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The EP4000 comes with a technical manual describing every aspect of the machine - its purpose, its use, and how to use it. It also has a section describing the whole process of program development. And if you ever need technical help or advice, you can now dial direct to our technical department for instant attention - Tel. (0803) 863580.

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1980 saw a genuine breakthrough—the Sinclair ZX80, world’s first complete personal computer for under £100. Not surprisingly, over 50,000 were sold.

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Today, the Sinclair ZX81 is the heart of a computer system. You can add 16 times more memory with the ZX RAM pack. The ZX Printer offers an unbeatable combination of performance and price. And the ZX Software library is growing every day.

Lower price: higher capability
With the ZX81, it’s still very simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same microprocessor, but incorporates a new, more powerful 8K BASIC ROM — the ‘trained intelligence’ of the computer. This chip works in decimals, handles logs and BCD, allows you to plot graphics, and builds up animated displays.

And the ZX81 incorporates other operation refinements — the facility to load and save named programs on cassette, for example, and to drive the new ZX Printer.

Kit: £49.95

Higher specification, lower price — how’s it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 41.

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80.

New, improved specification:
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• Graph-drawing and animation display facilities.
• Multi-dimensional string and numerical arrays.
• Up to 26 FOR/NEXT loops.
• Randomise function — useful for games as well as serious applications.
• Cassette LOAD and SAVE with named programs.
• 5K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
• Able to drive the new Sinclair printer.
• Advanced 4-chip design: microprocessor, ROM, RAM, plus master chip — unique, custom-built chip replacing 18 ZX80 chips.

Built: £69.95

Kit or built — it’s up to you!
You’ll be surprised how easy theZX81 kit is to build. Just four chips to assemble (plus, of course, the other discrete components) — a few hours’ work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor — 600 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.

16K-byte RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

With the RAM pack, you can also run some of the more sophisticated ZX Software — the Business & Household management systems for example.

Available now
the ZX Printer
for only £49.95

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumeric and highly sophisticated graphics. A special feature is COPY, which prints out exactly what is on the whole TV screen without the need for further instructions.

At last you can have a hard copy of your program listings — particularly useful when writing or editing programs.

And of course you can print out your results for permanent records or sending to a friend.

Printing speed is 50 characters per second, with 52 characters per line and 9 lines per vertical inch. The ZX Printer connects to the rear of your computer — using a stackable connector so you can plug in a RAM pack and a roll of paper (65 ft long x 4 in wide) is supplied, along with full instructions.

How to order your ZX81
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Model 3009-R

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- Thin-walled stainless steel tone arm.
- New design lateral balance system with longitudinal and lateral fine adjustment for cartridges weighing from 1½ - 26 grams, or plug-in heads up to 33½ grams.
- Extra-rigid low mass shell with double draw-in pins.
- Geometry optimised for 12" records.

The 3009-R has a typical effective mass of 12.7 grams and is intended for cartridges requiring a vertical tracking force of 1.5 grams and upwards. It is therefore particularly suitable for the many MC's in this category.

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A quiet word...

The characteristics of an ideal printer, whether it be for use as a teleprinter or a printer terminal might be stated as an off-line, quiet machine that can produce high quality text on plain paper in clear, legible script.

Siemens' Model 1000 teleprinter and the versatile PT80 series printer terminals possess these attributes and many more. Indeed they are designed to satisfy a variety of today's text and communication requirements.

Teleprinters and Data printers for the office

The conventional teleprinter, has been greatly refined over the years but some machines still need frequent maintenance checks and are too noisy for use in an open office. However, Siemens' development of printing mechanisms has allowed these producing parts to be reduced. This, together with the introduction of advanced electronic techniques have been built into the Model 1000 teleprinter.

Model 1000 S

The teleprinter Model 1000 S is an exciting new development using the latest technological advances. The versatility of the Model 1000 S is illustrated by the fact that it will produce both Latin and non-Latin script and switch between them when required, e.g. Arabic, Greek, Cyrillic, Hangul or Farsi. The Model 1000 S is available with either a dynasty, a needle-printer head, or an ink jet. Optional items include a visual display unit and floppy disk message store.

Security — a growing problem

Industry, commerce, government departments, and large international concerns and institutions frequently have a communications security requirement. The Model 1000 CA (Cryptographical Application) gives the message originator and recipient protection from any electronic 'eavesdropping'. This is done by encrypting and deciphering the message through a built-in cryptographic device. The machine has been designed to be compatible with all standard telegraph circuit options.

PT80 — a concept for today

The PT80 printer terminals are a result of many years' operational experience in both text and data communications. In essence, these machines are electronic terminals suited to a wide range of communications and data networks as well as process control.

The PT80 printer terminal uses either a 12 needle printing head for refined print quality, or alternatively the Siemens revolutionary ink-jet mechanism to achieve the ideal particularly in respect of minimal noise. The PT80 uses the latest jet principle to attain a printing speed of up to 270 characters per second. The concept is featured very simply in the illustration on this page, with the droplet being ejected by means of a shockwave which causes a momentary increase in pressure in the nozzle. What happens immediately afterwards in front of the nozzle orifice is shown in our illustration. The shockwave in the nozzle is generated by a piezo-electric transducer to which a voltage is momentarily applied. Siemens has ensured that ink is ejected only as and when needed.

Versatility

As well as Siemens' Model 1000 teleprinters a number of PT80 variants are available to suit specific requirements. For example, there are receive-only machines with needle or ink-jet printing, a teleprinter (PT85-S) and a variant with paper tape attachments for automatic send/receive. There is also a wide variety of character sets and an extensive range of interface modules to suit novel telecommunications and data peripheral requirements.

Easy servicing

Again, as with the Model 1000 teleprinter, these printer terminals are based on the modular design concept. For example, plug-in modules of the PT80 enable a fast and therefore economical service support.

Operational flexibility

PT80 machines generally operate with seven-bit codes or alternatively the PT80-S printer variant uses the flexi-bit code. The standard terminals are suitable for operating at speeds of up to 600 baud, the teleprinter version up to 200 baud, and the PT80 up to 4800 baud. All the PT80 terminals satisfy the requirements for a flexible character set.

Nonwithstanding their advanced specification, the PT80 range of printer terminals is compact and simple to use and along with the Model 1000 teleprinter they are perfect examples of 'quiet words from Siemens'.

For full information, cut out the coupon and send to Siemens, Marketing Services Dept OR 70, Sir John Forbes Road, Burbury-on-Thames, Middlesex, TW5 7DS. Or telephone Burbury-on-Thames 56951. Fax: 08931391

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High-resolution weather satellite pictures

Receiver design by M.L. Christenson

TIROS-N series satellites send high-resolution weather pictures in real time and are possible for the enthusiastic amateur – as well as the professional – to receive, display and store image transmissions direct from the spacecraft. The author presents the design philosophy and some practical details of a station for the receiving and demodulating these digital transmissions. Data processing and storage by computer are outlined in the article but interfacing is left to the constructor due to the large variations in computer systems. This part of the article discusses transmission characteristics, antennas and receiver design.

Facsimile weather pictures sent in analog form by a variety of scanning radiometer satellites are familiar to many people from either television weather bulletins or direct reception by enthusiastic amateurs. Some pictures come in real time from satellites in polar orbit such as TIROS and METEOR, while some are preprocessed and retransmitted from geostationary platforms such as GOES, Meteosat and GMS. Although the image scanning parameters differ, they are all sent as an amplitude modulated signal on a 2400Hz f.m. subcarrier, and can therefore be described as 'analog' transmissions. They all come under the generic term of 'automatic picture transmissions', or a.p.t.

Previous spacecraft have also presented pictures with higher spatial resolution on S bands (1700 MHz to 2100 MHz) or METEOSAT and GMS (500 MHz) on V.H.F. (137 MHz) in analogue forms, using the same system but at a considerably lower radiance value of the ground below.

This type of transmission, however, is not the usual application. Typically, meteorological data a.p.t. is sent over S band (1700 MHz) or L band (1.2 GHz), and the transmitted signal is frequency modulated, unlike the direct modulation employed by the TIROS series. The TIROS series is providing good images throughout the world, and they will be replaced as a matter of routine.

The equipment is designed for use with a television set, was developed using the signal from NOAA-6.

A.V.H.F. transmission characteristics

The advanced very-high resolution radometer has a rotating mirror like many of its predecessors and scans successive lines as the spacecraft passes over the ground below at a rate of 360 lines per minute. The incoming radiation is split into five spectral bands, each having its own detector.

The five bands are:

1. Channel 1: 0.58 - 0.68 μm
2. Channel 2: 0.725 - 1.10 μm
3. Channel 3: 3.55 - 3.9 μm
4. Channel 4: 10.3 - 11.3 μm
5. Channel 5: 11.5 - 12.5 μm

A full description of the radiometer is beyond the scope of this article but has been published. The spacecraft also carries several other instruments used for atmospheric measurements. These generate low data rate t.o.v.s. (T.I.R.O.S. operational vertical sounder) data, the content of which is described elsewhere. The outputs from the radiometer, detectors are digitized in digital form, consisting of a stream of ones and zeros containing numerical information about the signal.

The transmitted signal is a series of ones and zeros, the same data stream as used by TIROS-N, the first in a new series of TIROS satellites, and Meteosat-1, a new breed of pictures became available in Europe. These are sent in digital form, consisting of a stream of ones and zeros containing numerical information about the signal

For a given receiver, the bit-rate is a function of the receiver's antenna gain, atmospheric conditions, and the signal-to-noise ratio at the receiver. The signal-to-noise ratio at the receiver is determined by the antenna gain, the signal strength, and the noise in the receiver and the propagation path. The antenna gain is a measure of the ability of the antenna to collect and concentrate the signal. The signal strength is a measure of the intensity of the signal at the antenna. The noise in the receiver and the propagation path is a measure of the random variations in the signal that are not due to the antenna or the signal itself.

The bit-rate is given by the following formula:

bit-rate = antenna gain x signal strength / noise

The antenna gain is determined by the size and shape of the antenna. The signal strength is determined by the distance between the satellite and the antenna, and the power of the signal. The noise in the receiver and the propagation path is determined by the properties of the antenna, the receiver, and the propagation path.

The bit-rate is a measure of the amount of data that can be transmitted per second. A higher bit-rate allows more data to be transmitted, but it also requires a higher power and a higher signal-to-noise ratio at the receiver. The antenna gain is a measure of the ability of the antenna to collect and concentrate the signal. The signal strength is a measure of the intensity of the signal at the antenna. The noise in the receiver and the propagation path is a measure of the random variations in the signal that are not due to the antenna or the signal itself.

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The circuit board for the G-mixer and the first amplifier board is made from p.t.f.e. microwave substrate and the second amplifier board from 1/8in glass-fibre p.c.b. with 1oz copper. The ground-plane is retained on the reverse side of both boards.

Brass tubing 9mm x 95long with 70long brass end plugs tapped 2BA and soldered in place.

\[ T_n = \frac{10\log|N(FN1 - 1)|}{10} \]

where \( N(FN1) \) is the numerical gain of the first mixer. There is a possibility of a reference point that could be used, but the only one that can be used here is the output noise power in terms of that produced by a hot resistor. For a resistor at \( T_n \), noise power = \( 10B \), where \( B \) = bandwidth, \( k \) = Boltzmann's Constant and \( K \) = temperature in Kelvin.

Using this relationship the noise input power can be expressed alternatively as the 'noise temperature' of the source, and for standard noise figure measurements it is 290K. Clearly, the output-noise power is the amplified version of the source plus that generated in the amplifier. This additional noise could be represented by an apparent increase in the source temperature which would give the same noise output if the amplifier were noiseless. This is called the 'effective' noise temperature of the amplifier and is related to noise figure, \( NF \), by

\[ T_n = 290(N(FN1 - 1)) \]

None of these, of course, a physical temperature.

Using this type of analysis it is easy to prove that if \( T_n \) is less than 290K (as would be the case), the signal-to-noise ratio improvement resulting from a reduction in first amplifier noise figure is greater than the noise figure reduction itself. The converse is also true.

All the amplifier noise figures may be estimated from the device data sheets, but \( T_n \) which has a large effect on \( T_{in} \), is unfortunately difficult to define for individual stations. A general guide is given by Fig. 2 as a function of frequency. Examination of this plot shows how quickly \( T_n \) decreases with frequency. Working through the equation for \( T_{in} \) for various frequencies shows how little benefit it is realized by very low noise amplifiers below 200MHz. This type of analysis may also be used in ground based calculation; for example to find how much benefit might be realized by reducing feeder loss on a 144MHz amateur station receiver.

The requirement for h.r.p. reception with an error rate better than 1 in 10 is shown in Fig. 3. Note that due to the gain profile on the spacecraft the signal reaches a maximum at an elevation of 30°. For example the minimum \( T_{in} \) possible in order to cope with worst case with zero margin is 4.5dB.

