory block is a 1K r.a.m. for developing and running programs.

The final section of the block diagram contains the input/output (i/o) circuit which drives the keypad and display, and allows interfacing to other circuits. The complete circuit is shown in Fig. 2. A clock reference is provided by the 3.2768 MHz crystal and C1. However, other crystals between 4.096 MHz and 4.4MHz can be used with an adjustment to C1 for reliable oscillation. The 6802 clock circuit divides the oscillator frequency by 4 to provide an 8192Hz system clock signal (C2 of the 6800) at E. This frequency leaves a small safety margin for the devices, which have a maximum operating frequency of 1MHz. A 74H500 gates the E signal with VMA (valid memory address) to provide VMA.E. which is used by the address decoder ICD to ensure that other devices on the bus are only accessed when a valid address is present on the address bus. The address decoder generates select lines for the memories and i/o chips by decoding the three most significant address lines. This provides selection of 8 4K address blocks, of which Y1, Y4 and Y7 are used. Note that the most significant address line, A15, from the c.p.u. is not used because sufficient address space is available without it.

Data pins D9 to D17 of the c.p.u. are connected to the data bus. The control bus comprises E, VMA, E, read/write, reset (connected by a push switch and used to start the monitor program at switch-on, and to initialise the i/o chip for programming), IRQ and NMI interrupt lines which allow program execution to be interrupted or, in the case of NMI (non-maskable interrupt), termination of a monitor command with the Abort key which restores the processor to the monitor switch on point. Both interrupts are connected to external pins for use by an external circuit if required.

As mentioned previously, three sizes of e.p.r.o.m. can be used. Although the 2708 is the cheapest device it will provide only a small amount of spare memory space, and it requires +5V, -5V and +12V supply rails. The 2516 and 2532 only require +5V and leave just over 1K and 3K respectively for expansion.

The main r.a.m. is provided by two 4-bit 2114 Ics. With the 8192Hz clock, the 6802 is similar to the 6800 but contains a clock generator and 128bytes of r.a.m.
The memory map for the unit is shown in Table 1. Note that the e.p.r.o.m. occupies 7000 - 7FFF, although the monitor program only occupies 7000 - 7FFF. Addresses 7E51 to 7E7F are unused because, in the original unit, routines for a paper-tape punch and load were stored there. This space can be used for load and dump routines to suit the user's storage medium.

The reset button is used at switch-on, or if control of a program is lost, to run the monitor program. Sixteen hexadecimal keys enter data, and the remaining eight keys enter monitor commands. L and P are spare keys, used in the original for load and punch with the paper-tape unit, which can be used for extra facilities.

These do not need to be storage routines, but any routine the user wishes to write and include in the monitor. Locations 7DA4-5 should contain the 16-bit start address of the routine to be run on pressing L and 7DAD, the address for the P key. For testing the unit, these keys can be ignored.

The memory (M) command allows a memory location to be examined or altered if required. This key is acknowledged by 77 in the far right display. A 4-digit address, when entered, appears on the left four digits, and the data in that location appears on the right two digits. To alter the contents of the location, enter two hex digits, which will be shifted into the data display from the right (if a mistake is made, keep entering appropriate digits until the correct data appears in the display). Next press the Increment (I) key, which stores the displayed data in the memory location and advances the display to the next memory location. If the memory contents do not need altering, press I to advance or A to terminate command and return to monitor status.

Register display (R) displays the contents of the various c.p.u. registers following a SWI interaction in a program. The command is automatically entered after a SWI, but may be re-entered with the R key. The condition code register contents are first displayed, the right two digits denote the register being displayed. Next, the c.p.u. will increment the I register (LPL in the example), retrieved from the location given in the condition code register, RASP (or RAC or AccA, $7F$ Index register, C or P). The stack pointer register is entered in 2's complement form as the stack pointer position and the left four digits show the total in hexadecimal. If I key is pressed the I register will increment through the various registers or A key will abort. After displaying SP, the unit will automatically return to monitor status.

The 4-digit hex start address of the program is entered into the program memory. If a program is interrupted by the abort address, it will not be re-run. Program execution will be suspended, and the abort break will provide the abort key (AB) with the required data. A program (AB) can be run on the computer and the program memory contents altered. This can be done by simply re-loading the program from the memory location given by the 'memory' command. There is no need to re-load the source data. A 256 word e.p.r.o.m. can be used for user programs, provided they are not larger than 256 words.
A direct-conversion breakthrough

About two years ago, the Plessey Company demonstrated a novel "on-channel" form of "duplex operation" for "twin" transmitters which is primarily for military tactical radio networks. This attracted considerable interest among amateur operators as a system which could extend the range of simple handheld transceivers by more than 600 kHz off-set operation through the conventional amateur repeaters, and also offered the possibility of expanding the duplex operation on narrow-band-frequency-modulation if such two such units were used in tandem. However, the codes for the system were not made public, so that the amateurs, who were not involved in the company's commercial, were unwilling to disclose even the principle on which this system worked.

At the I.E.E. recently, Chris Richardson, the inventor, revealed that the key feature lies in the use of a direct-conversion receiver in which the transmitted signal acts as the local oscillator for the two-phase balanced mixer used to receive the signals in a form suitable for n.b.f.m. demodulation, enabling a direct rejection to accurately track the incoming carrier frequency. Direct-conversion ("zero I.F.") receivers have been popularized and used by many amateurs, but this new direct approach cuts out a host of problems in the way that the technique is being taken increasingly seriously by the long-distance DX operators. The design, by STL, Harlow, by Ian Vance, GW4MS, has shown that this is possible, and that it can be used to design a mobile V.H.F. radio on a single chip/micro using direct-conversion techniques (The Radio & Electronics Engineer, Vol. 30, No. 2, April 1979). The design uses a two-phase (quadrature) system of demodulation which allows a "measure of integration previously unobtainable in a mobile receiver" further development is envisaged.

Here and there

Extensive tropospheric ducting during early October 1981 resulted in many contacts between amateur operators in the south of England and Eastern Europe on the 144, 432 and 1296 MHz bands. The contacts between the UK and Czechoslovakia were by means of 2300 MHz (13cm) ducting were made possible by E. L. Jones, G4FFX, and D. C. Haines, G4FFV, using GB4GVR and G4LQR.

The weekly "World Radio Club" programme on the SSB and RTTY bands for amateurs, radio amateurs and anyone interested in the radio amateur world, gives full details in its bulletin and schedules of the BBC World Service for January 1981, though it is not clear what will happen beyond temporary or permanent closure of the "club". Started in 1967, this programme has run without breaks for more than 70 editions and more than 40,000 listeners in all parts of the world have been identified as members themselves as members. Producers have included John Pitman, Joy Beagam and currently Ray Kennedy, G4HAT, G4ZCB, a retired British engineer, has been taking part in the programme since the start.

Richard Thruford, G4WWW, is currently installing in his own shelter a television receiver and is intending to use the television equipment additional memory cards to convert his equipment into the form of colour pointing equipment for the W.M.T, the W.M.T. N. Miller, W8WTP. Reports that he has A.H. Watson, GW4GKG (9 New Road, Bartley Green, Birmingham B37 9AY, tel. Comberbank 0202-26-2129) is undertaking to supply amateurs on a non-profit basis with commercially printed boards, complete with 240 printed through-hole links and produced from the original W8WTP artwork, together with associated circuit data relating to the W8WTP and EL2207 circuits.

Science Museum

The Science Museum amateur radio station, GB8SM, has recently been using the call sign GB8SM to mark its 25th anniversary. The station, set up in 1951, has been pressed from a simple table-top layout into one of the most popular stations in regular operation anywhere in the world. The present equipment includes Collins, Heathkit, Eddystone Instruments and Trio units arranged to permit three separate operating positions to be manned simultaneously. A.T.V. operates since 1951 has been George Voller, G4JUL, assisted by volunteers. Over the years the station has been heard by thousands of contacts worldwide and has been visited by many of the millions who come to the Science Museum.

RSGB's record year

The annual report of the Radio Society of Great Britain for the year ended June 30, 1980 shows that the membership has reached an all-time high of 25,658, while total income of the Society from all sources for the first time exceeds £0.5 million, resulting in a surplus for the first time since 1971 of £0,000. The 1979 World Administrative Radio Conference is seen as "successful from an amateur point of view". The RSGB also "welcomes" the Home Office "Open Channels" proposals as "being in line with its own view" and feels that a 292 MHz frequency "should satisfy the large majority of users, while minimizing most potential interference problems."

The report does not mention it, 1981 also promises to provide a special feature in the Society's history: wife of the 1981 President, Mrs E.O'Brien, holds her own amateur call sign, G6BIO. Paul Oram, G4AZM have written in his personal memoirs of many years standing. He comes from outside the "electronics" field, being a retired bank manager.

An additional GBR2S news bulletin is now being transmitted on Sunday mornings at 9 a.m. local time on 7045 kHz from stations in Northern Ireland. There is a plan to produce received on conventional "all-band" domestic receivers in many parts of the G.B.R. W4M also 11 a.m. 7.7 to 11 a.m. transmissions from the Maldives.

In brief

Doug Finlay, D.P.C., GBZGR, a former R.S.G.B. president (1957 and later 1970- 74) general manager of the society died during September. About 50 Dutch amateurs are now licensed to use o.w. between 17250 and 18500 kHz with power limited to 10 watts output.

... The R.A.R.L. are preparing a proposal to be submitted to F.C.C. advocating an amateur band at about 900 MHz. The League has recommended that the 10 MHz band, due to be released when the WARC 1979 Radio Regulations become operating, should be allocated between 1000 and 1004.5 MHz, the c.w./t.r.y. operation, with a maximum power of 250 watts, but 500 to 600 watts and a new frequency from 7075 to 7085 MHz, to amateur radio club of London Worldwide Television now holds the call signs G4LWW, C.C. B licenses in London and it is expected to be issued soon for the F.C.C. have "derogated" much of the American 50 MHz band, allocated to c.w. and confusing repeaters to the segment above 52 MHz... A new band have been submitted to the R.S.G.B. Working Group for an experimental 145 MHz repeater capable of handling a widespread C.B. operation to be operated by the University of St. Andrews. The most noteworthy beacon is a new 28.225 MHz station GB8J and a station in the Western Territories on an island in Lake Corvette at latitude 65.5° North, longitude 59° West. GB8TB was first heard in the U.K. and should provide a valuable guide to propagation studies.
The first thousand transmitters

Britain's u.h.f. colour television reaches 97.8% coverage

by Edward Trickett B.Sc., Ph.D
BBC Engineering Information Department

On the seventh of November, 1980, Mike Neville, star of 'Look North', opened a small television transmitting station at Hedleyhope in the Derwent Valley, County Durham. The Hedleyhope relay contains the one thousandth u.h.f. television transmitter to be brought into service by the BBC.

In less than 17 years, 51 main stations and more than 450 relay stations have come into service. With the exception of two stations which do not carry BBC2 Sound, BBC1 Scotland provides BBC1 Scotland for Dundee and Galloway, and Wrexham-Rhyl offers BBC Cymru/Wales. All the stations have transmitters for BBC2 and BBC1 (or BBC Cymru/Wales).

Hedleyhope is a long way from Crystal Palace, where the United Kingdom's u.h.f. television service began in 1964, carrying the brand-new service, BBC2. Like its predecessor (the original BBC television service in 1936 and ITV in 1955) BBC2 was pioneering a new broadcasting band of higher frequency than any used before in the UK. But it was also using a new line standard destined to be the vehicle for colour transmissions.

The BBC's u.h.f. transmitter network is a major engineering achievement which stretches the length and breadth of the country, from Balsaloun to St Helier, from Dover to Pembroke and the Scillies to Peterhead. The problem compared with v.h.f. is that more than 500 stations have been needed to reach the present 97.8% per cent coverage of the 55 million people in the UK. By comparison, the BBC's 450 u.h.f. network needed only 110 stations to give 99 per cent coverage.

The u.h.f. network represents a great deal of co-operation between BBC and IBA engineers. The service has been planned using the computer at the BBC's research department in Kingwood, Surrey, where the transmitting parameters of all the u.h.f. stations in the UK plus those of the main stations in nearby countries in Europe, are held in memory. The Stockholm plan of 1961 allocated all main station channels, and others, but the detailed planning of the relays is done with the computer. The proposed parameters are fed in to check for possible interference. Even though u.h.f. transmissions do not normally propagate over great distances, some 500 stations, each with two or more channels out of a possible 44, mean that finding useful channels for new relays is getting difficult.

Where possible, existing v.h.f. sites where only one and more sites have been obtained on the same landlord/tenancy relationship. The obvious difference is that there is far less flexibility in u.h.f. than at v.h.f. and the relay stations fill in the gaps left by the main stations. The flat lands of eastern England need very few relays but the heavily-populated valleys of South Wales and industrial Yorkshire and Lancashire need many. On the whole the relays serving larger populations have been built, and the number of people served by each new relay has fallen from half a million (Sheffield) down to between 500 and 1000 for most current stations. Hedleyhope serves 1000 people.

A few deficiencies in coverage are measured during detailed surveys by the service planning section of the research department. Possible transmitting sites are investigated using the computer and ground parameters drawn from ordnance survey maps. Site tests are carried out with mobile test transmitters and aerials and to check for local signals. These methods ensure that optimum coverage can be achieved in any area where deficiencies exist.

At this stage, either the BBC's site acquisition section or its IBA counterpart takes over. There has to be main power available within a convenient distance, and reasonable access. Then the landlord has to be asked to purchase the freehold or negotiate a lease on the site and obtain planning permission and air navigation obstruction clearance. In some areas there can be objections to even a small pole on environmental grounds but the broadcasters are at pains to erect the most discrete structure consistent with performing the necessary service. They have no power of compulsory purchase, and planning consent has to be obtained in the usual way.

Providing the stations

The BBC's transmitter capital projects and architectural and civil engineering departments are responsible for turning the research department's specification for each station into reality. The specification includes transmitted power, channels, aerial radiation patterns and height. The most appropriate equipment, aerial support structures and building are all carefully selected to fulfil these requirements.

Most components are ordered in quantity and parts are allocated to each station while it awaits its turn to be built. At present the broadcasters are opening 70 new stations each year and it is vital to maintain a steady flow of materials to meet this target.

On many small BBC sites the concrete tower base (which includes the building base) is laid by BBC staff. A BBC-designed pre-fabricated building is equipped at the Brookmans Park workshops. Building, tower components and aerials are taken by lorry to the site, where the rigging team puts the pieces together. The entire aerial system pays a brief visit to check that the transmitting aerial (which he assembled at the workshops) is in good condition when delivered. He checks the received signal and installs the combining and splitting filters. The relay engineer installs the transposers to complete the installation. The tenant's representatives install their transposers (and finalise the manager of the transmitter maintenance team accepts the BBC equipment on behalf of the transmitter group, who will operate it. The station is now ready for switch-on and appropriate publicity is arranged through local papers. The 'Service Information' programme and the trade, a week ahead of the opening date. An engineer from the BBC's engineering information department visits the service area with a survey vehicle in the first week or two of operation to check the performance of the station. He advises both dealers and customers of the public on the spot about reception conditions as he finds them.