Assuming a value for \( T_{in} \) of 70K and the best possible amplifier combination yielding about \( NF = 1.5dB \), inserting it into the equation for \( T_{in} \) gives

\[ T_{in} = 70 + 110 = 190K \]

This must now be converted to dB so as to conform with the unit of \( G_A \).
required antenna gives

\[ G = 4.5 + 12.8 \log d = 27.3 \, \text{dB} \]

This could be achieved using a parasitic dish several metres in diameter (4 metres is recommended commercially), but together with the difficulty of tracking such a massive object, it would be very expensive to try to do or build. In order to focus the antenna, some sacrifice must be made in error rate.

Practical antennas
The prototype antenna is a set of four 28 decibel yagis for right-hand circular polarization. This type of antenna has been developed by amateur-radio operators interested in receiving meteor scatter for 1296MHz. They have been described in several articles and work admirably. The antenna has simple dimensions which would not be difficult to reproduce and, even at 1296MHz, it would perform well. Figure 2 shows the dimensioned drawing of the antenna. The antenna also has a multiple of 28 decibel gain.

Mixer/local-oscillator
This is based on a previous design used for the mixer of the 600KHz version of Meteor. There are some improvements made to satisfy the more stringent requirements for this frequency band. The original design comprised an oscillator driving a local-oscillator chain feeding one port of a mixer mixer using Sideband blockers. The other mixer port was connected directly to the output of a further signal-frequency amplifier using NE64535. The main change is the insertion of an interdigital filter between this amplifier and the mixer input. This amplifier design remains similar but the microstrip dimensions were changed to be identical with those in the NE64535 section of the antenna amplifier. The glass-fibre board is extended to include a capacitor for the interdigital filter. Figure 3 shows the mechanical details of the assembly. This type of filter has a high Q and has been used in microwave receivers for a number of years. The local-oscillator crystal frequencies to use are as follows:

- 1698.0 MHz, 86.6944MHz
- 1702.5 MHz, 86.6944MHz

These are for use with an i.f. of 137.500MHz which was used to fit in with the Home Office decision not to allow them to operate on the 70MHz band when the service was first launched. They are recommended for the next year. They appreciate that 70MHz is not an international amateur band but international activity does occur in the very wide gap between 28MHz and 144MHz. A group of amateurs in Regions 2 and 3 who band 50 to 54MHz is used at amateurs. At WARC 1977 this band was also to give r.f. polarization when the amateur operation was changed to allow administrations to issue licences without a minimum test for frequencies above 30MHz (instead of above 144MHz) and it was widely assumed that the Home Office would amend the Class B licences to include the 70MHz band.

Even those of us who are keenest to encourage Class B amateurs to learn Morse, and so qualify for the Class A licence, feel uneasy at the way in which the Class B conditions have to concentrate so much activity in the UK, into 144-146MHz, leaving 70MHz (and in sparsely populated minimum years) 28MHz relatively unmolested. So while the Home Office is clearly acting within its rights, it seems a puzzling decision.

Some of the next generation of 'personal' transmitters are making their way into the market. Some of the best known are the Yaesu 8500, the Icom IC-240 and the Kenwood TM-100. All these are for use with an i.f.

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Reference
1. VORNS-N/NOAA A-G Satellite, NOAA technical memoranda NWS NSR 83.
2. Data Extraction and Calibration of VORNS-N/NOAA Radiometers, NOAA technical memoranda NESS NSR 83.
3. R. C. Hapgood. Communication, January 1975, Microwave E.
4. A. van Riper. Communication, January 1976, Microwave E.
5. F. E. Application Note, Plessey Optical and Microelectronics.
6. Calculators Notes Electronics, February- May 1978, Microwave C.
7. Low-noise GaAs f.e.t. amplifiers, Plessey Microwave Notes.

Personal hi-fi
If all started with the Sony Stowaway (rapidly re-named the Stowaway 2000), this was a casselette player which was easily portable and had no headstands. It played pre-recorded stereo minicassettes through headphones. This meant that power amplifiers were not needed and the whole unit was very compact. One of the advantages was the very lightweight headphones which used cobalt-neon-magnet drivers, giving high-quality sound with very low power.

One of course it was inevitable that other companies, especially the Japanese, would jump on the band-wagon, and there was a proliferation of personal hi-fi systems, some incorporating stereo cassettes, some with the ability to record as well as play back.

Receiver frequency

- 1698.0 MHz, 86.6944MHz
- 1702.5 MHz, 86.6944MHz

These are for use with an i.f. of 137.500MHz which was used to fit in with existing equipment.

To be continued

Guide to repeaters
The UK FM Group (London) has recently published a revised and extended edition of "A newcomer's guide to FM simplex and repeater operation on two metres" by Antony Askey, GB4BC with a foreword by the Secretary of the UK amateur radio repeater operators association. This book outlines that whereas in the early days of repeaters most amateurs had experienced two-way working, in the modern era most repeaters are of the low-power handheld or mobile transmitter in conjunction with a 144MHz repeater. The 16-page booklet contains a lot of good advice, although unfortunately no information on price or address. (Membership secretary, Pat Specky, 67 South Downs, Epsom, Surrey KT18 5UJ, may be able to provide some of the information for those unfamiliar with current operating techniques.

Repeaters operation, particularly in the London area, is not without its special problems and the booklet has a useful section on the subject. In addition the booklet will provide some useful advice for those who are interested in QRT and will inform the reader of the location of some of the others.

No Class B on 70MHz
Class B licence holders (phone operation on 70MHz) will have to face the Home Office decision not to allow them to operate on the 70MHz band when the service was first launched. They appreciate that 70MHz is not an international amateur band but international activity does occur in the very wide gap between 28MHz and 144MHz. A group of amateurs in Regions 2 and 3 who band 50 to 54MHz is used at amateurs. At WARC 1977 this band was also to give r.f. polarization when the amateur operation was changed to allow administrations to issue licences without a minimum test for frequencies above 30MHz (instead of above 144MHz) and it was widely assumed that the Home Office would amend the Class B licences to include the 70MHz band.

Even those of us who are keenest to encourage Class B amateurs to learn Morse, and so qualify for the Class A licence, feel uneasy at the way in which the Class B conditions have to concentrate so much activity in the UK, into 144-146MHz, leaving 70MHz (and in sparsely populated minimum years) 28MHz relatively unmolested. So while the Home Office is clearly acting within its rights, it seems a puzzling decision.

Here and there
Translational working on 1.8MHz should find restaurant with the London marine navigation system already largely phased out although not due to end in the near future. In Australia, the FCC has already lifted the transmitter power restrictions on the band to 10 watts. The FCC is currently studying a number of geographic restrictions and is considering whether to make it easy to use to invest in new equipment for the band until the new International Frequencee Table has been finalised. The FCC 1979 restored 1810 to 1850 kHz as an exclusive amateur band but in the US and North America amateur stations will be permitted to use 150 watts in the 1810 to 1850 kHz section.

According to Electronics to Australia a Parliamentary report suggests that about half of the equipment in use in Austra-


The International Amateur Radio Union was formed in the GSSB's 1981 National Field Day. The Southern Cross, Western Contest Group, the Greensleigh trophy, several large Australian groups, the Fraser Memorial Trophy to South Australian Radio. The Scottish Trophy to the British Amateur Radio Club.
Massive support from broadcast organisations, the Bundespost and almost the entire entertainment industry will make this the biggest show of its kind.

As if by way of commemoration Clément Ader's 30 August two-channel sound demonstration in Paris a hundred years ago, Gebr. Bleicher's Deutsches Fernsehen tv authority commenced regular stereo tv broadcasting at the Berlin show. Not only does transmission of a second sound channel give a stereo sound option for current events and sport events as well as the usual musical programmes (to say nothing of trials using a dummy head platted by WDR, but it also provides a second language option for foreign films and European music programmes etc. Transmission standards were fixed jointly with industry, the Bundespost and the two broadcast organisations. When ZDF commissioned the Bundespost to equip the second tv channel for stereo sound (transmitters built after 1976 are convertible to stereo operation).

The other broadcasting organization, Arbeitsgemeinschaft der öffentlich-rechtlichen Rundfunkanstalten der Bundesrepublik Deutschland to give it its full name, is not in a position to up-date its older equipment even if revenue from an increase in licence fee becomes available. (A star distribution point at Frankfurt, for instance, is not stereo-equipped. This will mean a difference of a few years in providing two-channel sound (even though the present ZDF coverage is only 29 transmitters out of a total of 89, it represents a proportion coverage of 60%, 95% of all set owners, a "thoroughly regrettable" state of affairs, according to Dr. Ing. Müller-Kömer, who is technical director of Bayerischer Rundfunk, one of the 12 ARD stations. As he is also chairperson of the joint ARD/ZDF technical commission, it can be presumed it is the scheme is going ahead at this time. The reason is tied up with the state of the television receiver industry, where development is not too rapid. With the tv set production curve falling back as fast as it has advanced... and as was anticipated, the reason for this performance is, few companies in the red and many suffering from the effects of competition. From abroad, however, companies that have technical innovation to spur the public into buying their product. Even though the start of stereo tv was delayed, it is estimated that sales of stereo sets will be as much as 65% of the total by 1983, in spite of the added price of 13 to 18%.

But it is with the gradual expiry of the tv industry's PAL patent portfolio that the day has come when stereo video and radio transmissions, stereo set sales and stereo music consumption has been its main protection against competition from the Far East in the large screen business, that the industry is now developing some patentable innovations whose licensing they will control. Patent actions are being signed to the industry patent-holding group, and they do not intend giving licenses to licensees even until 1983 at least. This was born out by Finnish set maker Salora who were cartoucheing their new "three channel" stereo sets or at least had not been granted a licence. (Don't expect any two channels of course, means three speakers, one with a sum signal feed for the front and antiphase difference signals for the sides, an idea which goes back more than a decade ago to David Hagger Duax and Ducau Cooper, even earlier in Blumenheim...).

And it isn't only tv sets that won’t be licenced. Japanese video recorder with tuners will have to receive mono sound, while the Philips/Grundig 2000 receivers will receive stereo sound (transmitters built after 1976 are convertible to stereo operation).

Japanese studies started as far back as the early sixties and led to NHK's adoption of a frequency-division stereo system whose sound channel uses an f.m. subcarrier for the stereo difference frequencies of 31.5kHz, twice the line frequency. Comparison with the traditional technique of using twin carriers for sound has shown that both methods offer adequate crosstalk and noise performance under normal conditions, but that mountainous regions a two-carrier method shows less degradation.

The German idea, which also originated in the studios from the ARD/ZDF Instituto für Rundfunktechnik in Munich, is to use two separate sound carriers, one for a compatible signal at 5.5MHz, the other for a compatible signal at 5MHz, a third channel (standard in CCR systems B & G) and the other separated by 524.175kHz, which is an odd multiple of half the normal scan frequency 42kHz to minimize Moiré interference. Both carriers are pilot-modulated to a deviation of 30kHz, while the second carrier is in addition modulated with a 1.2MHz pilot sub-carrier (3/4 by 5kHz) up to 2.5kHz deviation for signal identification. For transmission purposes it is unnecessary to modulate stereo sound, it is stereo 50% amplitude modulated at 117.5Hz (fs = 133), and for dual channel use at 274Hz (fs = 57). As the second channel carries the R signal, simple and effective is an L signal from the compatible (L-F+2) signal. Demodulated identification signals when converted into a two-bit binary code active audio route switches and panel indicators, which also account for the viewer's selection of sound (mono, stereo, language 1 or language 2).

The cheapest way of using the new transmissions would be to build a second intercarrier-type demodulator using the standard TBA1205. Using a dual carrier stereo stage and a new i.c. this provides matrixing and identification decoding, selection of either channel is possible as well as mono sound; but we don't see such a simple scheme. The least i.c. count way to do the job is with a quasi-split

and decoder i.c.

Some months ago, before the new i. c. were available, Philips suggested a way of using available components. Starting with the two audio-frequency signals, the basic idea was to demodulate with an op-amp and emitter followers, then to post-em- phasise signals through the routing switch using TDA1297 controlled by t.t.l. circuits. These took their feed from a TDA2436 dual 1.f. amplifier and demodulator and TDA083 contain a second demodulator together with matrixing and identification decoder. But the push way to do the job is with i.c.s that allow separation of a.f. and i.f. sections for the modular-chassis approach (TDA2435, 2 x TBA189), plus matrix sound system that claims better signal to noise ratio, where the vision signal in separately processed and the sound section retains a video component to allow intercarrier demodulation. Two new i. c. are needed for this, TDA2436 dual i.f. amplifier and demodulator and TDA189 contain a second demodulator together with matrixing and identification decoder. The circuit, due to RCA Labs, feeds high and low frequencies preferentially to one speaker and middle ones to the other. But at two carefully chosen frequencies of 320 and 370Hz, said to be the dominant ones in speech, both speakers have equal feeds intended to give a central image. and the idea seemed to work for the voice chosen. Metz appear to be the only tv maker with a separator stage, who make a民用 model. Most others that plug-in decoders are available for 60 sets one year old. Blu- punk, another model, is claimed to have increased the tv sound market by share by one and two per cent rather than 10%, so decoder is not available from them for pre-1980 sets, which presumably goes for Siemens tv sets as they are made by Blupunk.

Considering that direct broadcasting from satellites will not start on a trial basis before 1985 in Germany, and that permanent broadcasts are unlikely before the end of the 80's, there was a surprising amount of involvement in evidence. Not only from organisations directly involved such as the Bundespost, the Arcivo Research Establishment (DFVLR), ARD and West Germany commercial interests (Siemens, Grundig, GEC, Philips, Tekna, TE, KA DE and others), but also from Finland's Saltor, who aim to sell individual receivers, and Japan's Sony. Since the last Funkausstellung Sony has added sound to its satellite receiver for home use. This time their prototype receives the full WARC agreement five tv channels, one of which can be converted to 13.2kHz stereo. In the demonstration, in which the first phase-p.a. i.c. was used, SONY-built, 12kHz signals were reflected back within the confines of the stand and converted to 113MHz p.m. audio and microwave i.c. The digital audio processor was actually sampling at a 52kHz rate but no. In the demonstration, in which the first phase-p.a. i.c. was used, SONY-built, 12kHz signals were reflected back within the confines of the stand and converted to 113MHz p.m. audio and microwave i.c. The digital audio processor was actually sampling at a 52kHz rate but...
Another response to the coming transformation in the record business has been that of coding a computer as the main entity as its digital rival. This is a way by dx is currently promoting its sound work, and is thinking about dynamic ones. dx en-coded disc need a decoder. If you can decode at a certain level of digital tape recordings, with little noise, then the whole response, instead of level mismatches, and that is compatible, i.e. acceptable with an end. Such is the CBS scheme, called CX, currently being manifested to manufacture.

It is a widespread companion with a 2:1 band transmission to below the below which is linear. In operation, carriers are significant levels, but have designed to provide 94 improvement. Transmission earlier this year by ITT, however, this is interest for a time too long. Further tests are planned around a 12dB circuit.

Some quick work on decoders for the new internationally-agreed standard for video-data (Bildschirmtext) resulted in some fine displays of graphics from almost-complete systems. At the CED show and Bundespost stand.

The new CEP T standard includes a digital signal, 220, improved characters and graphics, a personal computer character set, smooth graphics, curves, dynamic range. Information may form a feasible proposal with the availability of satellite channels. For example, one of a decoder costs — both offer signal-to-noise ratios of around 60dB. Both offer signal-to-noise ratios of around 60dB. A noise reduction system that provides, say, 65dB signal-to-noise ratio, will degrade the signal to only 59.5dB. The results of these improvements are also applied to the better source signal. Hence Telefunken is interested in improving signal-to-noise ratios of records with CX.

To try to improve radio channel signal-to-noise from 60dB to 65dB, some figures are claimed to provide 94 improvement. Broadcasters earlier this year by ITT, however, this is interest for a time too long. Further tests are planned around a 12dB circuit.

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Discrete Fourier transform

Let us return from the brief digression into techniques of digital signal analysis to the problem of determining the frequency spectrum of speech. Although a bank of bandpass filters such as is used in the channel vocoder is perhaps the most straightforward way to obtain a frequency spectrum, there are other techniques which are in fact commonly used in digital signal processing.

It is possible to define the Fourier transform of a discrete sequence of points. To motivate the definition, consider first the ordinary Fourier transform (FT), which is

\[ G(f) = \int_{-\infty}^{\infty} g(t) e^{-2\pi j ft} dt \]

This takes a continuous time domain into a continuous frequency domain. Sometimes you see a normalizing factor \(1/2\pi\) multiplying the integral in either the forward or the reverse transform. This is only needed when the frequency variable is expressed in radians/second, and we will find it more convenient to express frequencies in Hz.

The Fourier series (FS), which should also be familiar to you, operates on a periodic time waveform (or, equivalently, one that only exists for a finite period of time, which is notationally extended periodically). If a period \(T\) lies in the time range \([0, T)\), then the transform is

\[ G(n) = \frac{1}{T} \int_{0}^{T} g(t) e^{-2\pi j nt/T} dt \]

The Fourier series takes a periodic time-domain function into a discrete frequency-domain sequence. It is not surprising that another version of the transform can be defined which takes a periodic frequency-domain function into a discrete time-domain one.

Fourier transforms can only deal with a finite stretch of a time signal by assuming that the signal is periodic, for if \(g(t)\) is evaluated from its transform \(G(f)\) according to the formula above, and \(T\) is chosen outside the interval \([0, T)\), then a periodic extension of the function \(g(t)\) is obtained automatically. Furthermore, periodicity in one domain implies discreteness in the other. Hence if we transform a finite stretch of a discrete time waveform, we get a frequency-domain representation which is also finite (or, equivalently, periodic), and discrete.

This is the discrete Fourier transform (DFT), and takes a discrete periodic time-domain function into a discrete periodic frequency-domain one, as illustrated in Fig. 14. It is defined by

\[ G(k) = \frac{1}{N} \sum_{n=0}^{N-1} g(n) e^{-2\pi j nk/N} \]

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Fourier transforms can only deal with a finite stretch of a time signal by assuming

Figure 14 illustrates the properties of symmetry and periodicity.

Estimating the frequency spectrum of speech using the DFT

Speech signals are not exactly periodic. Although the waveform in a particular period will usually resemble those in the preceding and following pitch periods, it will certainly not be identical to them. The articulation of the speech changes, the formant positions will alter. Furthermore, the pitch itself is certainly not constant, because the intonation of speech varies continually. Hence the fundamental assumption of the DFT, that the waveform is periodic, is not really justified.

However, the signal is quasi-periodic, for changes from period to period will not usually be very great. One way of computing the short-term frequency spectrum of speech is to use pitch-synchronous Fourier transformation, where signal pitch periods are isolated from the waveform and processed with the DFT. This gives an estimate of the spectrum. Unfortunately, it is difficult to determine the beginning and end of each pitch cycle, as we will see later in this article when discussing pitch extraction techniques.

If a finite stretch of a waveform is isolated and Fourier transformed, without regard to pitch of the speech, then the periodicity assumption will be grossly violated. Figure 17 illustrates that the effect is the same as multiplying the signal by a rectangular window function, which is 0 except during the period to be analyzed, where it is 1. The windowed sequence will almost certainly have discontinuities at its edges, and these will affect the resulting spectrum. The effect can be analyzed quite easily, but we will not do so here. It is enough to say that the high frequencies associated with the edges of the window cause considerable distortion of the spectrum. The effect can be alleviated by using a smoother window than a rectangular one, and several have been investigated extensively. The commonly-used windows of Bartlett, Blackman, and Hamming are illustrated in Fig. 17.

Because the DFT produces the same number of frequency samples, equally spaced, as there were points in the time waveform, there is a tradeoff between frequency resolution and time resolution (for a given sampling rate). For example, a 256-point transform with sampling rate of 8 kHz gives the 256 equally-spaced frequency components between 0 and 8 kHz that are shown in Table 4. The top half of the frequency spectrum is of no interest, because it contains the complex conjugates of the bottom half (in reverse order, corresponding to frequencies greater than half the sampling frequency). Thus for a 30 Hz resolution in the frequency domain, 256 time samples, or a 32 ms stretch of speech, needs to be transformed. A common technique is to take overlapping periods in the time domain to give a new frequency spectrum every 16 ms. From the acoustic point of view this is a reasonable rate to compute the spectrum, for as noted above when discussing channel vocoders the rate of change in the spectrum is limited by the speed that the speaker can move his vocal organs, and anything between 10 and 25 ms is a reasonable figure for transmitting or storing the spectrum.

Table 4 Time domain and frequency domain samples for a 256-point DFT with 8 kHz sampling frequency for transmitting or storing the spectrum.

<table>
<thead>
<tr>
<th>time domain sample number</th>
<th>frequency domain sample number</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>125</td>
</tr>
<tr>
<td>2</td>
<td>250</td>
</tr>
<tr>
<td>3</td>
<td>375</td>
</tr>
<tr>
<td>4</td>
<td>500</td>
</tr>
</tbody>
</table>

Table 4 shows that 256 samples are needed for the 8 kHz sampling frequency. The DFT is a complex transform, and speech is a real signal. It is possible to do two DFTs at once by putting one time waveform into the real parts of the input and another into the imaginary parts. This destroys the DFT symmetry property, for it only holds for real inputs. But given the DFT of a complex sequence formed in this way, it is easy to separate out the DFTs of the two real time sequences. If the two time sequences are \(x(t)\) and \(\bar{x}(t)\), then the transform of the complex sequence \(x(t) + \bar{x}(t)\) is a real DFT.
It follows that the complex conjugate of the aliased parts of the spectrum, in the upper frequency region, are

\[ G(\omega) = \sum_{n=-\infty}^{N-1} x(n)e^{-j\omega n} \]

and this is the same as

\[ G(\omega) = \sum_{n=0}^{N-1} x(n)e^{-j\omega n} \]

because \( b(n) = 1 \) (recall the definition of \( b(n) \)) and \( s(n) = 1 \) for any \( n \). Thus

\[ X(\omega) = \sum_{n=0}^{N-1} x(n)e^{-j\omega n} \]

exacts the transforms \( X(\omega) \) and \( Y(\omega) \) of the original sequences \( x(n) \) and \( y(n) \).

With speech, this trick is frequently used to calculate two spectra at once. Using 256-point transforms, a new estimate of the spectrum can be obtained every 16 ms by taking overlapping 32 ms stretches of speech, with a computational requirement of one 256-point transform every 32 ms.

The fast Fourier transform

Straightforward calculation of the DFT, expressed as

\[ G(\omega) = \sum_{n=0}^{N-1} x(n)e^{-j\omega n} \]

for \( n = 0, 1, 2, \ldots, N-1, \) takes \( N^2 \) operations, where \( N \) is the length of the transform, a complex number. There is a better way, invented in 1965, which reduces the calculation to \( N \log_2 N \) operations, very much simpler and much faster. This is the Fourier transform (FFT) for historical reasons, it would actually be better called the "slow Fourier transform", with the straightforward method above known as the "slow Fourier transform"! There is no reason nowadays to use the FFT, for it is surprisingly simple.

It is important to realize that the FFT involves no approximation. It is an exact calculation of the values that would be obtained by the slow method. Problems of aliasing and windowing occur in all discrete Fourier transforms, but they are neither alleviated nor exacerbated by the FFT.

To gain insight into the working of the FFT, imagine the sequence \( g(n) \) split into its aliased and non-aliased components, and evaluate the even and odd parts respectively.

Even \( e(n) \) and \( o(n) \) are generated by the transform of \( x(n) \) and \( y(n) \).

Then it is easy to show that if \( G(\omega) \) is the transform of \( e(n) \), and \( O(\omega) \) the transform of \( o(n) \), then

\[ G(\omega) = \sum_{n=0}^{N/2-1} e(n)e^{-j\omega n} + j \sum_{n=N/2}^{N-1} o(n)e^{-j\omega n} \]

or for \( N = 256 \) the summation is reduced to the following:

\[ G(\omega) = \sum_{n=0}^{N/2-1} e(n)e^{-j\omega n} + j \sum_{n=N/2}^{N-1} o(n)e^{-j\omega n} \]

The even part \( e(n) \) is aliased exactly into the transform of the odd part \( o(n) \). But don't stop there! The even half can itself be broken down into even and odd parts and so on to infinity. With this technique, the calculation is exactly the same as the original but divided into two at each stage. Providing \( N \) is a power of 2, this process is repeated until one point is left to be evaluated by the theory of linear systems.

Discrete linear systems. Figure 20 shows an input signal exciting a filter to produce an output signal.

The DFT can then be calculated in the frequency domain from the convolution in the time domain.

\[ x(n) \rightarrow X(\omega) \]

\[ Y(\omega) = \sum_{k=0}^{N-1} \sum_{n=0}^{N-1} x(n)h(n-k) \]

\[ h(n) \rightarrow H(\omega) \]

\[ Y(\omega) = X(\omega)H(\omega) \]

where \( x(n) \) is the input, \( h(n) \) is the system impulse response, and \( y(n) \) is the output.

The DFT of the input signal is multiplied by the DFT of the filter response to get the output signal.

\[ y(n) \rightarrow Y(\omega) \]

This convolution in the time domain is the same as multiplication in the frequency domain.

The frequency spectrum of the output is the product of the frequency spectrum of the input and the frequency spectrum of the filter. So we can see that the frequency spectrum can be transformed to the frequency domain and vice versa.

The spectrum of the input is multiplied by the frequency response of the filter to get the output spectrum.

\[ Y(\omega) = X(\omega)H(\omega) \]

where \( Y(\omega) \) is the spectrum of the output, \( X(\omega) \) is the spectrum of the input, and \( H(\omega) \) is the frequency response of the filter.

The DFT of the input signal is multiplied by the DFT of the filter response to get the output signal.

\[ y(n) \rightarrow Y(\omega) \]

This is the same as multiplying the frequency domain representation of the input by the frequency domain representation of the filter to get the frequency domain representation of the output.

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**Literature Received**

Catalogues of passive and active electronic components, hardware and tools, which includes a greater number of optoelectronic devices than usual, can be obtained from Oriel. The catalogue of electronic components by Micrometrics, who offer a catalogue through distributors March Microwave Ltd, 112 South Road, Reading, Berkshire, also contains a list of passive and active electronic components, hardware and tools.