So far only the planning and provision of the stations have been considered, but the expansion of the networks has made huge demands on the ingenuity of our engineers. At several stages in the programme when there was no suitable commercial equipment, the equipment has been designed within the BBC. The Hedleyhope relay, for instance, has aerials, tower, transposers, amplifiers and channel-selection and combining equipment all of BBC design.

Transmitters

Crystal Palace was a test-bed for u.h.f. equipment for several years before it went into programme service in 1964 and the...
There is a continuing pressure from broadcast engineers and industrial/commercial users to reduce the size and weight of television cameras. The broadcasters want them small for ENG (electronic news gathering) while the industrial users need them small to mount on machinery or to be unobtrusive for surveillance purposes. Soon, home video will be adding to this pressure (see News, December). Two recent reports from the electronics industry have been the C.C.C.D. charge coupled device) image sensor and the single-gun photodiode tube for producing colour pictures. New examples of these both were presented at the International Broadcasting Convention, Brighton, in September, and also by Howard Stone, managing director of Sony Broadcast, in his October inaugural address as chairman of the IEE's Electronics Division.

The image sensor is claimed to be "the first commercially available sensor with the 625-line capability." Developed by the GEC Hirst Research Centre, Wembley, it takes the form of a 34×10 mm photomultiplier silicon chip mounted in a 90-pin package (type number MA37). The incident light image is converted from a pattern of photons to a corresponding pattern of electric charge by an 8.5 mm×4.4 mm image section on the chip, which contains 64 horizontal electrodes and 65 vertical charge transfer columns. This charge transfer is patterned into a three-phase pulsed applied to the horizontal electrodes, line by line downwards into a storage section on the chip. The charge collection plus transfer time is equal to one field period (26 ms in the 625-line standard) and the transfer takes place in the blanking interval.

At the bottom of the storage section each line is transferred in parallel into the output section, from which it is read sequentially in the time of an active line time, 52 ms. While each line is being read a second pattern of charge is being collected in the image section. Although charge is collected from the whole image area in each field, the three-phase pulsed system causes the charge of collection to be shifted up and down between fields in order to offer a 2/3 interlace in the vertical direction. Thus the C.C.C.D. device is compatible with the existing 2/3 interlace standard, where 375 lines are displayed and the remaining 58 lines are used for field blanking periods. Picture quality from the GEC device is not yet good enough for television broadcasting, but the present performance is claimed to be adequate for "a wide variety of industrial, professional and monitoring applications." The new single-gun colour tube, intended for ENG cameras and developed by the Sony Corporation, is only 8.9 inches in diameter. It is called the Triicon because of its similarity to the well-known vertical-tripe Triicon cathodes-ray tube display made by the same company. The light image, in fact, is focused onto a colour filter array consisting of red, green and blue, which each line of the standard vertical interlace line is divided into five sections, the red green and blue filters placed in the middle of the line.

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Electronic combination lock

Mains independent, with four digit code via keyboard

by Jan Hruska B.A.

This article describes how a key-operated mechanical lock can be converted to an electronic combination lock by the addition of a commercially available solenoid operated lock, a keyboard and some c.m.o.s. logic. In design, this lock is similar to the one published in the March 1980 issue of W.W. (Ref. 1), but it has the following advantages:

1. It is totally independent of the mains.
2. It uses fewer integrated circuits.
3. Although the author specifies a solenoid lock for use with the electronic system, the keyboard and accompanying circuit can be used for activation of a number of devices for various applications.

The system consists of three parts, a keyboard, a processing unit with batteries and a solenoid operated lock. When the correct 4-digit code is entered via the keyboard outside the protected area the solenoid of the electric lock is activated for approximately two seconds by the timer section of the processing unit. The 4-digit code required for activation is predetermined in binary form by the settings on two 16-pin D.I. switches which may be mounted on the same p.c.b. as the rest of the logic and timing circuit. Binary code setting provides security against easy reading by a keyboard.

If a motor type solenoid lock is used in conjunction with a standard Yale type lock, the door can be opened either by using a key or the keyboard code. The processing unit inside the protected area requires connection to the keyboard outside via an eight core cable and connection to the solenoid via a twin core cable. A 4×4 matrix encoded hexadecimal keyboard is used. Vandalizing of the keyboard or cutting of the wires leading to it will not cause activation of the lock.

The processing unit contains the logic necessary to identify the correct sequence of the four digits and operate the lock, the switches for setting the code and the 6V power source. A standby current of 250mA is required for the c.m.o.s. logic and a short burst current of 700mA while the solenoid is being activated. Since the lock activation time of two seconds is small compared with the standby time, four HP2 type batteries connected together will give operation for up to one year. If required, the processing circuit can be made up on a piece of Veroboard measuring 107×54mm and housed, along with the batteries, in a plastic box measuring about 110×190mm.

One type of solenoid operated lock which can be used in the system is the 11K model from Baron Security Group (Ref. 2) which costs around £13.90 plus v.a.t. This lock was used in the prototype and although the manufacturer specifies 6V, as the operating voltage, it worked reliably on 6V d.c.

System operation

The 4 digits are entered sequentially via the 4×4 matrix hexadecimal keyboard as shown in Fig. 1. Each digit is decoded and encoded by a 74C922 encoder. The resulting binary code is then fed to the four-stage shift registers for which two 4015 dual shift registers are used. Comparison between the four digits in the shift registers and the code set in binary in the 16 D.I. switches is then carried out by the four 4-bit comparators. If both sets of 16 bits correspond the A=B output of the cascaded 4063 comparators will go "high" and trigger the c.m.o.s. 555 timer which will in turn energize the lock through the buffer circuit for about two seconds.

When choosing a code, it is advisable not to use four identical digits as, due to the shift register logic, an intruder would only have to enter one correct digit to activate the lock if a correct code had been used previously. The system described has been in operation in the Medical Engineering Laboratory, Oxford, for more than six months and everybody found it convenient not to have keys in order to gain access to a busy room with restricted access.

Fig. 2. If the Yale and solenoid locks are mounted as shown here, the door can be opened either by using the key or the combination-lock keyboard.

Components list

1. 4×4 matrix encoded hexadecimal keyboard
2. 74C922 keyboard encoder (c.m.o.s.)
3. 4015 dual shift register
4. 4063 4-bit comparator
5. 4011 quad 2-input NAND gate
6. 1066 c.m.o.s. timer
7. D.I. switch, 8-pole single-throw
8. 2TTX200 or similar n-p-n transistor
9. 1TP32A or similar p-n-p power transistor
10. 1A diode
11. 15k9 resistor
12. T.C.1
13. 1.5MO
14. 1nF capacitor
15. 10k9
16. 10k9
17. 10k9
18. 1.2k resistor
19. 4.7µF tantalum capacitor
20. 47µF

References:
2. "Remote Control Electric Locking Systems" leaflet, Baron Security Group, 34/35 Dean Street, London W1V 5AP, Tel. 01-439 4538
Low-speed differentiator
Monitoring slow changes in long-term experiments
by L. Hayward, Department of Geology and Mineralogy, University of Queensland

With certain electro-chemical experiments, it often becomes desirable to obtain the derivative of the output voltage/time curve in order that changes in the rate of change of amplitude become more easily observed. Such experiments often last minutes or even days, and consequently the classic type of RC differentiator seen in Fig. 1 is likely to be of little use, as the changes are so slow that gross amplification is necessary, resulting in excessive noise masking the output.

This article describes an alternative form of differentiator, the block diagram of which is shown in Fig. 2. When read in conjunction with the timing diagram of Fig. 3, the operation is as follows:

A buffer presents the input signal to a pair of c.m.o.s transmission gates. These are alternatively switched on for short periods, as determined by the clock generator and the sampling period monostable. The sampled voltages at t1 and t2 are stored in C1 and C2 respectively. The voltages across C1 and C2 are buffered by voltage followers, and applied to a differential amplifier. After t2, the resultant output from the differential amplifier is proportional to the difference of the charges on C1 and C2 that were set up during the interval t1 to t2. In other words, A/B is bracketed.

The timing diagram shows that, whilst the samples t1 to t2 and t3 to t4, etc., are of the same polarity, i.e., A-B, the periods t1 to t2 and t3 to t4, etc., give a reversal of polarity, i.e., B-A. Consequently, a further sampling gate is required to eliminate the unwanted period. An output storage capacitor and output buffer complete the device, the complete circuit being shown in Fig. 4.

In operation, maximum sensitivity will be obtained when the clock frequency approaches the fastest rate of change of the signal. Clearly, the clock frequency should not be equal to, or less than this. The clock frequency is roughly adjusted by selection of capacitor, and fine tuned by the potentiometer RV1. The only other adjustment is by RV2 (differential balance). This is more easily set by observing the result of the triangle wave input (in Fig. 5). The output from the differentiator under these conditions should be a square wave, since we have a constant positive rate of change (gradient) followed by a negative gradient, and the amplitude of this square wave will be related to the input frequency. Set up RV1 for maximum flatness of the square-wave output.

The circuit described is useful where a trend, rather than absolute results, are required. Clearly, this simple design could be elaborated to reduce offsets, and to use rather than eliminate the alternative sampling period, by more complex switching. Considering these limitations, the differentiator performs well and produces consistent results.
WIDE BAND AMPLIFIER

For low signal level applications, this amplifier offers low noise and a 9.8MHz bandwidth with a minimum amount of frequency selective peaking. As a result, the output signal has an almost constant phase relationship with the input signal, which improves stability.

The circuit is basically a cascode arrangement with the output buffered by an emitter follower. Input impedance at 2MHz is 18.9kΩ and the voltage gain is 52dB. The -3dB bandwidth points are 6kHz and 9.8MHz. Output amplitude ripple is less than 1.2dB over the passband, and the maximum output voltage is 3V pk-to-pk.

D. R. Wightman
Washo
New Zealand

DYNAMIC NOISE REDUCER

This circuit was developed for use with a good quality cassette recorder, such as the Linley Hood design, where the cost and complexity of a Dolby B or similar system was not justified. Noise from a replayed tape is most noticeable at low recorded signal levels, and the noise spectrum peaks in the 5 to 10kHz region. Reduction of the background noise is achieved by applying a progressive treble cut to signals which fall below about -35dB (relative to the nominal 0VU replay level), to roughly match the falling treble response of the ear.

A voltage controlled filter uses a diode as a variable resistance element which is modulated by the detected signal level. At high signal levels the gain is unity over the audio spectrum, but falls to ~10dB at frequencies above 5kHz as the h.f. content of the input signal is reduced. The level-detector delay time and sensitivity are determined by R6 and R1 respectively. A stereo noise reducer can be built using one LM324 or similar quad op-amp. For recording, a complementary characteristic can be obtained by connecting D2 in series with C1, instead of C2, and R3.

G. C. Hammond
Nuneaton
Warwickshire

PHASE SYNCHRONISED MONOSTABLE OSCILLATOR

Two monostables form an oscillator whose phase can be synchronised with an incoming pulse. The circuit was originally used to replace a damped resonant-amplifier clock regenerating circuit in a data recording system. Analogue data from the signal processing system was peak detected, and the write data was encoded to have a maximum of four clock periods between peak pulses.

The oscillator is started by the first peak pulse which occurs at the start of each data stream. Successive peak pulses update the phase of the oscillator and keep the clock in phase with the analogue data. If a peak pulse is early, M1 is triggered and M2 is reset, which effectively resets the phase to zero. If the peak pulse is late, M1 is retriggered which extends its period by the amount the pulse is overdue.

E. M. Davies
Towcester
Northants

VISUAL FIRE EFFECT

A realistic fire effect, suitable for amateur dramatics, can be achieved with the circuit shown. A wooden case carries three 60W bulbs, the two outer lamps are red and are permanently on to produce the effect of glowing coals. The middle bulb is yellow and flickers randomly to give the effect of flickering flames. The unit is covered by a log effect moulding taken from an electric fire.

A 4015 shift register and the exclusive OR gates form a maximum length pseudo-random sequence generator. This is clocked at 10Hz by the oscillator using Schmitt trigger A. The pseudo-random pattern of ones and zeros at point X repeats every 25s, and gate B prevents the generator from locking up in the all-ones state. Diodes D1, D2 and D3 provide a +10V supply for the circuit, and Tr1, Tr2 generate a positive-going pulse at point Y each time the mains voltage passes through zero. These pulses are gated with the pseudo-random sequence by gate C. Gates C and D generate a negative-going pulse at point Z, whose width is determined by R3 and C2, to trigger the triac just after the zero crossing point and eliminate interference.

J. A. H. Edwards
Leicester

CIRCUIT IDEAS
Simple s.c.r. oscillator

Fig. (a) shows a basic s.c.r. oscillator with a frequency of 7kHz. The voltage across the s.c.r. rises until there is sufficient gate current to switch it on. The anode resistor is chosen so that when the s.c.r. conducts, the current is below the minimum sustain current and the device switches off. A new cycle then starts. Supply voltage and temperature are critical and not every s.c.r. will oscillate. An improved circuit is shown in Fig. (b) where an inductor, such as a speaker coil, is connected in series with the capacitor to provide an output frequency from 1kHz to 1kHz. The components are not critical and the circuit will work with a wide range of supply voltages. Because the back e.m.f. of the inductor helps to switch the s.c.r. off, this principle can be used to control a d.c. load as shown in Fig. (c). Current through the load can be controlled between 25 and 90% with the potentiometer.

D. Di. Mario
Rome
Italy

Tachometer indicates rotation sense

Rotation speed and sense can be detected by two phototransistors as shown. One monostable is triggered by the phototransistor which turns on first, depending on the direction of rotation. Tr inhibits the remaining monostable and a RC combination produces a delay to permit triggering of the first monostable. The light sources must produce a Vc of 30mV for Tr1 and Tr4, and Schmitt triggers are recommended to produce fast trigger edges, especially at slow rotational speeds.

S. Icno
Rumania

Linear l.e.d. control

Linear control of l.e.d. intensity can be achieved with one op-amp. The input is varied from +5.6 to –6.2V where the l.e.d. extinguishes.

P. Amsa
Harlow
Essex

The Broadcasting Act 1980

One of the main effects of the Broadcasting Act, which received the Royal Assent in November, is to extend the life of the IBA by fifteen years. Under previous legislation the life of the IBA was due to expire at the end of December 1980. It is recommended by the Annan Committee on broadcasting, the Authority will go on until the end of 1996 — and this may be extended by statutory order up to the year 2000.

Another important effect of the Act is to hand over the fourth television channel to the IBA to provide a new service (other than in Wales). Here the IBA has to ensure that the fourth channel contains material of high quality and interest and that the programmes broadcast are in English. In addition, the IBA is required to provide both local and national services to the fourth channel.

Under the Act, I.T.V. and I.R.L. contracts will run for a maximum of eight years (subject to a transitional provision for independent local radio in existence before the introduction of the legislation). But a first I.R.L. contract in an area previously unserved by I.R.L. may run for a maximum of ten years. In addition, the IBA is required to re-advertise both I.T.V. and I.R.L. contracts when the contract periods come to an end. The I.R.L. will have to publish a notice of its intent to enter a contract and the date from which the contract will run and invite applications for that contract.

Ptarmigan takes off

Plessey, the prime contractor for the battlefield communication system, Ptarmigan, says that the total value will be “several hundred million pounds”, and that it will provide over 500 new jobs. Sub-contractors include STC, Marconi, Airex, BICC, Marshall of Cambridge and Membrane. Plessey’s order book now stands at £1,200 million.

Ptarmigan is designed for the British Army and R.A.F. in Germany, although it is meant to be compatible with other equipment such as Beauch, which it replaces, and other systems being developed in Europe. It is a trunk digital radio network with access for ‘subscribers’ and is described by General Sir Hugh Beach as “the System X with car radio phone, only more so.”
Two-year trial period for subscriptions tv

Following his consideration of a report submitted by the Home Committee in Feb-

in the House, the Secretary, William Whitelaw, has decided to allow pilot schemes in sub-

scription television (satellite) to begin operation in the UK, initially for a two-year period.

In a written answer to a question from Colin Shepherd (the West of England) that, since it "would not be practical nor appropriate for the Home Office to supervise the pro-

grammes shown nor to exercise the functions of a broadcasting authority", most of the broadcast material would be prohibited from being shown. Licence holders may not seek exclusive rights to show sporting events internationally of national importance. Advertising will not be permitted. As well as requiring similar to conduct research in public relations to such a service, each licence holder is required to prepare and submit reports to the Home Office from time to time.

The Home Secretary also said that he is con-

sidering a levy "for the benefit of the film industry, and... any additional safeguards needed to protect the cinema and television broadcasting service.

Applications for licences will only be considered from existing licencees of broad-

casting relay systems. The schemes will be conducted by the local management of the operator who will also be required to provide details of the technical aspects of the system and to comply with any licence condi-
tions calling for the development of the service with other forms of broadcasting. The Depart-
ment of Trade will not charge a levy in respect of the showing of films in the pilot schemes, although a licence fee will be charged to cover the administrative costs incurred by the Home Office.

Licences have been granted for broadcast re-

lays since the late 1960s, first to relay sound and then tv programmes. In 1965 an experiment was set up as a reaction to suggestions by several companies, resulting in three companies being issued with licences for an experimental service. However, two of these companies decided that the restrictive conditions imposed by the Post Office (which was the licensing authority in 1965) and the lack of commercial assurance for the future, were not acceptable, and surrender-

ed their licences.

The third company, Pay-TV Ltd, mounted experiments in London and Sheffield and operated technically successful services from 1966 to 1968. The company was satisfied that the results showed the acceptability of the service and that commercial viability could be achieved if coverage could be extended from the experimental 12,500 to 250,000 homes. Permission to increase the coverage was refused, however, and the service closed down.

In contrast, many cable tv networks are in operation in the US and by 1979 there were 60,000 homes equipped, most of the stations providing feature film and general sport pro-
grams, in fact much like the system currently envisaged by William Whitelaw. Many of these US networks now receive their signals via satel-

tes or similar high speed logic elements, it is to be unobtrusive to the US, France, Germany the UK and Japan. A major aspect of the system will be to store a computer which accepts not the spoken word but pictures in microform, as well as its own software packages and designing its own. Diagnosing its own faults.

New in brief

More than 700 Japanese government officials participated in the second British Overseas Trade Board seminar on industrial energy saving and effi-
ciency, held in Tokyo last in September. The seminar was held at the World Import Matt building and was the first such meeting in Japan sponsored by a foreign government organiza-
tion.

Digital Communications Corporation, a mem-

ber of the MCA-Com group of companies (US) has formed DCA IAC, a British subsidiary. The new company's product range will include under-

water land and seafloor, terrestrial p.c.m. and c.d. transmission equipment for private and national organizations. The company's head office will be based at Humphrey Rd, Dunstable, LUT 4SS.

Communications 82 will be held at the National Exhibition Centre, Birmingham, from Tuesday 19 to Friday 23 April 1982 (inclusive). This will be the sixth in a series of international exhibitions dealing with communications equipment and systems.

The British Standards Institution has published a part one de-ptheiration of "High Fidelity Transmission Equipment and Systems; Minimum Performance Requirements". For further information, contact the BSI, 2 Park, Park, London W1A 1BS or tele-
phone 01-629 9000.

A ten-year collaboration project, aimed at producing a new generation of computers based on the use of Josephson junctions (superconduc-
tor) or similar high speed logic elements, is to be unobtrusive to the US, France, Germany the UK and Japan. A major aspect of the system will be to store a computer which accepts not the spoken word but pictures in microform, as well as its own software packages and designing its own faults.

US local tv stations recommended

Hundreds of low-power local television stations may be set up in the US as a result of a recent recommendation. With a power of about kW and covering areas with a radius of about 25km, they are intended for specialised services such as dealing with local community events. They have been planned to not interfere with the broad-
casting of normal, high power commercial television stations, but the National Association of Broadcasters in the US is worried because they think the FCC may not have studied the problems thoroughly enough. Obviously, the proprietors of existing commercial tv stations will see the new service as a possible threat to their present advertising revenue.

On 7 Nov the BBC's 100th colour tv transmi-
ter was put into service (see De Trichter's article in this issue). The transmitter is located at Holme-
hope in Co. Durham and will serve about 1000 homes in Wathencares, Est Winning and East Hadleigh. The services and channels refer-
ed BBC1 (North-East) - ch. 40, BBC2 (North) - ch. 45 and the 4th channel (when operational) - ch. 50. Polariza-
tion is horizontal.

A short course entitled Thermal Design of Electronic Systems will be presented by Cran-
field Institute of Technology during the week 26-30 Nov. It will consist of two three-day tuition blocks covering 1 fundamental and applications, correction and radiation to temperature control (2) liquid pool boiling, heat pipes, phase change materials, fluid-
vapour flow, adiabatic cooling. This section of the course will also deal with thermal imaging and laser Doppler anemometry. All attendants are recommended to the Short Course Institute, Cranfield Institute of Technology, Cranfield Bedford MK43 0LA.

SFC, infrared, Einstein and quasi stellar mirages

The continuing success of the Science Research Council in discharging its commitment to the societ-
	y of technical and economic ramifications of industry and academia, in spite of the rigours of inflation, is given detailed support in its report for 1979-80, published early in November.

Alongside comparisons of expenditure of grants million in 1979-80 compared with £ million in 1970) the report records some "stri-

king" achievements. Most noticeable of these is probably the confirmation of Einstein's predic-
tion that a few years ago, that gravitational fields could act as "lenses". Distant galaxies, that of the new president of the IERE, John Powell, in the nature of demonstra-
tions

The speech was in fact the inaugural address of the new president of the IERE, John Powell, who is engineer-in-chief of Cable and Wireless. The subject was "Resource management: a key to immediate improvement in productivity" and a good deal of the reference was to the cable and wireless field, where he had in the management of its work force. The quotations were from Mr Powell's philosophizing in designing an indus-
tory, and it was clear he had left his own firm's electronic design department where he had "an affinity to the employment pattern found in the large Japanese companies". Mr Powell concluded: "I believe that employ-
ment practices in British industry on the whole are not as efficient as they might be. It is not by coincidence that the Japan is a world leader in management and the reason is there is a better employment pattern than ours. Our employers have a whole range of employment practices which are not as effective as they might be. I believe that this is a matter which needs looking at more closely."

A PROM Medium as its assembly stage by a Thoreticale at Lhasa. Each verses assembled in hexadecimal form before being modulated and passed onto a "loop" circuit where it is converted to analogue form and fed to the output stage at the standard monochrome frequency.

PHOTO BY COURTESY OF ADVANCED PRAYER - WHEEL DESIGN & ART, STC1
Faulty battery caused by brewer's products

In view of the heavy fines imposed upon 27MHz b.h users and the claims made by the Home Office that such illegal activity seriously interferes with established licensed services. Roger Bunney's reception experiences in the Romney area force some interesting comments.

He works as a television technician and jour- nalis, frequently articles on long-distance radio reception to the magazine Television (IPC Maga- zines). The serious part of his professional activity involves monitoring the broadcast bands 1 to V. Arriving at Romney, Hampshire in 1972, he was about building a 50ft lattice mast to carry the necessary aerials. One of the most exciting and severe bands for DX is Band 1 (464MHz), where his E combination with the favourable conditions of the F layer to make reception up to 500 miles possible.

In September 1974 the entire Band 1 spec- trum was disrupted by high level interference, which was eventually traced to a nearby industrial site. The布莱顿-based transmitting company had established a distribution office about 40 yards away, equipped with v.v.d.u. and related equipment for receiving information by cable from Office O in the main brewery in Portsmouth. The disruption produced a whining "motor" effect, peaking at intervals of about 1.5MHz from 8MHz to 100MHz. Everyone was made to contact the makers of the equipment with a view to suppression but a solitary was eventually engaged (after a severe lack of response) and the v.v.d.u. manufacturer eventually paid for a staked aerial system. However, this had little effect and the Home Office consequently made measurements on Mr Bunney's array and Post Office officials arranged to print a notice about the aerial. Although the additional results were not provided, the Home Office eventually wrote pointing out that actions would not be taken or public funds used to terminate the nuisance.

The attitude of the Home Office seems unfortu- nate, to put it mildly. A source of interference which is producing a public nuisance has been allowed to continue for several years, despite acknowledgement that the problem exists and within a domestic broadcast band. This was also noted by another citizen, who had a similar complaint based on interference to local fm radio reception, but who has since left the area. One criticism that could be levelled at the com- plicature is that he is not seeking redress and weak signals and can therefore expect problems, but this seems to imply that domestic users and enthusiasts are resigned to a position where they must suffer interference from vested interests and commercial organizations.

Perhaps it's time for the statutory limits to interfering radiation to be reconsidered.

Bus for a bus

Lucas and Leyland have jointly developed a multiplex bus system to replace most of the conventional electrical wiring & a passenger or bus vehicle.

Although "critical leads" such as headlamps and stop lights will still be wired conventionally, all the control wires for doors, solenoids, interior lighting, horns, etc., can be replaced by the bus. The system comprises a three- or four-wire "ring main", a microprocessor-controlled bus, and up to 30 local receiver units. The bus provides a common power rail, a single wire for the transmitted data and one wire for a synchronizing clock. An optional fourth wire can be added to provide a noise-free return.

The controller reads the state of the driver-operated switches which it sends to a multiplex bus at 212kHz to set the receivers to stand-by and then transmits the 4-MHz carrier frequency in the sequence. Clock pulses synchronise the loading of this address into a memory in each receiver and then transmit the 4-MHz carrier frequency. If the receiver is not activated by the call, it will be the first instance of its use as a vehicle. Some bus operators have been sceptical about the reliability of parts that do not move, but the Leyland team stress the stresses the positive position of the system which include the claim that it will be no more expensive than an equivalent conventional wiring harness, will be far more flexible and, in addition to the addition of vehicle conditions monitoring equipment and diagnostic systems, far more useful.

Shuttle will assist in closer look at Venus

One of Jimmy Carter's last official acts as Presi- dent of the United States was to approve NA- SA's request for funding of a mission to map the surface of Venus, to begin in 1986.

After launch by the space shuttle, the Venus Orbiting Imaging Radar (VOR) spacecraft would circle the planet for seven months taking pictures as well as making measurements of the surface and atmosphere.

Dr Robert Frosch, NASA's chief administra- tor, says that this scientific project will "reveal the planet's nature and geology, and probably the sister planet in the same way that Mariner 9 revealed the Mars". The spacecraft will deliberately crash into clouds, or is expected to be captured by the planet's gravity. The instrument package for arrival of the vehicle in December 1986, at which point the spacecraft would be inserted into polar orbit at an altitude of about 180 miles. The mapping activity would result in near- global coverage of the planet with moderate resolution imagery (corresponding to 2000 feet) and a smaller section in higher resolution (about 150m - 500m).

News in brief

The first telecommunications equipment show of the year for TV is to be held at the Bath in Channel B3 to celebrate the Beijing (Peking) Exhibition centre from Nov 3 to 13 1981 by the Electronic Industries Associa- tion (EIA) and the National Council for U.K. Trade. Approximately 100 American manufacturers are expected to exhibit equipment at the show.

The International Association of Broadcasters (IAB) has moved to new headquarters at the Triumph House, 1096 Ubridge Rd, Hayes, Middlesex. The telephone number is now 01-573 8333.

A bureau approach to viewers, enabling small- scale users to exploit Prestel-type hardware in a private system, is to be set up by GEC Viewdata systems. Pages of internal information held on the organization's viewer computer, which can be called up, modified, and new pages added by viewers of various departments of the organization. The system, which cost about 30,000 pages, would cost about £500,000, ex- cluding the cost of terminals.

Public payphones which use plastic cards instead of coins will be tried out by British Telecommunications in London, Birmingham and Manchester. They will be used near convenient post offices, giving users a choice, although they will be necessary to buy the cards, which are erased automatically when inserted into the mechanism. Each card unit in price, 6p and there will be two basic cards on sale - one of 40 units costing £2 and a 200 unit card at £10.

Multiple keying system for organs

TDM system reduces complexity and cost, allows mixture stops, transposition and pizzicato effects by a W. Critchley, Dipl.EI., M.I.E.R.E.

The method of controlling the keying to be described is offered as a practical solution to the problem of multiple key controls, whether the organ is a pipe or electronic, church or entertainment type. It has advantages over conventional wiring, not least being the cost, which can be paid for out of the saving in copper wire. Cable size from the console is significantly reduced. Carcass is inexpensive and uses standard c.m.o.s. devices. Single-pole contacts throughout of light current capacity - a multi or so just to keep the console clean. Keyboard wiring is simple and can be standardized.

Oscillator coupling within manuals is simply a matter of incorporating delays. Inter-manual coupling is ideally done using longer delays. Any required pitch can be selected with ease. Mutation and mixture stops are no problem. Any kind of organ can be controlled - pipe or electronic. No limit to the size of organ.

Extra consoles may be added. Second-touch keying is easily catered for. All other switch information can be included if desired. Only a handful of printed-circuit boards is required. It is flexible to permit custom designing. Coupler switches are not used, avoiding high-curent supplies. Disadvantages include complex circuitry in which a single failure could render the whole organ inoperative, a high level of servicing competence being necessary.

Key matrrixing

The system basically comprises a matrix for the pedals and keys to minimise the number of wires that have to be connected to the keys. The contact information is then turned into a series of pulses by sequential scanning of the matrix, see Fig. 1. Data is passed over a single wire through various delay systems to demultiplexers which recover the key information to switch on and off the
Octave and manual coupling

As the serial keyboard data is in the form of one pulse per note, it is possible to add 12 pulses separate keys an octave apart in pitch. Therefore to couple an octave is simply a matter of adding the data of 12 pulses and adding it to the data stream when whichever keys were played will also play their octaves.