**Technical Articles**

- **WIRELESS WORLD NOVEMBER 1981**
  - **Cartridge alignment gauge**
    - Simple device offers accuracy with convenience by R. J. Gilson, M.I.Mech.E.
    - As anyone who has attempted to position a pick-up cartridge accurately on a breadboard will realise, the so-called "protractor method" currently recommended is not by any means as positive in use as its advocates claim. There are two major difficulties; first, the fact that the cartridge is usually well hidden under the breadboard; and second, the fact that zero angle at the two projector radii cannot be achieved unless the overhang is correct. It seems not to be generally realised that the stipulation of zero angle at any two radii on the record necessitates a specific overhang value. The relationship between these factors was given in "The Cartridge Alignment Problem" in Wireless World, October 1981 (see later): $\theta = \sqrt{O^2 - R^2} - C$, where $\theta$ is the overhang, $C$ is the centre distance from the arm pivot to the turntable axis and $R$ is the radius for zero angular error. In practice it is not easy to measure overhang with any accuracy, and it is even more difficult to line up the cartridge with the protractor marked lines. Many cartridges are only about 12 mm or so long, and an error of 1 mm in this length could easily occur, giving an angular error of more than 5°.
    - Both these problems are avoided with this universal setting gauge. Figure 1 shows at the customary "protractor" method, and at (b) the new method, in which the replaceable y unit is removed from the cartridge body, and the setting gauge is inserted in its place. Figure 2 gives the detailed design of a gauge suitable for the VM-20 EII cartridge. For the other types the gauge position which engages with the cartridge body would, of course, be modified. The essential features of the form a snug fit in the cartridge without lateral play, and that it line up exactly 90° to the setting line running along the horizontal limb of it; it is necessary also that this setting line passes through the stylus point position.
    - The overhang is set first by aligning the turntable spindle with the slot near the cartridge which is elongated to accommodate a range of arm lengths of around 7-9 in. The correct end to use is indicated by the 7 and 9 figures marked near the slot. Intermediate figures can of course be judged, but suggested by the marks on the edges. Ideally, the overhang-setting slot should be located in line with the cartridge axis, but this would make it too inaccurate, and the position shown is more convenient. For those arms which have insufficient outward movement for the slot to reach the turntable spindle, an alternative slot position is indicated, but the nearer position is preferable.

<table>
<thead>
<tr>
<th>Dimensions below suit</th>
<th>VM-20 EII</th>
</tr>
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<tbody>
<tr>
<td>Width</td>
<td>2.65</td>
</tr>
<tr>
<td>Height</td>
<td>2.25</td>
</tr>
<tr>
<td>Depth</td>
<td>1.85</td>
</tr>
</tbody>
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Zing's newsletter Z-Bits is now in its second issue, the latest one including details of the Z-Lab development system for sixteen users, new peripheral devices, 2800 and 8048 c.p.s., conversion of the Z-Lab development system and a new 4K 8-bit quasi-static unit. Copies can be had from Zing (UK) Ltd, Beagle House, King Street, Maidenhead, Berks SL6 1AF.

A useful range of test and measuring instruments is being produced by Ross Instruments Ltd. The catalogue of instruments from Electroplan Ltd, PO Box 19, Orchard Road, Reynosa, Tamaulipas, MEX 811.

**WIRELESS WORLD DECEMBER 1981**

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Subscription television experimental station

One company's equipment in the pilot cable schemes just starting

by A. M. Peverett, M.I.E.E., Rediffusion Engineering Ltd

In the early sixties Rediffusion, in conjunction with the Rank Organisation, developed a coin box pay-per-view system designed for a payment-per-programme service. A monitoring system was also included to assess the popularity of each item. Although this cable television experiment was scheduled to start in Leicester in 1965, for various reasons it never went into operation. Indeed, British Relay was the only one of several companies preparing experiments to put a system into public service, successfully operating one programme in London and Sheffield for a year or so. The experiment was ended when the then-government refused permission for it to be expanded to an economic size.

Rediffusion is now making a contribution to the new pilot cable subscription television schemes in the UK, this company being one of several licensed to take part in the experiment. Called Starview, this service will operate in Burton-on-Trent, Pontypool, Taunton & Wells, Reading and parts of Hull, showing recent films — that is, about a year old — well before they appear on broadcast television. About fifteen movies are to be shown in any one month, in a schedule comprising two transmissions each evening with a late night film on Fridays and Saturdays, and a Sunday matinee.

The first screening is at 7.oo p.m., and no films with X certificates are transmitted before 10.00 p.m. by government regulation. This basic schedule is likely to be expanded as the experiment gains under way. During the painting and afternoon the networks will become a "community notice board" which may include messages from the Citizens’ Advice Bureau, the Job Centre, the Samaritans etc., as a sort of Exchange & Mart, and possibly even a weather forecast, accompanied by background music.

An economic charge for the channel is £1.2 a month, but in some areas this will be reduced to £8 or £10. This is in addition to the normal service charge input charge. The movies can be viewed as many times as the subscriber wishes.

Experimental pilot equipment

A typical Starview control room (at Hull) is shown in Fig. 1 and its block diagram in Fig. 2. The Starview system is capable of serving houses most of the electronic equipment apart from the standby video cassette recorder (v.c.r.) and the items associated with the caption generator, which can be seen in the middle of the block diagram.

Three editing U-Matic v.c.rs housed at the bottom of the bay in the Starview control room. The major part of the electronic equipment is in the bay on the left, but the stand-by v.c.r. is on the desk.

Fig. 1 Control room of the station at Hull. The major part of the electronic equipment is shown in the bay on the left, but the stand-by v.c.r. is on the desk.

rector is also required to adjust any frequency variations that occur between the tape drive system and the tape itself. In order to feed the programme with the correct v.c.r. start and changeover information, audio cue tones are recorded on channel 1 audio sound track of the video tape, channel 2 being used for the film sound track. The "start" tone consists of a 300Hz signal correctly positioned at the "start" point of each tape. The "changeover" or "finish" tone is a 450Hz signal, each lasting for approximately 10 seconds. These tones "cue" the programme, which in turn sends back the necessary "start", "stop" or "rewind" signals to the remote control sockets of the v.c.r., as described below.

Video cassette recorders

The reason for using editing U-Matic v.c.rs is that they have speed control of both the video drum (which contains the video scanning heads) and the capstan. This allows the scanning heads to be synchronized with the recorded signal and at the same time permits the video signal to be locked to the broadcast standard sync pulse generator. However, a timebase corrector is required to adjust any frequency variations that occur between the tape drive system and the tape itself. In order to feed the programme with the correct v.c.r. start and changeover information, audio cue tones are recorded on channel 1 audio sound track of the video tape, channel 2 being used for the film sound track. The "start" tone consists of a 300Hz signal correctly positioned at the "start" point of each tape. The "changeover" or "finish" tone is a 450Hz signal, each lasting for approximately 10 seconds. These tones "cue" the programme, which in turn sends back the necessary "start", "stop" or "rewind" signals to the remote control sockets of the v.c.r., as described below.

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Programmer

The programmer serves four basic functions:

- To start the v.c.r.s at pre-selected times.
- To change over from one v.c.r. sound and vision signal to the next (when more than one v.c.r. is in use), by means of cue tones.
- To stop the last v.c.r. at the end of the film programme and change back to captions.
- To transmit a 6-minute tone at the end of the last programme warning viewers to switch off their v.c.rs. This is in accordance with broadcast practice and will probably be accompanied by a suitable worded caption.

In Fig. 3 the programmer's front panel is shown. The shaded times for each programme are set up on thumbwheels, the programmes in set per day being controlled by switches below them. The "cove" or "finish" tone is a 450Hz signal, each lasting for approximately 10 seconds. These tones "cue" the programme, which in turn sends back the necessary "start", "stop" or "rewind" signals to the remote control sockets of the v.c.r., as described below.

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dard sync pulse to the v.c.t.s, and an electronic circuit to bypass the timebase corrector when the caption generator is in use, as this is not required for non-v.c.t. equipment.

Time base corrector

The v.c.t. video from the programmer and the broadcast standard sync pulses both go to the timebase corrector, where the video signal is decoded into its luminance and chrominance components. Any timing difference between the video and the sync pulses, due to speed variations between the tape and the tape drive, is converted into an error voltage inside the unit and used to alter the value of the charge coupled variable delay lines until the two signals are synchronized. The output is then used to deal with errors of up to two horizontal lines.

As the output signal is in an RGB format, a PAL encoder is used to convert it back to its previous (PAL encoded) form. The decoder in the process does not reduce the chroma noise.

Emergency switching

The three (coaxial) switches shown in Fig. 2 perform the following emergency functions:

S1 changes from the main v.c.t.s to the standby equipment in case of a v.c.t. (or cassette) breakdown.

S2 bypasses the timebase corrector, the encoder, and the sync generator in case any of these fail, all three being interdependent.

S3 switches between the v.c.t. and the camera, should the latter be used.

The audio signal selected by the programmer (or by switch S1A under standby conditions) is taken to the 2.9MHz f.m. sound modulator and them combined with the 8.9MHz vision signal prior to transmission down the network. As mentioned earlier, an audio signal is also transmitted for earlier Redifusion cable receivers.

The standard 'off-air' receivers are connected to the 'in circuit' timebase corrector via a battery connection to the tape deck, the remaining seven pages being used to store apology captions, forthcoming movie programmes, announcements, etc. In addition, any of these seven pages can easily be updated when necessary.

To maintain a permanent record of the captions actually transmitted, a printer is also provided.

Caption colour background. By feeding the sync pulse to the vertical sawtooth signal from the sync pulse generator to the Red, Green and Blue socket of the PAL encoder, two

Back-up battery power supplies are provided in order to keep the programmer, sync pulse generator crystal oven and the two modulators operating in the event of a power failure. This ensures that as soon as the mains supply returns (or a standby mains supply is switched in) the programme will continue from the point at which it stopped.

Caption generator

Block diagram of the caption generator equipment is shown in Fig. 4. The basic caption generator comprises a keyboard and a memory unit which is capable of storing eight pages of information, each of which can be previewed on the video monitor. However, by using a cassette memory interface together with an audio cassette recorder, it is possible to store approximately 150 different captions on a C50 cassette. In addition, by using a cassette recorder which has an auto reverse facility when it reaches the end of the cassette, with a total of five complete cycles, 10 hours' playing time can be achieved.

Each taped caption appears on the monitor as a "print-out", the page being completed in approximately 15 seconds. It is then held for a further 12 seconds or so before the next page begins. The caption will be accompanied by background music, playing a recording of an identical cassette recorder/playback.

One of the eight pages of the basic memory unit is to be kept free for the taped captions, the remaining seven pages being used to store apology captions, forthcoming movie programmes, announcements, etc. In addition, any of these seven pages can easily be updated when necessary.

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Caption colour background. By feeding the sync pulse to the vertical sawtooth signal from the sync pulse generator to the Red, Green and Blue socket of the PAL encoder, two

thing are achieved: the caption generator is locked to the broadcast standard sync, and the caption generator is then made to follow the beat and saturation depending on the signal levels fed to the RGB sockets of the encoder.

In fact, orange has been found to be quite a remarkable colour when using white lettering, and is obtained by using the red and green inputs only, the blue input being omitted.

The colour generator is designed to provide a wide range of colour systems, and is capable of colorizing any material, including news reports, commercials, and live shows.

Caption generator output is fed to the caption encoder, which is responsible for converting the caption signal into an RGB format suitable for transmission.

The caption encoder is a black box, and is not visible to the viewer. The caption signal is fed into the encoder, which then converts it into an RGB format suitable for transmission.

The RGB signal is then fed into the caption decoder, which is responsible for converting the RGB signal back into a format suitable for display.

Caption decoder

The caption decoder is a black box, and is not visible to the viewer. The RGB signal is fed into the decoder, which then converts it back into a format suitable for display.

Caption decoder output is then fed to the video monitor, where it is displayed to the viewer.

News on delect

I was very interested to read Len Brown's "Arau's" September columns. I feel, however, that the optimistic over-enthusiasm which took the place of the change of news in the August column makes one point that is true. The point is that we are concerned with the motivation and not the making of news. If, for instance, a politician, prime minister, pope, or president between early morning and lunchtime, then clearly we can report it.

On second thoughts, though, with computer systems becoming more sophisticated, and software more sophisticated, perhaps we should be getting into the news business. Or, perhaps not.

Graham Clayton

Slye Editor, Cariatid BBC Television Centre London W12

Making ploughshares

I would like to acknowledge Mr Adrian Belcourt for his letter in the August issue. I do not think I have received a more thoughtful or more eloquently expressed exposition of the "double standard" argument anywhere before.

The caption generator is rather different, but perhaps that reflects my own interest in the captioning of news programs. For one of those (the doctors say because of some accident and another hypothesis involved in the case, etc.). This means that he lives in a very much simplified world, where many of the inhibitions and taboos are used by the rest of us as d e f e n s e  or abridgment. It is therefore sometimes possible to group the captions which we use to make him feel secure, instead of pushing aside the mask of masks that most of us endure ourselves.