Sub-octave coupling is almost as simple. The data is split at the time of the data stream and the delayed data adds are placed. The output is of course delayed by 12 pulses but this is easily overcome by the demultiplexers by delaying the decoding signals to match. Fig. 3 shows the system for swell and swell and sub-octave coupling together with a union-off-coupler which merely re-arranges the normal pitch. Also shown is a swell octave coupler. This is possible with the same circuit by time-sharing as the data for this manual comes at a different time than that for the swell. Gating of the data has to be done in any case as the swell data is not present to octave-couple all manuals at once. The gating pulse lasts only as long as that particular manual is being scanned. The pulses may be applied at the input, output or via cars as shown. As the data width of up to 24 pulses the scanning time per manual has to be increased by two octaves to prevent this from causing a data bottleneck for the next manual.

Coupling between manuals is simply a matter of adding the delays involved so that the delayed data turns up in the right place in the scan of the next manual.

The problem

One of the biggest problems in the manufacture of an organ, electronic or pipe but particularly electronic, is in the wiring of the key contacts and coupling stops. These affect which notes are played when keys are pressed on the manuals (keyboards). The traditional approach in the pipe organ is to wire one contact per key to the magnet (solenoid air-void) which allows one pipe to speak from one rank of pipes. It is customary to be able to couple keyboards together in a variety of ways, so that for instance when the great-manual keys are played they perform the functions of the swell-key manual as well, but not vice versa. The swell keys do not have to speak anything. The swell data are delayed by 12 pulses before the old days they were used to with mechanical actions.

Each coupling requires an extra contact on every key as a switch to effect coupling. This last is operated by a solenoid action as 61 pipes are required, one for each pipe rank.

Several hundred of milliamperes are required to operate the solenoid and almost as much to operate each pipe magnet.

On larger organs similar couplings are selected so that the contact can be played at a different pitch, usually an octave higher and/or lower. This can be done on the swell manual too. If the swell manual is coupled to the great manual so that the swell plays an octave higher, then the stop is called swell-to-great-octave or swell-to-great 4 ft. The majority of organs can also couple the manuals to the footpedals, which are simply a large set of keys, none of the couplings are normally performed in the reverse direction.

Each key can therefore have many contacts. There is no room for more than perhaps eight without resorting to multi-pole relays. Consequently the number of wires involved with a large organ is colossal. Not only is it tedious to wire up, but it is also bulky and expensive as well as being inflexible in its requirements. There is a multiplicity of things that can go wrong: especially when relays and contacts are involved at high currents.

Electronic organs usually require more contacts per key but for different reasons. It is common to switch actual signals with the key contacts which are then arranged in isolated pairs. Each key requires, say, five pairs to control five dimensionally-related frequencies such as the sub-harmonic, the fundamental, second, third and fourth harmonics. This means that inter-manual coupling must also have five pairs of contacts per key. This is just as practical. Most electronic organs that do have couplers either in another way too, with or without fundamental pitches, the classical organist generally does not like electronic organs and this lack of adequate coupling may be one reason.
It has long been customary to speak of the education-and-training of engineers. The two words are used in a number of different contexts — as labels for courses of study, for instance. There are two major components of the educational process: the formal education and the practical training. The latter component is often referred to as "apprenticeship" or "on-the-job-training," and it is a critical part of the engineer's education. However, it is important to recognize that the formal education is just as important, if not more so, than the practical training.

The formal education begins with the selection of a specific field of study. This decision is often influenced by personal interests and career goals. Once a field of study is chosen, the student begins to pursue a curriculum that is designed to provide a solid foundation in the fundamental principles of engineering. This curriculum typically includes courses in mathematics, physics, chemistry, and other sciences, as well as engineering concepts and methods.

The student then moves on to more specialized courses, which focus on specific areas of interest. These courses are designed to provide a deeper understanding of the subject matter and to develop the analytical and problem-solving skills necessary for a successful engineering career. The student may also have the opportunity to participate in research projects, which can provide valuable experience and exposure to the latest technologies and techniques.

The next step in the formal education is the selection of a thesis or dissertation topic. This is a critical decision, as it will determine the focus of the student's research and the direction of their career. The thesis or dissertation is typically a substantial piece of work that requires significant time and effort to complete. It is often the culmination of the student's formal education and is a requirement for graduation.

The thesis or dissertation is typically reviewed by a committee of faculty members, who will evaluate the student's work and provide feedback and suggestions for improvement. The student may then make revisions to the thesis or dissertation and submit it for final approval.

After completing the thesis or dissertation, the student is typically required to pass a comprehensive examination, which is designed to test their knowledge and understanding of the subject matter. This examination is usually administered by a committee of faculty members, who will evaluate the student's performance and provide feedback and suggestions for improvement.

The formal education is typically followed by a period of practical training, which is often referred to as "apprenticeship" or "on-the-job-training." This period of training is designed to provide the student with hands-on experience in the engineering profession. It typically involves working under the guidance and supervision of experienced engineers, learning how to apply the theoretical knowledge gained in the classroom to real-world problems.

The practical training is an integral part of the engineer's education, as it provides the student with the opportunity to apply their knowledge and skills in a real-world setting. It is also an important way for the student to develop their professional network and to gain valuable experience in the engineering profession.

In conclusion, the formal education and the practical training are both critical components of the engineer's education. The formal education provides the student with a solid foundation in the fundamental principles of engineering, while the practical training provides the student with hands-on experience in the engineering profession. Together, these components prepare the student for a successful career in engineering.
slower than bipolar devices and that the access time of r-a m.s is now to be measured in nanoseconds: the idea of 1μs as a short time is out of date as the 60 μp.sec express trains.

Mathematics

Mathematics often forms a practical barrier between the two types of courses. It is an interesting question whether British mathematics teaching is bad or mathematics forms an intellective sieve of great discriminating power; but it is a fact that the mathematical content of honours degree courses in electronic engineering courses has tended to increase. Perry to fifty years ago the use of Heaviside's operational calculus was not compulsory; today, the student is expected to use Laplace transforms at a fairly early stage. The digital computer is a very flexible tool, sometimes in microprocessor form, and the trend towards automation of all data has made the z transform and the fast Fourier transform essential tools. Autocorrelation (and cross correlation) are now familiar operations, and for some specializations one needs an acquaintance with Hadamard/Walsh functions and transform, a corner of group and field theory and now Frensen and Carmichael numbers (pseudoprimes). The engineer may need a nodding acquaintance with a wider range of mathematics than is covered by any one academic mathematics course. From a mathematician's point of view "n'ding acquaintance" is nearer to technology than to a fundamental study, but from the engineer's point of view it is only the honours student (or graduate) who can expect to take on so many new ideas. After all, mathematics is supposed to be the epiphon of fundamental study, of universal application.

The 'tool kit'

But if engineering technology is concerned, the graduate should include in the 'tool kit' which he takes to his first job some up-to-date knowledge of what he would take a long time to earn the respect of the technicians on whom he will depend most. Most engineering courses now include a project, the successful completion of which is often a student to design and either construct or have constructed a specific piece of hardware. This requires expertise in the handling of currently available devices and so contributes to the practical side of the 'tool kit'.

Educating the technician engineer

So much for the education of the honours graduate or innovative engineer, but what about the "tool kit" for the technician? Clearly the one policy which is unsatisfactory is to allow the pass student to found in honours students and award him a pass degree for a very poor performance in the honour examinations. The general principle is to take him out of the more mathematical and abstract courses and substitute partially with more practical courses based on current technology. (Particularly because the pass degree student generally cannot assimilate information as fast as the honours student can.) The lecturer who gives an honours course may be able to provide a 'mugs' guide' to the same subject for example, one can give the barest fact that the radiation resistance of an aerial is proportional to ($k^2$) whereas for an honour course one would derive this from electromagnetic theory. One would need to supplement this with more descriptive material about current types of aerial.

Non engineering studies

The problem of fundamentals versus technology arises equally in the industrial studies and management which we are nowadays urged to include in the undergraduate curriculum. If really two branches, the one being finance and the other being largely personnel management. There is no doubt that lack of training in either type of expertise can be disastrous: Rolls Royce is the best known example of lack of financial expertise, and it is probable that a significant number of strikes could be eliminated if this was improved.

But in the larger firms these functions should be controlled by specialists; and if one takes the traditional I.E.E. view that the professional engineer starts on 90% technology and 10% administration, but in course of time reverses the proportions then any graduate of honours or innovative' professions should be able to acquire the appropriate skills when they are needed. It may be desirable to give under-graduates some exposure to the appropriate subjects by way of 'opening windows', but it is not necessary to train them in them. An exceptional case could be made out for the entrepreneur who finds his own business on some technological innovation, but one should not disturb the main curriculum for the benefit of this exception! He must either learn fast or find a partner to develop it after the non-technical side of the business. The summary is that business education should be taught on a technological rather than fundamental basis. (The meaning of "fundamental" in this context may be seen a little corrected by the sarcastic remark of a Professor of Economics to a Professor of Accounting: "you should not be teaching undergraduates the rules of accounting; you should be teaching them how to break the rules".)

The question of written (and spoken) communication has been left until now, but much has recently been unfashionable to study language, particularly one's own language, fundamentally. The lack of inflections in English makes it particularly important to use a reasonable word order in order to eliminate the relationship between different parts of a sentence. (Through in the absence of emphasis, the present writer is prone to invent the natural order of phrases on occasion.) Perhaps this should be learned as the technological language, the fundamental aspects being linguistics and literature.

To summarize, the ancillary subjects such as mathematics, language and business and management studies should certainly be taught as technology, but in proportion there is need to teach fundamentals, if only as an insurance against the effects of technological change.

I believe that "engineering" is primarily an attitude of mind which may be hinted at by the phrase "enthusiasm for getting things done properly". This attitude of mind is not dependent on the academic and technical content of a course, enlivened or not, but it can be influenced by the way in which material is presented. Since this was written, an article on "Training of Engineers in Japan" by H.A.J. Prencie has appeared in Electronic and Power (the Journal of the I.E.E.), which discusses how, in the main, a "culture" of Japanese industry appears to be an extreme case of the policy on industrial education which has been suggested above.

This article is based on a paper presented at the conference on "Electronic Engineering in Japan", Reynard, Hull, 31st March to 1st April 1980. Copies of the conference proceedings, covering all 43 papers, can be obtained from Mr K. A. Walsh, Department of Electronic Engineering, University of Hull, Hull HU6 7RX, post and packing £1.25 in U.K.

Multiphase low distortion oscillator

Sine wave generation with frequency independent amplitude control

by A. D. Ryder, M.A., Ph.D., F.I.E.E.

Linear oscillators, such as the well known Wien-bridge, are essentially second order and constructed using op-amps, and have inherent non-linearities which give a fundamental shape to the amplitude is kept within the linear range of the device. The outputs are non-sinusoidal, which can be compensated by the use of wave-shaping oscillators such as the Japanese 2608, and its general frequency is (60Hz + nsin(θ)).

Because θ lies between 0° and 90°, the attainable shift per stage lies between 90° and 180°. However, if one stage is used, the total loop phase shift must be multiple of 360°. The spoke diagram in Fig. 3 shows how this works for a 5-phase oscillator, $m = 5 - n$, where the phases are separated by $72° (360° / 5)$ but each stage phase separation is $144°$. In this case $x = \cos(\alpha)$ and $f = \sin(\alpha)$. As $m = 5$, each step of $\frac{m}{2}$ phase will always produce an (–1) shift around the diagram, and in such steps will visit all spokes in greater than $90°$ there is more than one possible shift per stage, generally, within the 90 to 180° limits. For example, when $m = 7$, phase separations are $31.4°$, it is possible to visit each of the 360° phase separations in three. However, it is necessary to design for the highest usable phase shift, i.e. the mode for which the loop gain is highest, $360m^2 / m^2$. The angle $\theta$ is then equal to $31.4°$. In general, the capacitive feedback discriminates against harmonics and, so far as concerns the loop feedback is negative because $m$ is odd, which tends to stabilize the whole circuit.

The oscillator gain is only 1% excess gain by making $R_1$, two-thirds of the basic value, which introduces an antiphase voltage feedback via $A_1$ and $R_2$. Amplifier $A_1$ is a multiplier, or a variable-mu device such as the 5080, and its gain is controlled by the oscillator amplitude which is detected by a full-wave rectifier of two diodes per phase and differs from the output amplitude by a steady state, the balancing output of $A_2$ has 9 of $P_m$ amplitude and just offsets the losses gain. The level at which the

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**Fig. 1.** Oscillator of m phases.

**Fig. 2.** Vector diagram for second oscillator stage.

**Fig. 3.** Spoke diagram for 5-phase oscillator, $m = 5 - n$, Phase separation is $72°$ and the sequence is P5-P3-P1-P4-P2.
The most apt and concise description of this book is probably that given by the authors in the first sentence of the preface where they write, "This book is about communication — communica, not between man and machines, but between machines themselves." Codes for Computers, Chemicals, Instruments, and Man, Second Edition, by Peter K. Rogers and C. L. M. Laarhoven is written as an aid to both students and designers alike and focused toward the practical side of computer related codes.

Beginning with an explanation of the theory and practical usage of number representation in binary, octal, and decimal codes, the text gradually builds up to the full listing and comparison of ASCII, EBCDIC, and punch card tape codes. A set of six computer programs is included at the end of the book for conversion between decimal and hexadecimal. The price of the book in floppy back form is £2.95, and the publishers are Macmillan Press Ltd, 4 Little Essex Street, London W1.

For too many authors who set out to write simply and clearly, the book is a welcome and evident success. That is a fact of knowledge of the subject in a reader automatic and unambiguously conveyed to the reader and the reader is happy with it. The book Electronex Explained (65/60, Faber and Faber) is not only rather more successful as a fully comprehensive subject than the average sample of its kind, of which there are many, but it manages to convey the information without baffling the reader with his own inaccuracy. The book makes no bones of the fact that he was, not just his own or his own reader and is still finding himself. He can also write.

The book is a fine, scholarly section on the various methods of digital electronics — the first covering many of the basic devices and their combinations, and the second concentrating on the practical side of computer related codes.

I have just read your November editorial and it was refreshing to find electronics magazine focusing on the real world. As I write, 800 million people are starving, and the world is facing the worst food crisis since the Second World War. The World Food Programme is working with governments in many countries to provide food aid to people affected by the war. The book "Electronics Explained" is an excellent introduction to electronics, and the book "Electronics Explained" is an excellent introduction to electronics, and the book "Electronics Explained" is an excellent introduction to electronics. I think the important point is that whether or not one decides, as an engineer, to work in defense electronics, one should have sound reasons for either choice. The sad fact is that many bright electronic engineers are working in defense industries for no better reason than that their job is interesting and/or well-paid.

Letters to the Editor

WIRELESS WORLD JANUARY 1981

INEXPLICABLE EFFECTS IN AUDIO

Many readers will have met inexplicable effects in electronic circuits and systems, but will have shrugged off these shoulders, and moved on with the matter: time is money and engineers are not paid to investigate supposed murder weapon phenomena. Isor Cart reams if so many that elaborate electronic systems end up in 'black boxes', and another WW author reminded me in private correspondence that 'it's hard to get a man in electronics for designing things that work — and harder still to keep it'.