A couple of years ago, he developed a fascination for comics, and this could have been reaction against parents. I must say that this has not. When someone says something that is standing behind the gag, in order to obtain the captions that are a personal status which he felt that otherwise he was looking.

What I would like to achieve making ploughshares, I might point out that at least some of us have had the guts to use. Those of us who have used (and I have been involved in the founding of two companies, both of which are beginning to find their way in the world) have found that the captioning of military electronics is strictly for the boys of this world.

Agricultural electronics, which I am sure and more convinced must be classified as a discipline in its own right, has been described as "field equipment" and has been marketed as a specific equipment for agricultural purposes, and it makes that its operation of a magnitude more difficult and more expensive than a general IS, or a general operating system of any particular or of any particular. In fact H is in general consists of two components: one due to the captioning system, and the other arising from any magnetic field to quite and quite even though there are no free currents in the free space.

If one wishes to separate the B field into the component arising from free currents, then the component arising from any magnetization which occurs, then the equation B = H + M must be rewritten in the form

\[ B = H + M \]

where \( H = H_0 + M \) is which describes the spatial distribution of the free currents, and \( H_0 \) arises from any magnetized bodies that may be present in the vicinity, and is usually referred to as the demagnetising field. Only in the case of a uniformly magnetized line is \( H_0 = 0 \), and \( H = H \).

The falsification statement that \( \bar{H} \) depends only on the spatial distribution of the applied currents, with the implication that \( \bar{H} \) can be derived from the free current only, seems to be widely believed. The missing statement to arise from the fact that in the equation \( \bar{V} \times \bar{H} = 0 \) the \( \bar{H}_0 \) component of \( \bar{H} \) is everywhere. \( \bar{V} \times \bar{H} = 0 \). In general, \( \bar{H} \) is not everywhere zero, hence \( \bar{V} = 0 \). Similar remarks apply to the D vector.

T V-Broadcasting Education Centre

The author replies. I have opened the analysis proposed by W. James, but let us start with what I take to be a significant point to which he refers in his letter, and that is the complete specification of any vector, such as \( \bar{H} \), requires the specification of its components. For example, the relation between two "free" current lines as magnetic field lines is entirely spurious, whereas current lines are a physical object. The field lines are the result of the arrangement of certain electric charges. From this the solution follows from the relation \( \bar{V} \times \bar{H} = 0 \), where \( \bar{D} = \bar{D}_0 + \bar{D}_1 \) and \( \bar{D}_0 = 0 \times \bar{H} \). It is also impossible that \( \bar{V} = 0 \). Hence the \( \bar{H}_0 \) component is everywhere.

The author suggests that the existence of a "magnetic charge" which I can only interpret as a free magnetic pole, originates from the relation \( \bar{V} \times \bar{H} = 0 \), where \( \bar{V} \) is any vector and \( \bar{H} = 0 \). A complete specification of any vector, such as \( \bar{H} \), requires the specification of its components. The change in the sign of \( \bar{H} \) without any "free currents can produce a divergence of \( \bar{H} \) or any "free" currents can. Moreover, the existence of a divergence would mean that the existence of a "magnetic charge" which I can only interpret as a free magnetic pole, originates from the relation \( \bar{V} \times \bar{H} = 0 \), where \( \bar{V} \) is any vector and \( \bar{H} = 0 \). A complete specification of any vector, such as \( \bar{H} \), requires the specification of its components.

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The death of electric current

My attempt to argue in my reply to my letter in the August issue that the conventional theory of the electric current carried by conductors is anachronistic with transitional conditions, to which I cannot agree. However, I am glad that the controversy on this issue is to be resolved and it is possible to explain the attitude of the velocity of light thus creates an effect

Training medical technicians

I read the news items "Medical technicians get a new deal" in your May issue with grave concern. There are already existence in MPPM technicians, the majority of whom are trained in the NHB, national hospital and military hospitals.

I have there are many pitfalls not apparent to the technician one cannot isolate the need of hours of hard work to establish a correct mindset but even when the qualification is gained this must be supplemented by the employer and it should be first established whether the employer and the employees have been further examinations.

In many years the Federal Associations of Medical Technology have been working in close liaison with the Technical Education Council and the DRE for a Diploma Course at O TEC level and this is now in the final stage of preparation. Technicians are also represented by the HNCTEC through the Federated Associations of Medical Technology.

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with the heating effect of rapid charging, probably carried past the end point. However, this means of charging in 20 min from the cold condition is obviously here to stay at model radios and I merely suggest that cells should not be bound in and also to relay a rumour that new cells should be cycled twice before rapid charging is carried out.

NiCad packs accidently shorted can make the charging wire very hot indeed and hence constitute a fire risk, and I suggest interchangeable packs or battery boxes should be developed with contacts below the pack surface, so for instance in the sucker used on cassettes etc. for 6V power input, thus eliminating the fire risk. Finally it is hard at the moment to get chargers for 2 or 3 small cells and I hope large, versatile chargers will be produced.

Bernard Jones
London

Gag on authors

I think I can help Mixer. In the August issue is was wondered why "Wired" World does not get more contributions from Russia. Part of the answer may lie in the following extract from a book by John Baner.

"Science is controlled more closely than religion (in Russia). The party needs and scientists. It must allow them to function in executive scientific enquiry if the nation is to progress, yet it does not let them apply scientific enquiry to political, economic, and social subjects." It must grant access to Western research data while shielding them from Western ideas. It must grant enough freedom and status and incentive to do creative work but not enough to cause them to speak out publicly, as Sakharov has done. The RGB regulates this dilemma."

"KGB", 1974, p.120.

S. Frost
Edinburgh

Electronic organ sound

Mr F. E. Norrington asks in May Letters why so many electronic organs stop sound unsustained the presence of many of the upper harmonics in the sawtooth waveform applied to the stop-filters. One important factor in this matter must be the presence of out-of-tune harmonics in the output of a large number of styles of organ pipe as mentioned in "This Organ" by W. L. Sommer (Macmillan and London, 1973) and "Dictionary of Pipe Organ Terms" by Stevens Irwin (Schirmer Books, New York, 1980). Specifically, many of the flute pipes are tuned by rolling down strips of metal between the tops of the pipe and the reed mechanism is performed by adjusting the reed. The effect of such tones is to make the pipe appear to be a different length to different frequencies which will cause the harmonics to be out of tune (sharper in this case) return to the fundamental. In fact certain of the string stops have a fundamental at the top spique deliberately, apart from any tuning function, in order to give a distinctive sound by this means. In addition narrow pipes, as used in string-toned stops, will produce out-of-tune harmonics even if they are completely cylindrical, due to effects involving the resonance phenomena.

The effect of such harmonics is to form beats between themselves and the fundamental producing the rich sound a rudimentary and which is hard to imitate electronically.

Additional effects may also contribute, including the addition of noise of various kinds.

The brilliant effect of a full chorus on the pipe organ arises from the slight clashing of pipes which are inevitably slightly out of tune, in addition to any effect of the harmonics of individual pipes. This effect is termed the "chorus effect."

Some electronic organs use the expediency method of forming sawtooth waves and using some form of octave division to generate the correct harmonics. This prevents the occurrence of chords effects at all the unions of a number of are generated together and any octaves are phase locked to this. In addition, many electronic organs generate the mutations stop (rounding intervals such as flats to the union) by taking them from the appropriate generator. The use of the G generator to produce a fifth with C. This sounds wrong because the integers of the octaves are tempered whereas mutations on the pipe organ are tuned to integer values.

The lack of chorus effect with many designs of electronic organs can be improved if more octaves are used in generating the tones, and in particular if mutations are generated by their own oscillators. Inhibition of the out-of-tune harmonics is more difficult but may be produced by some form of frequency shifting or ring-modulation of the tone. This has the difficulty that different stops may require different degrees of modification in this way and there would also be changes necessary within the organ with different circuits to do this type of modification cheaply.

The production of a tone which is merely harmonically rich and one which is "harmony" of some kind or other in the latter. The most effective imitations of pipe organ reeds that I have heard use some form of electronic resonator (inductive or gyrator) with a fairly high Q to produce a fundamental with some extraneous noise level. To further add to the problem, the circuits used in a single string, several groups can be controlled as shown in Fig. 2. The transistors should be matched to provide equal Iregulation in each string. NorbaNet Electro-Optics
Reading
Berks.

The Nuvisor

The threat of damage to semiconductors by overcurrents in power supplies created a revival for valves, particularly in military equipment (News, September). I expected this trend to be accelerated by the introduction of the Nuvisor. Whatever because of this device? The only components which have been seen the oscilloscope. One would have thought that the circuit could have been designed to make good use of Nuvisors. A. J. Tromby
Plymouth

C.m.os. to mains interface

Mains control by c.m.os. logic can be safely achieved using this isolation circuit. Almost 360° conduction is assured by the a.c. voltages, and higher currents can be switched by using larger transistors. The 555 oscillator provides a master enable input and can drive extra switching stages as shown. L. Harn
Auckland
N. Zealand

Piezoelectric-crystal driver

Because piezoelectric-sounders are most efficient at their resonant frequency, drive circuits should be adjusted to match these individual crystals. This oscillator drives a crystal and does not need to be adjusted with the crystal in situ. The circuit is a non-inverting a.c. amplifier whose gain approaches the open-loop gain of the op-amp, and has a feedback signal coupled via the piezoelectric device. The ceramic element acts as a stable mechanical vibration which determines the frequency of oscillation so the circuit automatically oscillates at the sounder’s resonant frequency. The circuit shown requires about 3.5mA with a 5V supply. M. L. Ford
Worcester

Regulating l.e.d. outputs

Using a simple compensation circuit based on an op-amp controller, the power output of l.e.d.s in series can be maintained within ±25% of the value at 25 deg. C. Over their full range temperature range. Compensation is required to overcome the negative temperature coefficient of most infrared l.e.d.s which decreases the power output by 0.9% per deg. C. Increase. Fig. I maintains the output current at a constant value forward current If through the I.e.d. string. The in-op-amp is used as a reference device and the collector-base photodiode is used as an output monitor. A CA3140 op-amp regulates Ib by maintaining a steady current through the sensor. In addition, the l.e.d. output power can be controlled by the potentiometer. The supply must provide adequate voltage for the l.e.d.s, i.e. 2.4V ± 1.4 times the number of l.e.d.s in the string. Tempereature performance will be improved if the l.e.d.s are matched. Resistor Rf limits the current through the string and is determined by calculating the maximum current required and the value of Vcc above the minimum value required. Ib, due to a low Vcc, the l.e.d. cannot be used in a single string, several groups can be controlled as shown in Fig. 2. The transistors should be matched to provide equal Iregulation in each string.
Simple c.m.o.s. switch
A single c.m.o.s. transmission gate can be used as a touch switch which requires practically no current when off. The gate is wired as a bistable and two diodes steer a 50Hz signal to change the state of the switch. Resistors R should be 4M1 for supplies between 5 and 8V, but can be increased for higher supply voltages. Capacitor C smooths the 50Hz signal and prevents the transmission gate from turning on when the power is applied.

P. Record
Glasgow

Accurate op-amp bridge
When measurements are made using resistive transducer, the sensors are often included in the arms of a balanced bridge. An improved circuit can be achieved by using an op-amp in each arm of the bridge and positive going transducers (+AR) in arms 1 and 2 or negative going types in arms 3 and 4. The bridge can be built around a simple quad op-amp such as the LM324, and four matched sensors, and can be powered by d.c. or floating a.c. Output voltage is

\[ e_{out} = \frac{4AR}{R} \]

This shows that the output is linear over a wide range and has a four-fold sensitivity compared with a single op-amp bridge. The circuit can also provide high output voltage, low output impedance and high noise immunity.
N. Balakrishnan
Bangalore
India

Output amplifier with offset and selectable polarity
This circuit was developed as an output stage for a function generator. Output waveforms of either polarity can be selected and added to an offset voltage which is variable and unaffected by the polarity switch. Input impedance is 13kΩ with the switch in either position.
M. P. Hadley
Southampton

Interfacing microprocessors
Input and output functions
by J. D. Ferguson, B.Sc., M.Sc., M.Inst.P., J. Stewart, and P. Williams, B.Sc., Ph.D., M.Inst.P.
Microelectronics Educational Development Centre, Paisley College of Technology

Part one of this series outlined a universal interface for 6502 microprocessor boards and microcomputers. Part two describes the operation and functions of the main IC and gives simple examples of driving the devices using machine code or BASIC.