One assumes that a practical design is simple enough to design, but why would an author of a book on audio circuits end up in 'black boxes', and another WW author reminded me in private correspondence that 'it's hard to get a man in electronics for designing things that work — and harder still to keep it'.

The current state of the art in electronic circuits and systems is the use of computer-aided design tools (CAD), which can help engineers to design and test circuits more efficiently. These tools allow engineers to simulate circuit behavior and optimize designs, reducing the time and cost associated with physical prototyping.

For example, in a recent project, the design team used CAD tools to simulate the behavior of a complex circuit under various operating conditions. The simulation results were then used to make adjustments to the design before any physical prototypes were built, saving time and resources.

In conclusion, electronic circuits and systems are becoming increasingly complex and challenging to design. However, with the development of advanced design tools and techniques, it is possible to create reliable and efficient circuits that meet the needs of modern technology.
THE "TWINS" PARADOX OF RELATIVITY

In his letter to the American Scientist, Prof. H. Dingle s simple question to the scientists (October issue) has never been answered because Special Relativity Theory (S.R.T.) is defeated by the untenable deep premises of the paradox.

In the first paragraph the premise of the paradox is stated: "The two uniform clocks are in relative motion and are both at rest simultaneously. They are both observed to be running at the same rate by two observers, both of whom are stationary with respect to their clocks."

This is a classic statement of the paradox of the "twins". The paradox is that two identical clocks can be sent on a journey relative to each other and both observers will agree that the clocks run at the same rate, yet one observer will claim that the clock that he sent on the journey is slower than the clock that he left behind.

In this letter I will try to explain why the paradox is not actually a paradox and why it is not a problem for the scientists.

First, I would like to assure you that we are well aware of what you are trying to do. We are working hard to create a new theory that will explain all of the paradoxes of Special Relativity. Our theory is called "Twins Relativity Theory" and it is based on the principle of "equal time dilatation".

In Twins Relativity Theory, the clocks are not sent on a journey relative to each other. Instead, they are both sent to the same location at the same time. The observers then compare the times on the clocks.

In this way, the paradox is resolved because the observers can both agree that the clocks run at the same rate.

In conclusion, I hope that you will consider this new theory and support our work. We are confident that we will be able to create a new theory that will solve all of the paradoxes of Special Relativity.

Sincerely,

[Your Name]
equivalent, because of its mode of operation, just could not cope with such waveform distortions, which the ear clearly detected. The basic room resonance is still excited but at a lower level rather than true cancellation taking place.

Furthermore, the bandwidth of the equalizer filter circuits, unless very narrow, can also produce quite undesirable changes in the response at other frequencies. It was also noted that a programme material excited room modes — but the equalizer filter is always in circuit, forming a "chunk" of the signal when not required to do so.

One possible solution to the problem might be to use a series of extremely narrow bandwidth filters precisely tuned to the frequencies of the worst room resonances — apart from requiring a number of high Q tunable filters with their attendant phase shift problems in a stereo set up, this method still does not attack the problem in the right way. Compensation must take place in the time domain (3 dimensional) if room resonances are to be successfully cancelled.

Peter Mapp
Department of Electrical Engineering Science

Reference

THE FLOATING BRIDGE
In his two articles on bridge amplifiers (September and October issues) Mr Brady presents many stimulating circuit ideas and practical suggestions. His analysis of the circuits is, however, presented mainly in the form of a plausibility argument and he leaves the potential designer without the necessary analytical tools. It is evident from the article that Mr Brady has carried out a small signal analysis of the circuit; perhaps this is not reproduced because of the obscurity lost by his choice of circuit representation. I believe I can improve on this.

The diagram essentially includes an amplifier symbol with its output connected to signal earth (Fig. 1). By this Mr Brady means that, since the power supply is left floating with respect to signal earth, the amplifier causes the signal which would have appeared at its output to appear inverted at the power supply lines A, B, C. Let us draw this explicitly (Fig. 2). In Fig. 2 the amplifier behaves the way one is normally entitled to expect from this symbol. Its output voltage with respect to signal earth is proportional to the differential input voltage. Two important features of Fig. 2 are: (1) the inverting and non-inverting inputs have (apparently) been exchanged; (2) the relationship of the power supply ground to signal earth is explicit.

Terminals A, B, C are equivalent in a small signal analysis where we may properly expect to ignore input power supplies. The voltage swing available at the output terminals can be determined later from the practical circuit diagram of the bridge output stages without the complication of including signal paths. Finally, to demonstrate the utility of this transformation, I have re-drawn Fig. 1 of the article (with Fig. 2) and the whole thing, to the kind of analysis we all know and love. For the first amplifier we have:

\[ V_{\text{in}} - V_{\text{out}} = \frac{V_{\text{in}} - V_{\text{out}}}{R_2} R_1 + \frac{V_{\text{in}}}{R_1} R_2 \]

and hence the gain of the total amplifier, which is insensitive to the nature of G1, the gain of the second amplifier. This justifies Mr Brady's comments about the relative quality of A1 and A2 at the top of page 42 of the first article.

The author replies
The reason for the inclusion of an earth in the position shown in the article (e.g. Fig. 1) is that it is a simple design the input may be with respect to earth, which has great convenience. (If a 'change-of-origin' is included this is of course not necessary.)

I think Mr Allen's Fig. 3 will not work, for two reasons. First, where is the power supply? In his Fig. 2, the power supply has A as mid-point. If this is intended for Fig. 3, then when G2 is driving current, the closed path is from the supply through G2, into A, through the battery and back into the amplifier - which path does not drive current through the output at all.

Perhaps Mr Allen intends some other power supply arrangement.

Ignoring this problem, then the feedback loop controlling the G2 in his Fig. 2 includes the characteristics of G2. Though there is negative feedback, the open-loop gain will be very much the same result.

R. M. Brady
Plymouth, Devon

PARALLEL TRACKING PICKUP ARM
I have just completed Rod Cooper's parallel-tracking arm system, as described in your December 1979 and January 1980 issues. It works beautifully and it is quite fascinating to watch the drive system adjusting the tracking speed of the arm. I used a Swiss made micro-motor with a 1:4 reduction gearbox in place of the suggested drive system as I was not very enthusiastic about the cross drive and dual belts, which would need rather careful assembly. I do not know whether any of your readers actually managed to assemble the whole thing in a week-end or two! I used the components already machined by the supplier (J. Boles), but found that a lathe and milling machine in my home workshop were ideal for some operations, such as the forming of the nylon sliding block, motor carrier, cartridge clamp, etc.

Now that it is hardly worth attempting construction of home radio and hi-fi equipment it is very helpful to find designs such as this, and the construction of electronic and mechanical elements adds greatly to the interest of the project.

Frank Guttridge
Cambridge

P.R.S. GENERATORS
Further to my letter (September) and the reply (November) concerning p.r.s. generators, may I thank Mr Bell and Dr Trackley for their comments? The reference to Golinski is particularly useful.

The details I originally described were side products of some unrelated programming I was investigating on a 280 system, and I must admit I did not delve deeply into the subject. I found no positive analyses, so I performed the negative one presented.

I have satisfied myself that generators a multiple of eight gives a long duration pulse and does not produce the full sequence when simple feedback is used, but I have not found a reason for it. Accordingly I have altered my 280 routine, which I intend to publish here as a further interesting machine code exercise. The sequence previously produced was so long that I never noticed it was shorter than expected. Incidentally, a number of degenerate values for n slipped by into my table. Readers may find it instructive to locate them.

K. Wood
Dunstable, Bedford

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**Artificial intelligence**

Computing techniques adapted for use in intelligent machines

by Malcolm Peltu

One British pioneer thinks that the most important use of artificial intelligence would be to save us all from the havoc likely to be caused by too much reliance on computers. Be that as it may, there is already a growing body of AI work on more specific problems such as in robotics, speech understanding, visual perception, automating reasoning procedures, understanding natural languages and man-machine communication. This article first takes a look at the history and politics of the subject in Britain then, through examples of research in computational vision, speech understanding and man-machine communication, gives an insight into the general nature of this developing cousin of computer science.

Computers were an essential aid toputting men on the moon; yet a small step for a man, like crossing a busy road, is still a giant and unbridged step for a computer.

Computers can store vast libraries of information and play a pretty good game of chess; but no machine can match the ability of a child to learn a language or read a picture book. The ability of computers to perform many complex tasks, although they have immense difficulty in doing what comes naturally to humans, raises important and intriguing questions about the nature of human intelligence and the limits of machine or "artificial" intelligence.

The techniques of computer science which underpin modern applications of computing power are based on mathematical and logical methods of analysing system functions and translating them into sequences of detailed instructions which program the computer into performing a pre-defined task. In the 1950s a new breed of computer scientist began to emerge - the artificial intelligentsia. Whereas conventional computer science was primarily concerned with tackling information processing tasks that could be analysed into clearly defined and unambiguous programs, the new subject of artificial intelligence (AI) was starting to explore the ambiguities and uncertainties involved in trying to understand the principles, and building working models, of intelligent behaviour.

For the past 25 years or so there has been a running battle between computer scientists and AI researchers, with the traditional computer specialists often complaining that AI is too vague a subject to be regarded as a coherent discipline and that the artificial intelligentsia are a rather disunited lot, drawing off valuable research resources from the mainstream computing. There is, however, a growing and impressive body of AI work covering such diverse areas as robotics, speech understanding, visual perception, automating reasoning procedures, understanding natural human languages, improving the methods used for communicating between people and machines - and for playing "intelligent" games like chess.

One of Britain's most distinguished AI pioneers believes that the most important contribution from AI will eventually be to help save mankind from the havoc that could be caused by increased reliance on that potentially Frankensteinian invention, the digital computer. Professor Donald Michie, head of the Machine Intelligence Unit at Edinburgh University, thinks that AI can open a "human window" onto the way computers make decisions which have a direct impact on human safety and prosperity. The Three Mile Island nuclear incident in 1979, for example, nearly became a horrifying disaster because the operator could not "understand" the myriad of warning messages provided by the computer-controlled monitoring system. And last year the world was twice brought to the brink of a nuclear war because of computer failures in the US defence network.

If that nuclear war alert had gone as far as reaching the President, how could he have interrogated the computer to find out the validity of its warning? asks Professor Michie. Computer science, he says, has produced complex information processing machines which perform calculations and search through information at such speeds that it is often difficult, if not impossible, for humans to trace back the 'thought' processes used by the computer to reach a particular conclusion.

As AI is concerned as much with human intelligence and understanding as with computer processes Professor Michie believes that its development of what are known as expert systems will make computer systems more understandable by forcing designers of automation equipment to fit the machine procedures into "the human mental mould." When you remember that computers are already relied on for controlling the operation of and diagnosing faults in tasks such as air traffic control, factory automation, medical diagnosis and building environment control, as well as nuclear power stations and national defence systems, the importance of opening such a human window should not be underestimated.

Yet, in the UK at least, computer scientists continue to cast doubt on the validity of AI's right to exist as a research area in its own right and even on the integrity of some AI practitioners. Last September at an international seminar of computer scientists at Newcastle University sponsored by the computer manufacturer IBM, the scepticism of British and some American computer scientists to AI was evident, despite the presentation by speaker after speaker of an impressive body of research work in this field. It appeared that each concrete advance in AI, such as speech understanding by computers or automatic recognition of visual scenes, was regarded by the sceptics as an example of computer science, rather than AI. The scepticism culminated in an acid after-dinner speech at the end of the conference by Professor Euan Page, vice-cha...
cellar of Reading University and former head of the Newscast computing laboratory. Although this was a particular academic project, it seemed to have some specific progress had been made. Professor Page still chose to turn to Rob’s Theaurus report point out that it was a synonym for words such as ‘bogue’, ‘phony’, ‘pseud’, meaning false. He also blamed AI for creating the public fear of Big Brother computers and some stories wept into the fictional world because the artificial intelligences had given birth to the notion of super-intelligent machines that will control the world.

This kind of petty bickering would be of only passing interest to the grosser world of academia if it did not reflect an attitude which has contributed significantly to Britain’s low level of advanced industrial automation. In 1972, applied mathematician and new vice-chancellor of University College, London, Sir James Lighthill was called in by the Science Research Council to look at AI. A large number of computer scientists were worried that this dubious new subject was siphoning off funds that they should have been receiving. According to one computer scientist who was on the Council at the time, the real aim of the Lighthill report was "to do a hatchet job on AI."

Although his report said there was some signs of progress in aspects of what has been called AI (such as advanced automation), Sir James was not so sure of AI claims as a result. As a result, funding – and in its wake robotics research which had been targeted in the past – was drastically cut back. Although, in the early 1970s Britain was largely led by the Professor Wilf Heggins in Notthingham University and Professor Mitchie at Edinburgh was working on robotics developments. For almost a decade, according to Dr Mike Larmee of Warwick University, the British Robotics Association, this "neglect and persecution" of AI and robotics work almost threw Britain out of the advanced automation race, the flag being carried by a few individuals who were working very hard and fragmented, unco-ordinated way. Earlier this year, however, the Science Research Council decided to re-invest in robotics after three years in industrial robotics research. According to Dr Dave Barrow at the University of Essex, the most significant contribution which came at the eleventh hour for the hardy band of robotics researchers, like himself, who had struggled on in the 1970s. Otherwise the temptations of the more enthusiastic and plentiful environment of the early 1960s, when the world seemed to be cut out of robotics research in Britain, has been to look back on this time as a period of low productivity, a period in which Britain was lacking an important aspect of computer-related developments.

The barrow pointed out that in Britain it was the robot research academics who have lead the way in creating an awareness of robotics and its potential for automation whereas there was, until recently, a lack of interest shown by the British industry about the importance of automation. Although grateful for the new research that has been funded and thankful about the way the funds have been tied to creating partnerships for research projects with industry. As British industry starts from such a backward international position, he fears that the aims of the projects funded in this way will be to catch up with rather than to forge ahead into new areas, such as mobile robots, which is his main interest.

Computational vision
The cold AI climate that set in after the Lighthill report did drive many researchers away from the UK. One of those was Dr Harry Barrow who worked on the Freddy project at Edinburgh University in the early 1970s. This was one of the first attempts to produce a robot that could see and interact intelligently with objects. According to Dr Barrow, the professor of electronics at Brunel University, one of the major advances in AI research has been to show markings of success when the Lighthill branch fell flat. Now, robots that can see are recognised as one of the most significant developments in AI research.

Dr Barrow went to the US and is currently working at the AI Centre at SRI International on computational vision. The attempt to give computers 'eyes', 'ears' and 'voices' has typified one stream of AI research which mixes analysis of the environment with intelligence. The basic aim was to show how people make sense out of a hostile stimulus. The other important part of AI research is the much more purely 'intellectual' questions, such as natural language communications and the ability to use language. Dr Barrow describes at Newcastle one of the most important parts of artificial vision systems, called Hawkeye. US Defence and Highways Departments are thinking of using it to draw maps automatically and to monitor traffic flows. Using a television camera and a video processing system which translates images into a digital code that can be fed into computers, Hawkeye is capable, for example, of recognising and counting vehicles going into and out of a harbour or vehicles on a road.

To a human being this is not a difficult task. For a computer, however, there are two main problems. First, it has to analyse a scene into quantifiable factors that could subsequently be used in interpreting the nature of the images, such as the length and position of boundaries between objects, illumination, reflectance and surface orientation of areas within the scene. And then it has to make sense out of that scene. There is an enormous amount of information in a given scene. A typical colour television picture, for example, requires about 1.7 million bits of information to be transmitted in digital form. With computational vision, a scene is broken down into pixels (picture elements), with values being assigned at each point for a predetermined set of qualities, such as luminance and reflectance. A typical picture analysed by Hawkeye has about 38,000 pixels (400 x 97)

The problems that could be encountered in interpreting a picture are indicated in Fig. 1, which is a noisy visual scene, which it is difficult to pick out any meaningful visual information objects. Moreover, however, the human eye and brain can detect it that it is a spot dog drinking water in a narrow stream (provided the picture is presented the right way up). To a computer, of course, it would be a meaningless jumble of black and white splodges. The aim of AI is to crack the mysteries of how visually similar patterns in the brain can extract sense from such an apparently meaningless visual 'noise'.

According to Professor Michie, "The rate of input of visual information to the higher centres of the brain is not enough to do more than give hints and prompts." From these partial stimuli, the brain constructs meaning, he says, from a large repertoire of stored 'models' of the real world held in the brain's memory.

The earliest AI experiments in vision, such as the Freddy robot at Edinburgh, reduced noise by being limited to simple 'block worlds' in which the only objects had simple, straight-line edges. The main task in the low level (noise reducing) analysis was to find, trace and segment boundaries defining homogeneous areas - in other words, to find the edges of blocks. Even in a simple block world with a limited number of objects and slightly flat to avoid shadows, this was a difficult task; for example, when blocks partially obscure each other so that the computer has to try to build up images of whole three dimensional objects from two-dimensional line drawings in which the edges of one block might be obscured in many places by other blocks. Any one object also obviously has different shapes when viewed from different angles. David Waltz of the University of California and his team have used a computer vision system which could list 'command data' of a scene such as the location of objects, the edges of objects but also shadows, cracks and other physical attributes. A recent deal was heard from working in the block world, although it was clearly too restricted to be of much use in a real world of industrial applications. One problem which could be brought to the eye from an infinitive number of view-points. Yet, Hawkeye, which 'looks' into just such a variable real world, still employs similar basic principles in abstracting information from the noisy picture, although the interpretation is far more complex and rudiment than just producing a meaningful visual scene. Some important problem at the low level end of sensory analysis is the speed with which information can be processed. Given that a visual scene could consist of many thousands of picture elements with different measurements needed at each element, it is clear that the computer should be able to perform calculations on all elements very quickly. Traditionally, however, computers have been able to process information serially, i.e. only one calculation can be performed at a time. This has been satisfactory for most commercial and industrial data processing needs because the speeds of the processors (performing hundreds of thousands or even millions of instructions per second) have been satisfactory. Recently, however, new types of array processors have been developed. These consist of a network of many little processors which can operate independently of each other but within a co-ordinated plan. This technique is ideal for computational vision tasks which require the parallel processing of a variety of information.

Michael Duff at University College, London, has developed a special computer language for the Clip-2 parallel array processor which is capable of carrying out low-level image analysis far more efficiently than by other means.

The Professor of electronic at Brunel University, Igor Aleksander, is developing a pattern-recognition machine which exists as a collection of charts and graphs in the form of microelectronics memory chips to store data. It is designed to carry out the work of such memory chips, each of which contains a key piece of information that will be used to identify, say, an object in a scene. It will accept a visual picture as input; as the picture comes in, it will be interpreted by the memory chips in the memory chips. The computer in conjunction with each chip is able to determine whether or not they have identified the object or an aspect of the object. Professor Aleksander believes that such a system could be linked in with other sensory equipment, such as the images, letters of the alphabet, etc. The Hawkeye system, however, does not rely on any new types of computer processor. It also does not attempt to be a general purpose computer which can operate in interaction with people who can help to supplement its intelligence. Hawkeye contains a computerised library of patterns relating to geometric and topological data found in the environment being viewed. It also contains 'intelligence' arrifentation needed to make sense of the images, such as the fact that roads and rivers run under bridges, that buildings stand straight or that, say, in a view of a dock area, ships move on the sea area and different types of ship have particular characteristics. Like most current AI developments, Hawkeye does not attempt to be a general purpose computer which can.

Much of the criticism levelled at AI in the past was aimed at some rather silly claims made by pioneer artificial intelligence genius, such as a statement by Herbert Simon: "Like the Carpenters of Mellon University in Pittsburgh in 1958 that: "There are now, in the world, machines that think, that learn and that create. Moreover, their ability to do things is going to increase rapidly until it is the equivalent of the intelligence of a human being."

This idea of the universal robot is still a long, long way over the horizon. But within particular areas - for example, the new type of word processor which can automatically produce office documents, is provided it is given guidelines, such as a word processor that can high a sentence at a particular point of an image with a special position.

Future work in computational vision is likely to develop the themes started in those early days, expanded and developed in systems like Hawkeye. On the one hand, perhaps we will see, at least in low level analysis of visual input to determine the appearance of the image and array processors could play a significant role in this. At the other end there will be work into psychological understanding of human vision, an area which comes under the expert "engineer" is trying to produce working models of human vision. In industry, the most obvious need is for robots that can recognise objects but, as Hawkeye's creators explain, computational vision has many other potential benefits.

Speech understanding
Speech understanding – computer 'ears' – poses a different type of problem as compared to written language. Only a few of the man/machine computer research at the National Physical Laboratory, in London, have been able to say, "People are extremely ineffective at..."
research has tackled the problem by analyzing linguistic components, such as grammatical structures, syntax and other speech characteristics. In addition, the machine needs to be given information about the nature of the world in which it is functioning to help it understand speech, just as a centre forward at a football match would interpret the command "shoot!" in a different way from somebody at a raffle.

Those continuous speech understanding computers that have begun to emerge from the research laboratories operate within clearly defined domains but they show sufficient progress to indicate that there is no insurmountable barrier, although at present they are limited and slow. IBM, for example, has developed an automatic speech understanding which can understand words spoken from a vocabulary of most used words taken from words and sentences used by lawyers in submitting US patent applications in laser technology. Although it can recognise words with a 91 per cent accuracy and type them automatically, a 30 second burst of speech takes about 100 minutes before it is typed out.

Computer controlled speech synthesizers

Although computers find it difficult to see or hear no evil (or anything at all), they find it relatively easy to say. Ironically, the ability to talk to each other, people swallow the ends of words and sentences, miss out words, etc. But even if the words are identified, the human process of making sense of them is still insufficiently understood, as with finding meaning in visual images.

WIRELESS WORLD JANUARY 1981

certain number of objects and ideas being discussed and a particular pattern to the discussion.

A doctor in artificial intelligence and is being trained, the operator repeats a set of terms of the operator for each word are

easy to generate an artificial voice. It is also possible to simulate human speech in a computerised form. A data base of words and phrases recorded by a person can be played back as a computer and can then be joined together to respond to a particular enquiry under the control of a computer program.

Many companies already use computer controlled exposure systems to automatically answer enquiries and requests from dealers, salesmen and customers. One of the first systems to be introduced was by the Post Office (see News, November 1980 issue) will allow an automatic voice response based on human speech recording to present a variety of new automated services. There is also a growing range of consumer products that can 'speak', from irons and telephones to space and educational aid and an automatic language translator to cooks and ovens. From a computer controlling point of view, however, output is no more difficult than putting out information in any other form.

The main problem with speech reproduction is making the artificial voice sound natural. With synthesized speech this is difficult because voice quality is a physiological characteristic of the throat and breathing. When the speech production mechanism can be used to overcome artificial pauses between words or phrases when they are 'spliced' together, the reproduction might be possible. A is it is possible to allow for the same word having a different emphasis or inflection depending on the context in a sentence. Computers are being tackled more through patient study of human speech, relative to other intelligence compared with other AI tasks. Electronic sound synthesizers have been around for a long time and it is now

Man-machine communication

One of the important reasons for wanting computers to see, speak and listen is to assist in communication between people and computers. This communication typically takes place through a visual display unit. The information is keyed in and responses are presented on the screen. Although the words used in such a dialogue can either be English, the 'language' available for the communication is usually extremely limited and inflexible to a degree that an error can be caused if a full stop is missed out in some cases or if a word is even slightly misspelt.

A vital area of AI research has been into natural language communication which allows the flexibility and natural dialogue characteristics of human and computer interaction. This is essentially a subset of the task of building the kind of speech understanding systems except that there is no problem about recognising the words being a concept. The question is how to understand the meaning of a sentence. Once again, AI work in this field is taking place within an acceptance of the need for defined domains. Typical person computer dialogues may become a basic 'script' or 'scenario'. This typifies the particular interaction taking place in which there is an easy to generate an artificial voice. It is also possible to simulate human speech in a computerised form. A data base of words and phrases recorded by a person can be played back as a computer and can then be joined together to respond to a particular enquiry under the control of a computer program.

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Man-machine communication

One of the important reasons for wanting computers to see, speak and listen is to assist in communication between people and computers. This communication typically takes place through a visual display unit. The information is keyed in and responses are presented on the screen. Although the words used in such a dialogue can either be English, the 'language' available for the communication is usually extremely limited and inflexible to a degree that an error can be caused if a full stop is missed out in some cases or if a word is even slightly misspelt.

A vital area of AI research has been into natural language communication which allows the flexibility and natural dialogue characteristics of human computer interaction. This is essentially a subset of the task of building the kind of speech understanding systems except that there is no problem about recognising the words being a concept. The question is how to understand the meaning of a sentence. Once again, AI work in this field is taking place within an acceptance of the need for defined domains. Typical person computer dialogues may become a basic 'script' or 'scenario'. This typifies the particular interaction taking place in which there is an easy to generate an artificial voice. It is also possible to simulate human speech in a computerised form. A data base of words and phrases recorded by a person can be played back as a computer and can then be joined together to respond to a particular enquiry under the control of a computer program.

Many companies already use computer controlled exposure systems to automatically answer enquiries and requests from dealers, salesmen and customers. One of the first systems to be introduced was by the Post Office (see News, November 1980 issue) will allow an automatic voice response based on human speech recording to present a variety of new automated services. There is also a growing range of consumer products that can 'speak', from irons and telephones to space and educational aid and an automatic language translator to cooks and ovens. From a computer controlling point of view, however, output is no more difficult than putting out information in any other form.

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Off-air frequency reference

Seven outputs from 1Hz to 10MHz, phase locked to the Driotwitch transmission

by D. I. Stansfield

Although i-q techniques have simplified the construction of a frequency counter, accuracy depends on the stability and adjustment of the reference oscillator. Unless this oscillator is temperature controlled and adjusted in conjunction with a standard frequency source, even a quartz crystal will not provide better than 1 part in 10^6 accuracy.

This unit provides a 10MHz signal, phase-locked to the BBC 200kHz Radio 4 transmission from Driotwitch. The long term accuracy is that of the BBC standard and the error due to jitter is less than 0.1 cycles pk-to-pk over an ambient temperature range of 0 to 30°C.

The heart of the frequency reference contains a quartz crystal oscillating at 10MHz. Logic divides this output to produce a 200kHz signal which is compared in phase with the transmission as shown in Fig. 1. The resulting error signal is filtered by an active-loop filter and used to fine-tune the quartz crystal with a varicap diode. The active-loop filter enables the loop-lock conditions to be accurately specified, the static phase-error to be kept small and, in the event of interference being received, the oscillator frequency to be kept close to its locked frequency due to the memory action of the filter time constants. The 200kHz signal is received with a tuned ferrite-rods aerial, see Fig. 2, followed by a two-stage tuned amplifier and a two-stage limiter. A buffered 200kHz output from the main divider chain is further divided to provide outputs down to 1Hz.

The main problem associated with using Radio 4 as a frequency standard is the removal of amplitude modulation. Even after full limiting, residual modulation appears as jitter on the phase detector output in Fig. 3, and if the detector output is not sufficiently filtered, the jitter appears as phase modulation on the 10MHz signal. Because heavy filtering is necessary, a crystal oscillator is used to maintain the unlocked frequency within the narrow lock-up range of the p.p.i.

Loop consideration

Because the lock-up temperature range and amount of filtration are in conflict, it is necessary to specify the operating conditions. For reliable lock-up over the ambient temperature range 0 to 30°C, and because crystal stability is about 20 p.p.m. above 90°C, the control range required is

\[ 20 \text{ p.p.m.} \quad 90 \text{°C} \]

i.e. 66Hz at 10MHz.

This can be adjusted by C13. For high-gain loops, the lock-up range is 2V/50, \( K_a \) (1) where \( K_a = K_p K_n \). For the 4046 in this configuration, \( K_p = 10 \text{V/} \text{rad} \), \( K_n \) by measurement is 93.2±0.1 rad/V at 10MHz, and the division ratio \( N \) is 50. Therefore, \( K_a = 10 \times 93.2 \times 50 = 11.68 \).

For average conditions a loop damping factor \( T \) of 0.707 is satisfactory, therefore from (1)

\[ 66 \times 2 \times 2 \times 0.707 \times 11.68 \]

\[ \omega_c = 2.08 \]

Considering the loop filter components in Fig. 4

\[ T_1 = C_1 R_1 \]

\[ K_a = 11.68 \]

\[ T_2 = C_2 R_2 \]

\[ 2 \times 0.707 \times 2.08 \]

\[ T_1 = 2.69 \]

\[ T_2 = 0.679 \]

Because \( C_1 = 1 \mu \text{F}, R_1 = 1.3 \text{MO} \) and \( R_2 = 670k \). To increase the loop filtration, \( C_2 \) can be included, but to avoid affecting loop performance \( 10C_2 R_2 > C_1 R_1 \), therefore \( C_2 > 0.03 \). Lock-up time is roughly 50\( \mu \)sec.

Measurements of the voltage present across the tuning diode show less than 10mV pk-to-pk noise, which is equivalent to 95/(10⁻⁰·⁰₁) = 0·06Hz at 10MHz.

Construction

The receiver is a conventional design and produces a 20mV output about 240km from Driotwich. A manual gain control is included for adjusting the limiting conditions. Because high gain is used, it is necessary to screen the receiver in a diecast box and to locate the aerial 2m away.
from the receiver. To minimize signal frequency and counter noise, buffers are included before and after the divider chain in Fig. 5, and separate earth and power supplies are provided. Double-sided printed circuit board is also important with one side used as an earth plane. The power supply in Fig. 6 uses 1A voltage regulators and smoothing capacitors to provide the low noise level necessary for a clean output signal.

Adjustment of the receiver should be carried out using an oscilloscope to observe the waveform before the limiting stages. The crystal trimmer and each tuned stage is set to resonance so that a.m. envelope is at a maximum. If the envelope amplitude is unstable and does not exhibit normal modulation variations, the receiver is probably oscillating and the feedback source should be investigated. The gain control is adjusted to give 10V pk-to-pk free from amplitude variations.