The 6522 v.i.a. is a very powerful device which can perform several functions simultaneously. It consists of several independent sections controlled by 16 8-bit registers which occupy 16 sequential locations in memory, the base address being selected by decoding on the microprocessor board. Some registers are directly accessible via the pins of the i.e., while others are set and monitored by the data bus. Each register is selected by the four least-significant address bits, A0 to A3, with the i.e. activated by chip-select pins. Data enters and leaves the 6522 in 8-bit bytes and two registers, called ports A and B, are reserved for this purpose. In a hardware oriented system the designer would specify one port as an input and the other as an output, but this would take no account of a common requirement for unequal numbers of pins. For example, if a dozen sensors are scanned and two or three warning indicators are driven, it would be costly to design a range of boards to cope with the large number of possible variations. An alternative scheme has a controlling register associated with each port called the data-direction register. For every bit set to 1 in the d.d.r., the corresponding pin of the port behaves as an output, while a 0 sets the pin to behave as an input. Changing the contents of the d.d.r. can, in one step, alter the status of any or all eight pins of the corresponding port. Similar control can be achieved over the functions, and Fig. 1 shows the format of the auxiliary control register. This is the eleventh register out of sixteen on the chip, and is itself selected by the address decoding at A000 to A00F. Therefore, the address of this register is A00B. Bits 0 and 1 determine whether the latches associated with the ports are latched, allowing data to be held during sections of a program. Bits 2 to 4 control the shift register, determining whether it is used for serial to parallel or parallel to serial conversion, and also the source of the timing pulses. One of the two internal timers can be used to generate simple time delays in a so-called

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monostable mode or to count the number of transitions on a particular pin of a port. The last facility is useful for event counting or as the basis of a frequency meter, while the monostable mode has wide applications in controlled time delays. The timer has an internal 16-bit register which can be preset to a prescribed value under program control, with interrupts being automatically generated at time-out. The second timer has a monostable mode under the control of bits 6 and 7, but can also be used as a free-running generator oratable to repetitively switch an output pin from 0 to 1, with each half-cycle set by the value latched into the corresponding register. This allows the value of a given half-cycle to be continually modified until the end of the previous half-cycle is reached, by which time the timers run independently of the microprocessor once a sequence has commenced. However, the microprocessor can always intercept and control the sequence.

The complete range of functions is large and a summary is shown in Table 1, which should be considered in conjunction with Fig. 2. Selected functions will be covered in future articles but full details are available in references 1 and 2.

### A-to-D converter

Most a-to-d converters take a single analogue input signal and produce a binary-coded output after an interval of typically tens or hundreds of microseconds. In engineering systems it is more often necessary to rapidly scan a series of inputs and collect the data for further processing. This is possible by combining an a-to-d converter with suitable analogue switching, and a suitable circuit is now available in a single low-cost IC. The ADC 0818 covers 16-channels automatically with an expansion capability for larger systems and, although the problem of signal conditioning remains, for applications with signals below 0.5 V a self-contained system is possible.

The block diagram in Fig. 3 shows the main features of the system. An 8-bit decoder, normally driven from the four least-significant bits of the address bus, selects the analogue channel in use. The decoder can be enabled and the conversion started by the rising and falling edges of a single pulse. The appropriate analogue signal is switched through, with an intervening common stage of signal processing or filtering if required, and a chain of resisters across a reference voltage is scanned with a successive approximation register until a match is found between its output and the signal being measured. The most-significant bit is latched first and accepted or rejected after comparison with the unknown. Each further bit of the eight is similarly tested so that the summation voltage becomes closer and closer to the unknown voltage. Each conversion takes exactly eight test cycles regardless of the value of the unknown, which provides fast and precise timing relationships suitable for multi-channel systems.

**Fig. 4. Internal ladder network of the ZN425E.** The ladder can be powered by an internal or external reference.

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### Table 1. V.I.A. registers and functions. L = 0.4 V, H = 2.2 V

<table>
<thead>
<tr>
<th>Register select</th>
<th>Addressed register</th>
<th>Address</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>132 H</td>
<td>W.B.8</td>
<td>16399</td>
<td>High, D = 0</td>
</tr>
<tr>
<td>132 L</td>
<td>W.B.8</td>
<td>16399</td>
<td>High, D = 1</td>
</tr>
<tr>
<td>133 A</td>
<td>W.B.8</td>
<td>16415</td>
<td>Low, D = 0</td>
</tr>
<tr>
<td>133 B</td>
<td>W.B.8</td>
<td>16415</td>
<td>Low, D = 1</td>
</tr>
<tr>
<td>134 A</td>
<td>W.B.8</td>
<td>16431</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>134 B</td>
<td>W.B.8</td>
<td>16431</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>135 A</td>
<td>W.B.8</td>
<td>16447</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>135 B</td>
<td>W.B.8</td>
<td>16447</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>136 A</td>
<td>W.B.8</td>
<td>16463</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>136 B</td>
<td>W.B.8</td>
<td>16463</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>137 A</td>
<td>W.B.8</td>
<td>16479</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>137 B</td>
<td>W.B.8</td>
<td>16479</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>138 A</td>
<td>W.B.8</td>
<td>16495</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>138 B</td>
<td>W.B.8</td>
<td>16495</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>139 A</td>
<td>W.B.8</td>
<td>16511</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>139 B</td>
<td>W.B.8</td>
<td>16511</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>140 A</td>
<td>W.B.8</td>
<td>16527</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>140 B</td>
<td>W.B.8</td>
<td>16527</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>141 A</td>
<td>W.B.8</td>
<td>16543</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>141 B</td>
<td>W.B.8</td>
<td>16543</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>142 A</td>
<td>W.B.8</td>
<td>16559</td>
<td>16-bit, W.B.8</td>
</tr>
<tr>
<td>142 B</td>
<td>W.B.8</td>
<td>16559</td>
<td>16-bit, W.B.8</td>
</tr>
</tbody>
</table>

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### Table 2. Driving the interface Lex in machine code and Basic.

<table>
<thead>
<tr>
<th>Assembly</th>
<th>Basic</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOV R1, 1</td>
<td>MOV R1, 1</td>
</tr>
<tr>
<td>MOV R2, 2</td>
<td>MOV R2, 2</td>
</tr>
<tr>
<td>MOV R3, 3</td>
<td>MOV R3, 3</td>
</tr>
<tr>
<td>MOV R4, 4</td>
<td>MOV R4, 4</td>
</tr>
<tr>
<td>MOV R5, 5</td>
<td>MOV R5, 5</td>
</tr>
<tr>
<td>MOV R6, 6</td>
<td>MOV R6, 6</td>
</tr>
<tr>
<td>MOV R7, 7</td>
<td>MOV R7, 7</td>
</tr>
<tr>
<td>MOV R8, 8</td>
<td>MOV R8, 8</td>
</tr>
<tr>
<td>MOV R9, 9</td>
<td>MOV R9, 9</td>
</tr>
<tr>
<td>MOV R10, 10</td>
<td>MOV R10, 10</td>
</tr>
</tbody>
</table>

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www.americanrepublisher.com
Table 2(a) illustrates how the v.i.a. can be used to output a byte in parallel form on port B. The v.i.a. registers are treated as memory locations by the programmer and can be read or written to in assembly language using LDA or STA instructions, or in Basic using Peek and Poke instructions.

The ADC 0817 has been designed to be compatible with a wide range of microprocessors and Fig. 6 shows how most of the signals used by the converter can be taken directly from the 6502.

Data bus
0
Channel select The four least-significant address lines can be used to select each of the sixteen input channels.

The R/W line is not used directly but is gated with the 0 clock to produce the Non Read Data Strobe, NRDS, and the Not Write Data Strobe, NWDS. NRDS and NWDS only go to zero during the positive part of 0 clock. A Read or Write cycle respectively as shown in Fig. 7. Fig. 6 shows how a Write operation to the i.e. activates the NWDS and creates the necessary transitions on the address-latch enable pin and initiate-conversion pin to perform the following tasks. Select the input channel from the address currently on the four least-significant address lines. Initiate an analogue-to-digital conversion. After a 100us delay, a Read operation activates the NRDS, enabling the tri-state output and placing the digital signal on the data bus. Table 2(b) shows the programming instructions used to drive the i.e. A Write instruction, STA or Poke, is used to define the input channel and initiate the conversion. After a delay a Read instruction, LDA or Peek, obtains the digital information.

The ZN425E is not directly compatible with a microprocessor and must be used with the 14L3573 which latches transient data from the processor and provides the 425E converter with a continuous digital input.

The latch is memory mapped and enabled by a chip-select signal from the address decode circuit, see Fig. 8. This ensures that the latch captures stable data on the bus during the positive part of the 0 clock. Table 2(c) shows how the 425E is used in Basic and assembly language.

In response to Mr Darwood's 'Accurate sine-wave oscillator' article in the June issue of Wireless World, the author shows here that the digital implementation used to generate accurate sine and cosine functions can be replaced by simple analogue circuits. A prototype circuit operated over three decades with ±1dB amplitude variation, less than 1° error between the quadrature outputs and around 1° or less distortion. The circuit requires only four quad-LCs.

The algorithm recently described by N. Darwood for generating sine and cosine functions with digital implementation may also be produced by analogue means, as will be shown. The circuit is really a form of recursive digital filter but I am unprepared in calling it an analogue implementation since no digitization in the proper sense occurs.

The prototype operated over three decades of frequency with amplitude variations of ±1dB, distortion about 3% or less, and phase error between outputs less than 1°. Only four cheap quad-LCs are required, although Fig. 2 shows six i/o, since the four dual op-amps can be replaced by two quad-op-amps such as the LF347.

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used two op-amps fewer but was limited to about 30 steps per cycle, as second order terms make circuit errors more critical. Phase-shift oscillators using three or four cascaded single-pole filters were also tried. These oscillators were more doile than those previously described, but four sections were required to obtain quadrature outputs and almost twice the component count of the circuit described here gave an inferior performance. D.C. stability was, however, better as feedback at d.c. is negative and thus reduces offsets. The circuit described here is sensitive to offsets because of positive feedback at d.c., so offset null adjustment is included.

Fig. 1. Circuit diagram of the oscillator and clock. Op-amps A1 to A4 were four LF353N ICs in the prototype but they can be replaced by, say, two LF374 quad ICs if required. These op-amps have D.C. inputs.

Fig. 2. Circuit diagram of the oscillator and clock. Op-amps A1 to A4 were four LF353N ICs in the prototype but they can be replaced by, say, two LF374 quad ICs if required. These op-amps have D.C. inputs.

Fig. 3. Oscillograms for oscillator frequencies between 5Hz and 16kHz. A single sweep time-base was used for all but the 16kHz wave-form in order to show the steps (the steps are not necessarily synchronous with the output frequency).

**Fig. 4.** (a) is the 50kHz sweep expanded to show the steps more clearly. (b) shows a Lissajous figure resulting from the two oscillator outputs at BNC, and (c) is as (b), but at a frequency of 5kHz.

**Technical Specifications**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Impedance</td>
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</tr>
<tr>
<td>Maximum Input Voltage</td>
<td>1000 V DC at AC point</td>
</tr>
<tr>
<td>User Resistance</td>
<td>1435 ohms to earth</td>
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<tr>
<td>Power Requirements</td>
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<td>9V DC</td>
</tr>
<tr>
<td>Weight</td>
<td>200 gms</td>
</tr>
</tbody>
</table>

The TH301 is a hand-held LCD digital thermometer designed to accept any standard type K (NiCr-NiAl) sensor and offering a measurement range of -50°C to 750°C with 1°C resolution. Accuracy is better than 0.5% and precision automatic cold junction compensation maintains specification over a wide ambient range. Battery life from the 9V alkaline battery supplied is in excess of 1000 hours and display indicators are provided for low battery condition and open circuit thermocouple. The TH301 is fitted with a standard type K socket which will accept a wide variety of standard probes. A general purpose fast response naked-bead thermocouple is supplied with every instrument, which makes it completely ready for use at a price of only £59.50 + VAT.
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Since their introduction a few years ago, Telequipment's D1000 series oscilloscopes have established themselves at the forefront of the market. High performance because they are the result of intensive research and design effort by one of the world's leading electronic instrument manufacturers, and low cost because of volume production in a modern automatic production plant.

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limits, not maxing. For example, the D1016A bandwidth is specified as 2GHz. The typical figure is actually in the region of 25 to 250MHz and the usable bandwidth near 200MHz. Input attenuator tolerances are now specified at ±2% for all D1000 series oscilloscopes, a considerable improvement over the previous ±5%. But again, the user may find the true figure closer to ±2%.

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The D1016A also has a new CRT. The size is just the same easy-to-view 10 x 8 Bum but with an internal graticule and a quick-heat cathode. It has a "G" phosphor which is near a equivalent to the P31 but is more efficient actinically at low beam currents and high writing speeds.

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100MHz or 20MHz with 50V/div sensitivity at full bandwidth and 10V/div at 5MHz in the D1016A, 4MHz in the D1011, and a choice of display modes. Algebraic Add, True X-Y, Channel 1 and 2 Chopped or Alternated, Channel 2 only, and Channel 2 Inverted.

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Telequipment

Cables were first used for broadcast distribution in the 1920's and were extended and updated to include television, two and then three channel tv. The sale of these to the broadcast areas to areas where the reception was poor or non-existent. Since then, improvements in apparatus, improved antennas and the development of the broadcasting networks have made the need for cable distribution redundant and the subtracter to the cable services were reducing in numbers. However, the cable networks exist, and Telequipment, amongst others, have been presenting the Government to be allowed to instal equipment.

Subscriptions for televisions.