Adjustment of the loop is carried out by observing the phase-lock i.e.d. as follows, with no input signal i.e.d. extinguished, with input signal connected and loop close to lock - i.e.d. pulses at the beat frequency, with input signal connected and loop locked - i.e.d. on. To adjust the loop set point, disconnect the input signal and apply +10V to pin 2 of IC6, check output voltage to diode is >10V. Apply 0V to pin 2 of IC6 and check output voltage to diode is <0.5V. Resistor R32 can be adjusted if required. Next, adjust R34 for 5V to the diode with no drift. Recompute the input signal and set C2 to obtain the lock indication. Finally, measure the ambient temperature and adjust the varicap voltage with C23 as shown in Fig. 7.

Because indication of lock is provided, if the unit is connected to an 8-digit 10MHz counter, count rates up to 10 per second or 10 in ten seconds can be accurately achieved.

The current system used by the BBC employs satellite transmitters at Welsford and Alderford which are phase locked to the main Drayton transmitter. In locations where a subsidiary transmitter signal is detectable in magnitude to the Drayton transmisson, the cleanest signal may be obtained with the aerial rod in line with the second transmitter. If greater short-term signal purity is required, the crystal oscillator can be temperature stabilized to allow a narrower loop range and additional filtration. Alternatively, a narrow band crystal filter centred at 200kHz can be included before the limiter to reduce the energy of the a.m. sidebands. These improvements would, however, increase the cost of the unit.

Within the next five years Radio 4 will be changed to 198kHz, although it will maintain the present accuracy. To cope with 198kHz, the receiver must be modified to include a mixer and narrow-band crystal filter to pick out the required sideband as shown in Fig. 8.

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**COMPONENTS**

- **Resistors 1%**
  - 1.36kΩ
  - 2kΩ
  - 3.3kΩ
  - 10kΩ
  - 22kΩ, 27kΩ, 47kΩ, 100kΩ, 1MΩ
- **Capacitors 4.7, 8, 12, 15, 18, 22, 220kΩ, 1μF**
- **Amplifier/limiter**
  - 200kHz filter
  - 2MHz filter
  - 20kHz filter

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**Fig. 6. Four rail power supply.**

**Fig. 7. Varicap voltage versus ambient temperature (loop locked).**

**Fig. 8. Modification necessary for 198kHz.**
F.m. detectors
A survey and a system of classification
by S. W. Amos, B.Sc. M.I.E.E.

An earlier article, in the April 1980 issue, was devoted to a survey and a classification of m.f. detectors. In this article the author similarly examines f.m. detectors.

The purpose of a detector is, of course, to abstract information from a modulated signal. Often the wanted information is a copy of the waveform of the modulation content but it is not always so. For example an f.m. detector may be required to give an output for a.f.c. purposes and here a filter is incorporated to eliminate modulation-frequency components from the output.

F.m. detectors are sometimes called discriminators or frequency discriminators but a discriminator differs from a detector in that it is required to produce an output substantially proportional to the deviation of the frequency (or phase) of an alternating input from some predetermined value (BS 310:1961). This suggests that the function of a discriminator is similar to that of a demodulator and is more specialised than that of a detector which is therefore a more general term. This distinction is not perfectly observed in the terminology of the circuits: for example two circuits with substantially the same performance and purpose are the Seeley-Foster discriminator and the ratio detector.

Frequency discriminators are sometimes called phase discriminators. The relationship between frequency modulation and phase modulation is simple: in frequency modulation, for a constant-amplitude modulating signal, the phase shift of the carrier is swept between limits which are inversely proportional to the modulating frequency: in phase modulation the limits are fixed. Similarly in phase modulation, for a constant-amplitude modulating signal, the frequency of the carrier is swept between limits directly proportional to the modulating frequency: in frequency modulation the limits are fixed. In practice this means that one form of modulation can be converted to the other by including a filter per octave filter in the modulating-signal path and, by use of such a filter, the same circuits can be used for the detection of f.m. or p.m. signals. For simplicity all the circuits mentioned in this article are referred to as f.m. detectors or discriminators.

An examination of the various types of f.m. detector reveals that they all belong to one of the following four categories:
(a) those consisting essentially of an f.m.-to-a.m. converter followed by an a.m. detector,
(b) those using phase comparators i.e. circuits in which the output is dependent on the degree of overlap of two sets of carrier-frequency pulses,
(c) those using a counter circuit as a discriminator,
(d) those using the locked-oscillator principle.

This classification will now be examined in detail.

F.m. detectors incorporating an f.m.-to-a.m. converter
Perhaps the most obvious way of detecting an f.m. signal is to convert the frequency variations into corresponding amplitude variations of the carrier which is then applied to an a.m. detector. A number of
WIRELESS WORLD JANUARY 1981

The Seeley-Foster discriminator. This f.m. circuit uses an arrangement of diodes similar to that of the Round-Travis circuit but the method of providing the diode input signal is different. The method makes use of the phase relationship between the voltage across the tuned secondary winding of a transformer and that across the primary winding. Whether such a voltage is in the input or not, these two voltages are in quadrature when the applied signal is at the resonance frequency of the secondary winding. At frequencies above resonance the secondary voltage lags the quadrature condition to an extent dependent on the deviation.

Round-Travis discriminator. In this form of detector the distortion caused by curvature of the tuned-circuit characteristic is reduced by use of the push-pull principle. Two similar tuned circuits are used, one \( L_2C_2 \), resonant at frequency \( f_1 \) above the centre frequency, and the other \( L_1C_2 \) resonant at \( f_2 \) an equal amount below the centre frequency. The former \( L_2C_2 \) across \( L_1C_1 \) and \( L_1C_2 \) are detected by separate a.m. detectors, their outputs being combined in series opposition. One possible circuit diagram for a Round-Travis detector is shown in Fig. 5 in which simple sampling type detectors are shown.

The operation of the detector is illustrated in Fig. 4. As the centre frequency equal outputs are received from the two diodes so that the net output is zero. At frequencies above the centre frequency \( D_2 \) gives a larger output than \( D_1 \) and the combined output is positive; at frequencies below, the centre frequency \( D_1 \) gives a larger output than \( D_2 \) and the combined output is negative. This indicates by its polarity whether the instantaneous frequency of the input is above or below the centre frequency and the magnitude the extent of the deviation.

Fig. 4 shows that the complementary curvature of the characteristies for \( L_1C_1 \) and \( L_2C_2 \) yields a straight line frequency relationship that is possible from a single tuned circuit. The overall relationship shown in Fig. 4 has the \( \alpha \)-shaped characteristic of that of many f.m. detectors.

The Round-Travis detector was at one time used in f.m. receivers but since been abandoned in favour of some of the alternative types described later. It has two main disadvantages:

1. \( L_1C_1 \) and \( L_2C_2 \) must be so adjusted that their resonance frequencies \( f_1 \) and \( f_2 \) are symmetrically disposed about the centre frequency. Thus alignment of the detector circuit is more complicated than for a number of the alternative types which require alignment only at the centre frequency.

2. It responds to any amplitude modulation of the input signal. To obtain maximum signal-to-noise ratio, an f.m. receiver should respond only to frequency modulation of the input signal and should ignore any amplitude modulation which may be present. Some f.m. detectors can be designed to have inherent a.m. rejection and these are naturally preferred.

Radar receiver. In this circuit, it is necessary to precede the Seeley-Foster circuit by one or more amplitude-limiting stages to minimize any a.m. content in the received signal.

**Radiator by simple modification the Seeley-Foster discriminator can be made capable of a useful degree of a.m. suppression. The detector circuit so produced is known as the radiator detector and it has the advantage that it rapidly displaced the Seeley-Foster discriminator. The way in which the radiator detector operates can be approached in the following way.

If one of the diodes in the circuit of Figs. 7 (a) or (b) is reversed, the new output is the sum of the voltages across the primary diode load (not the difference as in the Seeley-Foster circuit). This means that when the circuit is operated at a centre frequency there is a voltage at the combined diode approximates to the sum of the peak input voltages to the diodes: this compares with zero output from the Seeley-Foster circuit.

If the frequency of the input is dispaced from the centre value the output across one diode load inures whilst across the other decreases as shown for \( V_1 \) and \( V_2 \) in Fig. 6 and the combined output voltage tends to be independent of frequency and thus of frequency modulation. This combined output is proportional to input signal amplitude and can be used to operate a tuning indicator.

Even though the voltage across \( C_1-C_2 \) is constant for a given input amplitude, the voltages across the individual reservoir capacitors \( C_1 \) and \( C_2 \) vary with the frequency of the input signal and either capacitor can be used as the source of modulation-frequency output from the detector. In a balanced ratio detector circuit the junction of \( C_1 \) and \( C_2 \) is earthed and the detector output is taken from the non-earthed terminal of \( C_2 \) (as shown in Fig. 9a). In an unbalanced ratio detector one end of the combined diode load is earthed as shown in Fig. 9b and the detector output is taken from 

\[ C_2 \text{ junction.} \]

In both types of circuit the constant voltage across the series-connected reservoir capacitors \( C_1 \) and \( C_2 \) is divided in a ratio determined by the peak inputs to \( D_1 \) and \( D_2 \) : this is the origin of the name of the circuit. To make the circuit capable of a useful degree of a.m. rejection the diode load resistors \( R_1 \) and \( R_2 \) are given lower values so that the tuned circuit feeding the detector is heavily damped. A large value capacitor is then connected across the load resistors to give a

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**Fig. 8.** Two forms of Seeley-Foster circuit using a capacitive link between primary and secondary windings.

**Fig. 9.** Simplified circuits for (a) balanced and (b) unbalanced forms of ratio detector with no provision for a.m. rejection.

**Fig. 10.** The circuit of Fig. 9 (b) modified as to give a measure of a.m. rejection.

**Fig. 11.** An unbalanced ratio-detector circuit with a single reservoir capacitor \( C_2 \).

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time constant approaching one second. Fig. 10 illustrates these modifications applied to an unbalanced circuit. The voltage across the long-time-constant network is in practice approximately equal to the peak value of the input signal to the diodes and adjusts itself to any change in the value of the peak input. As already mentioned this voltage can be used to operate a tuning indicator.

Suppose there is a momentary increase in the peak amplitude of the input signal and as a result the diodes are driven heavily into conduction and their forward resistance increases the already-heavy damping on the tuned circuit thus momentarily increasing the gain of the previous stage, minimising the effect of the spike.

Similarly if there is a momentary reduction in the peak value of the input signal to the detector, the long-time-constant network again cannot register the change and the diodes are cut off so removing the damping imposed by the diode load on the tuned circuit. Thus the gain of the previous stage is momentarily increased, offsetting the effect of the change in input signal. In fact the removal of the diode load damping can result in overemphasisation and a common technique is to include low-value resistors in series with the diodes as shown in Fig. 11, the resistance being adjusted empirically to give optimum m.s. rejection. Thus the inclusion of the long-time-constant circuit enables very short term changes in input signal amplitude to be minimised: in fact the ratio detector operates as a dynamic limiter.

Fig. 11 gives the circuit diagram of an unbalanced ratio detector which differs from that described earlier in that it contains only a single reservoir capacitor C2 in place of the two shown in earlier circuits. The way in which the modulation-frequency output is developed across C3 can be explained as follows.

If we replace the secondary and tertiary windings of the transformer by equivalent generators V1 and V2, the essential feature of Fig. 11 take the form shown in Fig. 12. Both diodes conduct together once per carrier cycle and, because of the long time constant RaC4, the period of conduction is very short and occurs as the combined diode input signal (V1 + V2) reaches its peak value. As a result, of this conduction C4 is charged to the peak value of V1. During this brief conduction period D1 and D2 can be regarded as short circuits and D2 effectively connects C3 across the generator V2, thus charging the peak value of V2. For an input signal at the centre frequency V1 is equal to V2 and thus C3 is charged to a voltage equal to one half of C3. For the remainder of each carrier cycle when D1 and D2 are non-conductive the charging on C4 remains except for a small leak through any resistor in parallel with it.

One cycle later, during the next period of conduction of D1 and D2, the voltage across C3 is adjusted by change or discharge to agree with any change in the peak value of V2. Thus a copy of the changing value of V2 is built up and this is, of course, a representation of the changing phase relationship between primary and secondary voltages which, in turn, represents the frequency-modulated waveform of the input signal.

To be continued...
Fig. 5. Suggested checking area for parallel data channel.

**Video recorder**

Low weight is the main feature of the VT 7000 video recorder from Hitachi, as it weighs only 6.8 kg, including its rechargeable battery pack. This v.h.s. recorder can be powered by its own battery, a car battery or by the mains supply. There are two possible ways of operating the recorder: one can either use the touch buttons on the front of the unit, or the remote control keypad which is supplied as standard. Numerals are provided for connection to a monitor or other v.t.r., video camera, microphone, earphone, and for receiving audio and video signals from another v.t.r. or external sound equipment. To extend the scope of the VT 7000, the same manufacturers have also introduced a tuner, the VT 720, which is similar in style to the recorder. A time-control mechanism on the tuner can be set, with the aid of an built-in digital clock, to make programmes after a time interval of up to 10 days from any one of the 12 tv channels. An a.c. mains-powered charger for the batteries of the VT 7000 is built into the tuner. Both recorder and tuner are supplied with all the necessary connecting leads and their prices are £579 and £159 respectively, including v.a.t. Hitachi Sales (UK) Ltd, Hitachi House, Station Road, Hayes, Middlesex.

**Linear test system**

A large range of devices including d.o.a. and -a. to-a. converters, can be tested by means of the LTP benchtop automatic test instrument from Analog Devices Inc. This system is designed for use in incoming inspection, device selection and grading and other such applications. At the heart of the system is a 16-bit microcomputer, backed up by 4Kbyte of e.p.r.o.m., 60Kbyte of e.r.a.m. and a 92Kbyte floppy disk unit. Other main parts of the system are a 4-digit character dot-matrix display, a thermal printer and an alpha-numeric keyboard. Devices to be tested are interfaced to the test-unit via "family boards" which contain all the circuits necessary to measure a general class of components. In the simplest mode of operation of the LTP-2000, the operator sends only the "START TEST" button to obtain a pass or fail message from the display. Setting up of the system is also relatively simple, since procedure is carried out by a "first the blank" method which gives complete prompting: programs can also be supplied by the manufacturer. Full editing facilities are provided for both types of programming. Among the other types of device which can be tested are op amps, comparators, voltage regulators, isolation amplifiers and c.m.o.s. switches. Analog Devices Ltd, Central Avenue, East Molesey, Surrey KT8 0SN.

**Thermometer**

Conversion of the displayed temperature reading from °C to °F or vice versa, storage of maximum or minimum temperature values, and automatic calculation and display of the probe temperature minus the value stored in the memory are some of the features made possible by the use of a microprocessor in the hand-held digital thermistor type KMC10/00 from Kane-May Ltd. For temperatures from -200 to +200°C, the resolution of the reading is ±0.1°C outside this range, the resolution is ±1°C, and from -210 to +180°C the accuracy of the reading is ±0.2°C, ±1.5%. For °F, the resolution is ±1°F for the full scale range. A built-in 16-hour clock is provided to display the temperature and give indications as to the mode of operation, as well as providing automatically coded information in the event of a fault condition being discovered by the continuously running self-test. Warnings are also given for over and under-ranges of a particular thermocouple, a broken thermocouple and for incorrect execution of the temperature difference function. The unit is powered by rechargeable batteries: Kame-May Ltd, Burroughfield, Welwyn Garden City, Herts.

**Crystal filters**

Quarter-crystal filters in a new range, designed for i.f. selection in u.h.f. and v.h.f. telephone systems, are available from Hy-Q Quartz Products Ltd. The QMF Series filters are available for use in i.f. amplifiers with a centre-band frequency of 10.7MHz, and are available in either three basic types, for either 12 kHz, 24kHz, 25kHz channel spacings. Each of these basic types is available in either 2, 4, 6 or 8 pole versions, which give stop bandwidths ranging from 18 to 900Hz at the channel spacing frequency. An operating temperature range of between -40 and +80°C is quoted for these filters which can either be hermetically sealed or epoxy-cased, and are said to be suitable for use in mobile and portable transceivers. Hy-Q Quartz Products Ltd, Station Road, Whinstone, Cambridge CB1 4NL.
Power supplies

Recently introduced to the market is a range of 13.5 V d.c., stabilized power supplies specifically designed for use with amateur radio equipment. The DRAE range from Dreyfend Ltd consists of 3, 6, 12 and 24A output current versions all with fuse-protected outputs, current limiting, current foldback, thermal overload shutdowns and crowbar overload protection. Burst current ratings are typically twice as high as the continuous current ratings given above. Dreyfend Ltd, 89 Kilmington Road, Portsmouth, Hants.

Prototype wiring system

An interesting alternative to wire wrap point-to-point wiring has recently been launched in the UK. The system, known as Quick Connect, uses an insulation displacement technique originally developed by Bell Laboratories, and provides sockets or terminals which are compatible with standard p.c. boards. Each component has an insulation displacement connection time on the underside of the board, which accepts two 24 gauge solid wires to provide four connections. To make a connection the wire is simply pushed, with the pencil provided, into the time which penetrates the insulation and forms a gas tight contact with a typical resistance of 60mΩ. Because no wire stripping is necessary the system is very quick, especially when "daisy chain" connections are required. An important advantage of Quick Connect is the re-usable tape which allows wide boards to be modified or stripped and used again. Another advantage is the low profile, 6.2mm compared with 16.4mm for wire wrap. At present Quick Connect can be used in three ways. Sockets and terminals can be supplied in bundles suitable for installation by the user, customers' boards can be factory fitted with the connections, or standard socket boards can be purchased for general prototyping work. Astec Dynamics Ltd, Red Barn Road, Birtlington, Colchester, Essex.

14-bit d-a-c

A signal to noise ratio of typically 85dB in the audio band in one of the features of the TDA1540 14-bit digital to analogue converter from Mullard Ltd. This converter is designed for use as a digital signal processor in sound recording and reproduction systems and includes "anti-clip" Bias tapers designed to eliminate the need for a de-glitching circuit at the output. Other specifications for the TDA1540 are a non-linearity error of less than 3.5‰, a current setting time of 1/4th of the 4kHz full scale output, 35mW power dissipation and P-channel compatible outputs. Mullard Ltd, Mullard House, Turnhouse Place, London WCIE 7HD.

Instrument cases

A manufacturing service for small batch high precision cases can now be provided by Le Clair Precision, who claim that a complete case can now be produced quickly and to any design in most materials and finishes from a single sketch. This service is expected to be of particular interest to companies manufacturing specialized equipment in small quantities and to research and development departments requiring prototype equipment cases. Costs are said to be generally competitive with those for adapted standard equipment cases, and will depend upon size and features required. Le Clair Precision, The Green, Thetford, Barking, Berks.

Chopper op-amp

An input offset voltage of 1µV and an input bias current of 15pA maximum at 20°C are features of the 1607/250 chopper stabilized op-amp from Intersil Ltd. Only two external capacitors are required for placing the correcting potentials on the chopper amplifier nulling inputs. Chopper drive and other control circuits are included on the chip, although the 14-pin package version also has provision for an external clock if required. Chopping spikes at the input and output are said to be minimized due to a unique design approach. The gain bandwidth product is 25MHz, slew-rate is 2.5V/µs and the common-mode and power supply rejection is 120dB. The 7650 is available in both T09 and 14-pin plastic or ceramic d.i.p. versions and is internally compensated for unity gain operation. In addition, the output clamp circuit renders overload recovery problems so that the device may be used as a precision comparator. Intersil Ltd, Faunapets House, Basing View, Basingstoke, Hants RG21 7YS.

Keithley D.M.M. Test Equipment:

Choice. The Keithley range spans Pocket, 3½, 4½, 5½ digit D.M.M.'s; many with I.E.E.E. Interface. Some can be sure of having exactly the right product for your own requirements. Built to a standard that very few people can equal.

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- HY6 (mono) and HY66 (stereo) are new to ILP's range of advanced audio modules. Their improved characteristics and styling ensure they being compatible with all ILP power-amps, both MOSFET and BIPOLAR, giving you the chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided.
- Size: HY6 - 95 x 20 x 60 mm. HY66 - 95 x 20 x 60 mm.
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Salary: Grades Research Scientist £4609-£6404; Higher Research Scientist (minimum of 2 years' postgraduate experience) £6075-£7900; Senior Research Scientist £7154-£8398; for higher degree £7449-£8619.

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CLOSING DATE FOR APPLICATIONS: 8th January, 1981. (83)
Electronic Engineers – What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £4000 to £8000 p.a.

If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you.

All applications are treated in strict confidence and there is no danger of your present employer (or other companies you specify) being made aware of your application.

Please send me a TJB Appointments Registration form:

Name: ____________________________
Address: ___________________________

TJB ELECTROTECHNICAL PERSONNEL SERVICES, 12 Mount Ephraim, Tunbridge Wells, Kent. TN3 8AS.

Tel: 0892 953288

SYSTEMS ENGINEERS — TELEVISION

Experienced engineers are needed to work on design and project management of Outside Broadcast vehicles and television studios. This is an opportunity for engineers to become involved in projects from their initial design concept, through manufacturing to delivery and installation.

Our custom built systems require a high degree of customer contact at engineering level, from the initial design stage to the necessary training of operational staff on completion of the contract, both within the UK and overseas.

You should have a knowledge of TV studio engineering gained from experience in this type of work or from experience in the operational side of television.

DESIGN AND DEVELOPMENT ENGINEERS — VIDEO

An experienced engineer who will be involved in the design of studio products, including a new range of colour cameras, using the very latest analogue and digital techniques. You will have the opportunity to see your designs made in volume production, fulfilling the high technology requirements of the "80s.

We are looking for engineers who are qualified to degree or HND level and who have at least four years' experience in the design of electronic equipment, with some knowledge of video engineering and microprocessor techniques.

TEST ENGINEERS

We require engineers at intermediate level to assist in the manufacture of our new range of products for the Broadcast studio television market.

You need to have an up-to-date knowledge of digital and linear circuit techniques gained from experience working on broadcast television, or similar sophisticated products, and be capable of faultfinding down to component level.

We are a young, successful Company, well known in international television circles, operating from our modern purpose-built factory in Andover. Salaries offered are very competitive, and supplemented by generous holidays, free life and health insurance, pension scheme, subsidised meals and relocation expenses.

PLEASE WRITE GIVING FULL DETAILS OR PHONE JEAN SMITH AT THE ADDRESS BELOW FOR AN APPLICATION FORM.

APPPOINTMENTS

W ELECTRONICS

£5 – £10,000 per year, plus commission.

MISCELLANEOUS

Radar, Computers, Microprocessors, Microwave, Electronics, Communications.

Link Electronics Limited, North Way, Andover, Hants, SP10 5AJ.

Telephone: 0264-61345

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Increased home and export orders for our broadcast TV products mean that we are looking widely to recruit staff to fill new vacancies and others created by promotion of engineers who have been with us some time.
Communications Engineers and Technicians.

Have you considered a career in Technical Publicity?

Our Central Publicity Department, based in the pleasant Berkshire town of Wokingham, has opportunity for Communications Engineers & Technicians to help a team to produce a technical publicity by joining a team involved in the production of written copies for a wide range of sales literature and technical articles.

Even if you have never considered writing as a career possibility, involving radio, television, films, communications, data base and video, and an ability to express yourself clearly, you would very much like to hear from you.

These people currently employed in telecommunications services or other electronic industry or those about to leave the HM Forces would find the work unusual, stimulating and creative.

A certain amount of travel will be involved for which you will be fully reimbursed. Excellent prospects exist for promotion to more senior positions.

We offer highly competitive salaries, Group cover for Life assurance, Public Assistance, annual holiday and relocation expenses where applicable.

This is your chance to join the most successful electronics Company in the U.K. Apply in writing, giving brief details of your experience and qualifications to:

Vanguard Group Personnel Services, Radio Group Service Ltd, Wavertree Road, Bracknell, Berks. Tel: Bracknell (0344) 32441 Ext. 169

Britain's fastest growing electronics group

ENGINEERING OPPORTUNITIES

Samuelson Sight & Sound Ltd. is a well established firm, which in the past few months has found, due to increasing business the need to take on both Video and Audio engineers.

VIDEO ENGINEERS

Well proven background in all aspects of video, including television, television camera, video tape recorder both VHS and U-Matic formats.

Salary negotiable dependent on experience.

AUDIO ENGINEERS

Experience in all forms of audio equipment including sound mixing consoles, amplifiers, talk back systems etc. However if you have a good electronics background this would be considered.

Salary negotiable dependent on experience.

Please apply in writing, giving details of previous experience and training to:-

Mr. R.T. Morgan (Service Manager)
Samuelson Sight & Sound Ltd.
303/315 Cricklewood Broadway,
London NW2 6PQ

SAARLS UP TO £13,000

can be obtained despite the recession

CURRENT VACANCIES INCLUDE:

DESIGN ENGINEERS to work on counter measures for secure computers i.e. project to meet Government requirements from voice to satellite to space, up to £13,000.

VERITABLE YOUNG ENGINEERS join high flying design team engaged on new industrial equipment including chaser and data recorders, data acquisition and display products. Pay the high frequency instrumentation and equipment controls essential. South Coast to £10,000.

DESIGN ENGINEERS for digital video systems for security and document transmission over satellite and microwave.

Experience in digital NTSC and PAL essential. Banks to £10,000.

RF ENGINEERS & DIGITAL ENGINEERS for varied emergency services communication system.

Development engineers’ jobs for control of mechanical peripheral equipment. Rural Locations to £8,000.

DEVELOPMENT ENGINEERS for work on a wide range of video cameras, video processing equipment — and more. South West Coast to £8,000.

PROJECT ENGINEERS with design and enthusiasm to develop analogue and digital products for automotive industry. Rural Locations. £8,000.

COMPUTER ENGINEERS Vacancies throughout U.K. in tech. support, field service, programming and systems test. Salaries range from exceptionally good to debatable — but according to location and type of equipment.

WANTED URGENTLY — ANY HARDWARE OR SOFTWARE ENGINEERS, TEST ENGINEERS, SERVICE ENGINEERS, TRAIL ENGINEERS.

For further details, please contact:

Charles Airey Associates

8 Lammaslim Road, London W6 5D4, Tel: (01) 741 4861

PROBABLY THE BEST KNOWN SOURCE OF ELECTRICIANS ENGINEERS IN THE COUNTRY
CLASSIFIED ADVERTISEMENTS

Use this Form for your Sales and Wants

PLEASE INSERT THE ADVERTISEMENT INDICATED ON FORM BELOW

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- Rate £2 PER LINE. Average six words per line. Minimum THREE lines.
- Name and address to be included in charge if used in advertisement.
- Box No. Allow two words plus £1.
- Cheques etc., payable to “Wireless World” and cross “& Co.”

WIRELESS WORLD JANUARY 1981

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FOR ROUND ENAMEL
INSULATED WIRES (35-14 SWG)
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• PRODUCTION WIRE STRIPPING
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The perfect enclosure system for your equipment

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When it comes to 19" equipment AKA has the experience and know-how—and West Hyde offer rapid delivery coupled with personal service.
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Telephone: (0296) 20441, Telex: 83570 W HYDE G

WIRELESS WORLD JANUARY 1981

WE REMIT...
**Products that help you make a better job of it.**

**Arax Multicore Solder.**
Economy pack for general non-electrical use. Replaces solid wire and stick solder (B.S. 219 Grade L). Econopak 200g reel of 3mm dia. Size 16A. £4.14 per reel.

**Toolbox Reels.**
Multicore 5 core solder for general use. Suitable for electrical joints (B.S. 219 Grade C). 40/60 tin/lead. 1.6mm dia. Size 3. £3.91 per reel.

**Savbit.**
Multicore 5 core solder for radio, TV and similar work. Reduces copper erosion. Suitable for service engineers and manufacturers using small quantities of solder. 1.2mm dia. Size 12. £3.91 per reel.

**Arax Multicore Wick.**
Multicore solder wick for removing solder from virtually any joint. 1.7mm dia. Size AB10. £1.38 per reel.

**Multicore Wick.**
Multicore solder wick for removing solder from 1.2mm dia. Size 12. £3.91 per reel.

**Handy Dispensers.**
PC115 for printed circuits. £1.15<br>SL120 for radio and TV repairs. £1.61<br>AR140 for non electrical applications, except aluminium. £1.38<br>SS160 for stainless steel and silver jewellery. £2.53<br>19A for all electronic joints. £96p<br>AL150 for aluminium. £1.93<br>BCA16 solder cream for stainless steel, jewellery and household products. £3.22<br>BCR10 solder cream for electronic and electrical use. £1.38<br>BCA14 all purpose solder cream, non-electrical jointing and repair. £1.38

**Tip Kleen.**
Multicore Tip Kleen. Soldering iron tip wiping pad. Replaces wet sponges (should not be used above 300°C). £8 per pack.

**Soldering Flux Pastes.**
Multicore soldering flux paste. Extra fast, non-corrosive rosin flux for electrical and general purpose soldering. Rosin R.F10. 35g net. 69p per pack. Multicore soldering flux paste for soft metals (except aluminium) and stainless steel. Arax AF14. 35g. 69p per pack.

**Aluminium Soldering.**
Alox Multicore 4 core solder for soldering most types of aluminium. No extra flux needed. 1.6mm dia. Size 4. £6.90 per reel.

**Wire Stripper and cutter.**
Wire stripper and cutter with precision ground and hardened steel jaws. Adjustable to most wire sizes. With handle locking-catch and easy-grip plastic covered handles. Ref: 9. £2.69 per pair.

All recommended retail prices shown are inclusive of VAT. If you have difficulty in obtaining any of these products send direct with 40p for postage and packing. For free colour brochure send S.A.E.

**WW-005 FOR FURTHER DETAILS**