When Reao-Dacox bought several digital displays from Hewlett-Packard for use in radar equipment, the display incorporated in the displays were manufactured by Cheaps & Reed Ltd in London, 30 miles away from the Reao-Dacox Marine Radar Plant in New Mexico, Summit, to cover those mile they had to ration 90,000 miles across the Atlantic and back. The display was made up of 310 units to give an analog readout with three seven-segment i.d. digits to the centres. Because the printed pads has to match up with the local, the digits are positioned and the pattern registered to within 0.003m.
The British Standards Institution has published the first Part of DD 735 The structure and representation of data for computer application level (DAL), a major Draft for Development describing a technique for representing digital data that could lead to massive economies for users in industrial, commercial and public sectors. Envisioned Part 1: Basic principle, the Draft is designed to achieve direct computer comprehension and provides the basis for the "first language" that is to be used irrespective of differences in the equipment used.

At present, communications as such involve and require specialized organizations were written units of individual programs. Quite apart from the prohibitive cost, there are just not enough machines and programmers available to cope with interchange on this basis.

Obviously, the long-term solution is to adopt standard messages using standard software. Some industries with particularly urgent needs have, in fact, already developed their own standards; notably those now used in financial and airline computer systems. Currently, some 16 per cent of all clearing bank transactions and probably well over 90 per cent of airline communications are dealt with according to a common standard. Even within groups, however, has the necessary expense to devise independent standards, especially where messages are required to cross sector boundaries.

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One of the early uses of the equipment has been to produce a teleotter decoder capable of identifying the data sequences in the normal pages as they are broadcast, but with a better quality of character. The character set found at present, when the teleradiation specification was written, five years ago, the shape and style of characters were deliberately chosen to meet the requirements of the equipment. Manufacturers could offer a predictable sequence of characters, and could use a reproducible form of "alphaphotograph" coding. It has already been used by a teleradiation decoder on the Experimental Unit at the BBC, where the decoder can be driven without the need for a control computer.

The software, which controls the commands of the decoder, has been written to give a high degree of memory for the program. The character set can be stored in tables for each step of scanning for maximum flexibility. Each data table defines only those pages which need to be changed, assuming a current state. There is no need to define the whole screen for each step. The microprocessor is triggered 25 times a second by the input controller and the whole screen can be started automatically.

As a programme of work, supported by the Department of Industry, BBC research department has produced several design studies to enhance the British teleotter system.

Commercial communications, including television, require elaborate antenna systems on Earth.
Microcomputers in schools—free

An enterprising businessman in Berkshire, Mr. Len Lewis of Audio Systems Components Ltd., in Thame, has come to an arrangement with the local school whereby he will provide ten Commodore microcomputers for the first time.

He gets in exchange the classroom space to hold evening classes for courses in computer programming.

Mr. Lewis told us that his project was not entirely altruistic, that he wants to develop the idea even on the basis of well-attended classes, "I believe that any profit will be all the better for knowing that the school children are benefiting from high street battle of personal computers

Two items of news which affect the microcomputer came out at about the same time. One was that the market size is going to grow and IBM, is to market a micro. There have been many many such announcements, but a point of interest is that it is now in a market which is said to be worth £30 million a year.

The other announcement is a reduction in price from the BBC, who have recently announced a price for their small computer at £200. The BBC have also introduced a more sophisticated machine, the BBC micro, with a price of £400. The two machines are to be sold in kit form, but the BBC are to sell them under a licence agreement with Logik Design.

W. H. Smith & Son, Boots, Argos and Rumfords are all planning to test-market the Texas Instruments 99/1 computer, but at present there are not enough to go round the country and Commodore will be selling only through computer shops. The Victoria has been sold in many computer and software shops, and software for it is available.

Enthusiasts who are using the machines are expected to add to the software library, and it is hoped that they will form the basis of a large-scale distribution of software for the machines.

High street battle of personal computers

A LaserVision display at a visualisation station at the Blackburn Evening Press. There are produced under "tackled" conditions like those required for integrated circuit production.

High street battle of personal computers

When developing, testing or repairing complex digital circuits, particularly microprocessor based systems, a waveform display on the oscilloscope is an invaluable aid. The oscilloscope provides a visual confirmation of circuit operation and this information is helpful and often essential. A convenient method of displaying data is a dot matrix display, and this interface enables four to eight lines of information to be displayed simultaneously.

The circuit is connected to the address pins of a microprocessor system and provides X and Y inputs suitable for a 512x512 oscilloscope. The design is based on a 16 bit A/D conversion circuit which uses a dot matrix display. A surplus MK2002 is shown in Fig. 1, but any character generator which gives character patterns can be used. The display comprises 32 characters and is generated from a 5 x 7 dot matrix. Three dot spaces are used between characters and three line spaces between rows. The display does not use X-OR-nulation to produce the characters, instead character information is encoded and produces the X-Y dot data for each row. This bit by simulated display produces 1 of 1 data for each dot on a line. This by simulated display produces a binary code which is written on to the memory and is accessible by the computer.

Column output information from the MK2002 is selected each of the four 74151 1-out-of-8 switches which are used. The lines are shifted by each other by using weighted outputs from the 4515 and driving the Y axis of a static r.a.m. and, as the MK2002 to a m.o.s. device, a.t.t.i. to the m.o.s. interface is provided by two 4276 high-voltage NAND gate i.c.s and 74141 one-of-ten decoder-driver.

Clock pulses are generated to a 4003 7-stage column counter which selects the column decoder through eight steps and changes the column selected for each character. At the end of each 8th count, the r.a.m. address is incremented by the address selector to present the next character on the same row. After addressing and displaying 16 characters on the first line of the first page, the clock cycle is disabled by a flip-flop which detects the 128th count from the 4042. On the next line the clock gate is enabled by the rising edge of the time base signal, which is derived from the clock cycle. On the next line the clock gate is enabled by the rising edge of the time base signal, which is derived from the clock cycle.

IBMs character output on the standard BBC microcomputer uses a 4043 display character generator and allows 1.500 characters to be stored in the display. When the address decoder selects the 1st row, the display is updated by the 3rd row and so on. However, when the address decoder selects the 5th row, the display is updated by the 2nd row. The address decoder selects the number of rows to be displayed by the 4515 decoder, which is a 1-to-8 decoder and four of these are used to select the rows to be displayed.
**Electronic Displays '81**

With the continued success of Electronic Displays, this year's show was held in the more spacious Kensington Exhibition Centre, and attracted 55 exhibitors. Unlike some other areas of electronics, the display market does not seem to be seriously affected by the economic troubles. Several exhibitors were showing new products which had just been "unpacked" and they could not yet give prices or delivery.

**L.c.d.s - the fastest growing technology**

Because the traditional weaknesses of liquid crystal displays are steadily being overcome, they are now receiving a great deal of attention from many equipment makers. This trend was reflected by the large number of exhibitors, nearly a third, who were offering custom or ready-made displays. Most development effort at present is aimed at improving the step-response and temperature range of the fluids, and increasing the size of displays which is limited by the sealing process on the glass plates.

Most manufacturers are improving their hermetic sealing technique and consequently are offering much larger display sizes. Several exhibitors were demonstrating 7-segment and dot-matrix displays with character heights above 80mm. Lucid displays announced a new range of devices with an extended temperature range of -30 to +85 degree C.

**More distributors want a piece of the action**

New names in the l.c.d. business include Bulgin, ITT and Racal. Bulgin are now marketing the Data Images (a splinter company from LXI) range of displays which includes two and four-inch character sizes. These displays are supported with electroluminescent backlights and Bulgin's own range of bezel assemblies.

ITT Meridian have recently signed an agreement with the Japanese manufacturer Lipton who claim to have produced the first range of long-life l.c.d.s. These devices offer an expected lifetime of 100,000 hrs instead of the usual 50,000 hrs. Racal's stand generated a lot of interest following the announcement of a new l.c.d. division which can offer a custom design and manufacturing service for colour and large area displays.

Two innovations from this division are a display electronic module (d.e.m.) and a reconfiguring display/keypad. D.e.m. combines a l.c.d. and thick-film technology to produce a single display driver module. The l.c.d. backplane forms a thick-film substrate which carries the necessary circuits to produce, for example, a complete frequency counter and display module. This system allows the display to be used in the transmissive mode without the obstruction of a p.c.b. Racal's reconfiguring display/keypad combines a l.c.d. with a touch-sensitive switch, when pressed, reconfigures the display to show a new set of prompts in a similar way to the "menu" on a computer.

**Flat-panel displays are replacing c.r.t.s**

Flat-panel displays using liquid crystal, electroluminescent and plasma technology were all demonstrated as an alternative to the conventional bulky c.r.t. display. Hitachi, a newcomer to the show, claim to manufacture over 50% of the world l.c.d. output, including flat-panel types. One disappointment, however, was the "non-arrival" of Hitachi's prototype l.c.d. colour television. Exhibits which did arrive included a new range of colour 7-segment displays and a 64×200 dot-matrix display for larger characters. To support their range of displays, Hitachi have also developed a 4-bit c.m.o.s. microprocessor which will directly drive l.c.d.s.

G.E.C. have produced an 80-character d.c. electroluminescent display panel which only requires 8 and ±60V supplies. Each of the 80 characters is formed by a 5×7 dot matrix and they are arranged in four rows. The display panel is supplied with two circuit boards which provide supply regulation, data organization, character generation and display drive. A 128-character set is standard, but special character sets can be provided.

A 235mm square a.c. plasma panel from Thomson-CSF comprises 512 lines of 512 points. This panel can be used for displaying graphics where each point is individually addressed. Alternatively, for alphanumeric operation, 64 lines of 85×7 characters or 32 lines of 64×9 characters can be produced.

The three-day exhibition was supported by a conference which presented 24 papers covering display device technology, integrated display systems, and display applications. Reprints from these sessions and others presented at the 78, 79 and 80 exhibitions are available from Network, Printers Mews, Market Hill, Bungton, Bucks.
C.b. frequency synthesis

Generating 40 channels for 27MHz by E. F. da Silva, M.Sc., Ph.D.

This article reviews the digital frequency synthesizer systems which can be used to generate the crystal-controlled frequencies required for 40-channel British citizens’ band operating at 27 MHz. A practical design is also described which provides 40 channel operation.

The lower and upper frequency limits of c.b. are 27.601250 and 27.991250MHz, with a channel spacing of 10kHz and a frequency tolerance of 1.5kHz per channel. The carrier is frequency modulated with voice transmission and the maximum frequency deviation is 25kHz. In addition to the frequencies shown in Table 1, another set of forty frequencies (transmit frequencies and receiver intermediate frequency) must be supplied for the local oscillator in the superheterodyne receiver. In view of the requirements for frequency stability, manually controlled varactor-controlled oscillators are not practical and, if direct crystal-controlled oscillators are used, frequency multiplication and/or mixing will generally be necessary to produce the required frequency deviation. Unfortunately, direct frequency multiplication and mixing produce harmonics and increase the cost, so a cheaper and more practical method is desirable. Availability of high-frequency low-power c.m.o.s. is now making frequency synthesis a practical alternative. An ideal synthesizer for c.b. would comprise one or two i.f. units, as there are no dedicated devices available at present, standard components must be used.

The basic synthesizer as shown in Fig. 1 comprises a voltage-controlled oscillator operating at frequency f0. This frequency is divided by a programmable divider-counter N to produce a frequency fN, which is compared with a reference frequency fR. The difference between these two frequencies is translated into a d.c. voltage which controls the v.c.o. so that fN = fR. Because f0 = Nf R, fR is locked to the reference frequency by the programmable divider. In practice, f0 is normally chosen to be the frequency channel step or spacing, i.e. 10kHz for 27MHz c.b., or a sub-multiple of the channel spacing so that integer changes in N will step the output frequency to the required operating frequency.

Direct synthesis for c.b.

The block diagram of a direct synthesizer system shown in Fig. 2, is similar to Fig. 1, except that a prescaler, fP, is connected between the programmable divider and

| v.c.o. | The prescaler is necessary because c.m.o.s. programmable counters are not readily available for direct operation at 27MHz. Also, crystal oscillators operating at a frequency of 10kHz are generally bulky and expensive, so it is more convenient to use a higher crystal frequency and divide it for the reference frequency.

As mentioned earlier, the channel spacing is 10kHz, the lowest transmit frequency is 27.601250MHz and the highest transmit frequency is 27.991250MHz. The factors of these frequencies are 2 x 5 x 5 x 5 x 5 x 22081Hz, and 2 x 5 x 5 x 5 x 5 x 22082Hz respectively. With c.m.o.s. programmable counters restricted to around 10MHz at 5V, a –10 prescaler would give programmable-counter ratios

v.c.o., to produce an i.f. of 1.4MHz which can be fed directly to the programmable divider-counter. The advantage of such a system is, the reference frequency can be made equal to the channel spacing, a prescaler need not be used for c.m.o.s. programmable counters, the total division factor is greatly reduced which increases the loop bandwidth, more easily divisible frequencies can be chosen and the frequencies are lower, which eases production techniques. A disadvantage is the additional cost of a mixer and crystal oscillator. However, this cost is greatly offset by the saving in logic circuits which would normally be needed to generate the local oscillator signal.

Local oscillator frequencies

The set of forty local-oscillator frequencies for the transceiver when receiving can be obtained in several ways. The programmable counter can be made to perform an additional count when the transceiver is operating in the receive mode. For example, with fR at 27.991250MHz, fN at 10kHz, a division ratio of 140, and a receiver i.f. of 40kHz, the local-oscillator frequency must be 27.991250 + 0.460, i.e. 28.451250MHz.

This frequency can be generated by letting N count initially to 140 (the figure set by the operator), inhibiting its output and then setting N to count an additional 46 steps (40kHz – 10kHz), i.e. a total of 140 + 46. At the end of this count an output pulse is fed to the phase comparator. The additional 46 steps can be produced automatically by using multiplying devices such as the 4093. This system produces local-oscillator frequencies greater than the transmit frequency by the chosen i.f., but it can be more complex with the addition of c.e.s.

An alternative scheme uses early zero detection where, instead of letting the programmable counter reach its full count of 140, the counter is stopped at 140 – 46, i.e. the 94th step. Therefore, the frequency fN will initially be greater than the reference frequency and it will cause the phase comparator to decreases the v.c.o. frequency until it is 46kHz below its initial frequency of 27.991250MHz.

A third scheme, only applicable to frequency mixing systems, is simply to switch, in an alternative crystal which is offset from the transmit frequency by the receiver i.f. This method permits either high or low injection of the receiver local oscillator and is relatively easy to implement.

Practical circuit

A frequency synthesizer using the mixing method described above is shown in Fig. 4. The crystal reference-oscillator frequency fR is produced by a 1MHz crystal. No tuning controls are needed, and the frequency divider ratio R is incorporated within the 14568 phase comparator i.e.

Synthesizer mixing methods

A block diagram of a frequency synthesizer using mixing is shown in Fig. 4. The crystal reference-oscillator frequency fR is high, 27.991250MHz, is mixed with a 26.591250MHz crystal oscillator, fP, to produce an i.f. of 1.4MHz which can be fed directly to the programmable divider-counter. The advantages of such a system are, the reference frequency can be made equal to the channel spacing, a prescaler need not be used for c.m.o.s. programmable counters, the total division factor is greatly reduced which increases the loop bandwidth, more easily divisible frequencies can be chosen and the frequencies are lower, which eases production techniques. A disadvantage is the additional cost of a mixer and crystal oscillator. However, this cost is greatly offset by the saving in logic circuits which would normally be needed to generate the local oscillator signal.

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The division ratio has been programmed to 100 and the reference frequency is therefore 10kHz. The programmable diode-counter divides over the range 101 to 140. The units and tenth part of the division ratio is incorporated in the 14569 and is controlled externally by binary switches connected to the DPA and DDIp inputs respectively. The hundredth part of the programmable counter in incorporated in the 14569 in conjunction with the phase comparator. This part of the counter is hard-wired to divide by 1, so no switch is necessary. The local oscillator frequencies are obtained by switching in the 27.051250 M.Hz crystal in place of the 26.591250M.Hz transmit crystal.

To adjust the synthesizer, set the thumbed-wheel switches to 1.0 (i.e. a frequency-dunky ratio of 1:12) and check that the transmit crystal is being used. Adjust L1 in the v.c.o. until the LED turns off and then set the voltage at point A to 2.6V. If a counter is available, check that the frequencies agree with Table 1. Switch in the receive crystal, set the programmable counter switches from 1 to 40 and check that the output frequencies are 4060Hz above the corresponding values in Table 1. The synthesizer is now adjusted and should produce a spectrum similar to that shown in Fig. 5.

Fig. 5. Typical spectrum around the carrier for the circuit in Fig. 4.

To adjust the synthesizer, set the thumbed-wheel switches to 2:3. a.d.c. by using the turnable switch and check that the transmit crystal is being used. Adjust L1 in the v.c.o. until the LED turns off and then set the voltage at point A to 2.6V. If a counter is available, check that the frequencies agree with Table 1. Switch in the receive crystal, set the programmable counter switches from 1 to 40 and check that the output frequencies are 4060Hz above the corresponding values in Table 1. The synthesizer is now adjusted and should produce a spectrum similar to that shown in Fig. 5.

Further reading
3. RCA application note ICAN 6374, "Applications of the COS/MOS C800 Integrated Circuit in Telecommunications Systems". The note describes the circuit diagrams and alignment details of the COS/MOS C800 and its application to various telecommunications systems. The note also includes a bibliography for further reading.
4. RCA application note ICAN 6716, "Low Power Digital Frequency Synthesizer utilizing COS/MOS ICs". The note describes the circuit diagrams and alignment details of the COS/MOS IC, and its application to various telecommunications systems. The note also includes a bibliography for further reading.

High-frequency Application of Semiconductor Devices by Ferenc Kovacs. 391 pp., hardback Elsevier, 78 US dollars

Written by a Hungarian author from a research institute in Budapest, this expensive book is a fairly deep and rather academic treatment of the operation of discrete and integrated semiconductor devices at high frequencies. Basic design principles of many practical circuits are discussed in 24 chapters. The book is ideal for those interested in low-frequency semiconductor devices. It is also an extensive 15-page list of references.

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Diode function generation

Simple strategy for choosing break-points

by Muhammad Taher Abuelma’atti, B.Sc., Ph.D., University of Riyadh

This strategy for picking the necessary break-points when designing a diode-resistor networks avoids negative resistance values in the result which saves computational time. This simplifies diode-resistor network design and makes it more systematic than previously.

Resistor-diode networks are often designed to meet a given non-linear input-output specification. While modelling doldy's with the diode equations gives a solution which is both accurate and general[4], the choice of break-points becomes a problem where the input is limited \( V_D < 10 \text{V} \), especially for highly non-linear functions. Contrary to the ideal diode model where any two points on a curve such as Fig. 1 can be connected by a straight line, it becomes obvious using the diode equation that if two points are chosen too close together they cannot be realized. If two points are realized close together this sets up a condition whereby the next points cannot be realized[5]. This is mainly due to the need for negative resistance values which are not practically feasible. To avoid this difficulty a simple strategy for picking the break-points is needed.

Concave non-linearities

The non-linear input-output characteristic of Fig. 1(a) can be met by the diode-resistor network shown in Fig. 2(a). Design equations, rewritten from Bell's, are

\[
R_S = R_{RR} + V_{DD} + \frac{V_{DD}}{I_0} + I_0 \cdot R_{RR} \quad \text{in terms of known quantities}.
\]

(4)

For the ith diode, initial conditions in equation (5) are taken from the \((i-1)^{th} \) calculation (C2). Combining equation (2) written for \(j=1 \) and with equation (1) solving for \( R_S \) in terms of known quantities gives

\[
R_S = \frac{V_{DD}}{I_0} + I_0 \cdot R_{RR} \quad \text{in terms of known quantities}.
\]

(3)

For the supply voltage \( V_{DD} \) is chosen so that

\[
V_{DD} > V_{DD} + I_0 \cdot R_{RR} \quad \text{in terms of known quantities}.
\]

(2)

If the supply voltage \( V_{DD} \) is chosen so that

\[
V_{DD} > V_{DD} + I_0 \cdot R_{RR} + V_{DD}(V_{DD} = V_{DD})
\]

then

\[
R_S = \frac{V_{DD}}{I_0} + I_0 \cdot R_{RR} + V_{DD}(V_{DD} = V_{DD})
\]

(1)

This means that the supply voltage must be greater than the maximum output voltage. Also the break points must be chosen so that the difference between output voltages at two successive break-points will be greater than the voltage drop across the conducting diode (about 0.6V for G5 and 0.4V for S5 diodes).

This strategy was extensively used to design diode-resistor networks to meet given monotonically increasing convex characteristics. Fig. 3(a) shows a typical example for meeting the non-linear function

\[
V_1 = -0.00411 + 0.001V^2 \quad \text{with maximum input voltage of } 4V.
\]

Concave non-linearities

The non-linear input-output characteristic of Fig. 1(b) can be met by the diode-resistor network of Fig. 2(b). Design equations, rewritten in a generalized form from Abuelma'tti's, are

\[
R_S = R_{RR} + V_{DD} + \frac{V_{DD}}{I_0} + I_0 \cdot R_{RR} \quad \text{in terms of known quantities}.
\]

(4)

For the ith diode, initial conditions in equation (5) are taken from the \((i-1)^{th} \) calculation (C2). Combining equation (2) written for \(j=1 \) and with equation (1) solving for \( R_S \) in terms of known quantities gives

\[
R_S = \frac{V_{DD}}{I_0} + I_0 \cdot R_{RR} + V_{DD}(V_{DD} = V_{DD})
\]

(1)

If the supply voltage \( V_{DD} \) is chosen so that

\[
V_{DD} > V_{DD} + I_0 \cdot R_{RR} + V_{DD}(V_{DD} = V_{DD})
\]

then

\[
R_S = \frac{V_{DD}}{I_0} + I_0 \cdot R_{RR} + V_{DD}(V_{DD} = V_{DD})
\]

(2)

This means that the supply voltage must be greater than the maximum output voltage. Also the break points must be chosen so that the difference between output voltages at two successive break-points will be greater than the voltage drop across the conducting diode (about 0.6V for G5 and 0.4V for S5 diodes).

This strategy was extensively used to design diode-resistor networks to meet given monotonically increasing convex characteristics. Fig. 3(a) shows a typical example for meeting the non-linear function

\[
V_1 = -0.00411 + 0.001V^2 \quad \text{with maximum input voltage of } 4V.
\]

Concave non-linearities

The non-linear input-output characteristic of Fig. 1(b) can be met by the diode-resistor network of Fig. 2(b). Design equations, rewritten in a generalized form from Abuelma'tti's, are

\[
R_S = R_{RR} + V_{DD} + \frac{V_{DD}}{I_0} + I_0 \cdot R_{RR} \quad \text{in terms of known quantities}.
\]

(4)

For the ith diode, initial conditions in equation (5) are taken from the \((i-1)^{th} \) calculation (C2). Combining equation (2) written for \(j=1 \) and with equation (1) solving for \( R_S \) in terms of known quantities gives

\[
R_S = \frac{V_{DD}}{I_0} + I_0 \cdot R_{RR} + V_{DD}(V_{DD} = V_{DD})
\]

(1)

If the supply voltage \( V_{DD} \) is chosen so that

\[
V_{DD} > V_{DD} + I_0 \cdot R_{RR} + V_{DD}(V_{DD} = V_{DD})
\]

then

\[
R_S = \frac{V_{DD}}{I_0} + I_0 \cdot R_{RR} + V_{DD}(V_{DD} = V_{DD})
\]

(2)

This means that the supply voltage must be greater than the maximum output voltage. Also the break points must be chosen so that the difference between output voltages at two successive break-points will be greater than the voltage drop across the conducting diode (about 0.6V for G5 and 0.4V for S5 diodes).

This strategy was extensively used to design diode-resistor networks to meet given monotonically increasing convex characteristics. Fig. 3(a) shows a typical example for meeting the non-linear function

\[
V_1 = -0.00411 + 0.001V^2 \quad \text{with maximum input voltage of } 4V.
\]
maximum output voltage, and the break-points must be so chosen that the difference between input voltages of two successive points is greater than the difference between the corresponding output voltages by an amount at least equal to the voltage drop across the conducting diode. This strategy was extensively used to design diode-resistor networks to meet given monotonically increasing concave characteristics. Fig. 3(b) shows a typical example where the non-linear characteristic was expressed by

\[ V_o = V_i(0.0017) \]

with maximum input voltage of 3.5V.

The means of selecting break points for diode-resistor networks presented here is intended to simplify the design of function generators. Networks for monotonically increasing concave and convex functions illustrate the validity of the selection procedure.

### References

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**Multichannel digital tape recorder**

Design requirements of the digital circuitry

by A. J. Ewins, B.Tech., Research Laboratories, London Transport

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**IN OUR NEXT ISSUE**

Millimetre-wave lens aerals. An easier way of constructing metal plate refractor aerials, which hitherto have not been popular because of manufacturing difficulties. Dr Ken Smith gives design and construction details for aerials in the 20-30GHz region.

Understanding light units. Electronics engineers are having to use optical devices and techniques more and more but have difficulty in understanding the various units for measuring light. This interpretive guide is written specially to help them.

Direct digital frequency synthesizer generates sine waves in numerical steps, a 1MHz output, for example, being produced by stepping through the sine table at a rate of 45Hz every 12ns and feeding the result into a d-a converter. Range: 0-3MHz.

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continued from page 49

Having first set the overhang, the cartridge is then twisted round slightly until the two sighting holes at 110° and 49° mm radii both align with the centre of the turntable spindle as the arm is swung inwards. Due to the offset of the overhang setting slot, this twisting round of the cartridge may slightly alter the overhang, but the appropriate correction is easily made in a second slot if necessary.

The amount of overhang provided by the dimensions given is in accordance with the rule proposed in the above article, \( h = 0.50C \), where \( C \) is from arm given to turntable axis, in mm. Needless to say, the basic design can be used for any required overhang ratio, the position of the drilled hole and setting marks being changed accordingly. The 2 mm holes are only intended to act as setting marks, and could be omitted in favour of short cross lines.

The author has made up a gauge in accordance with Fig. 2, and finds it a major improvement. He can now be certain, for the first time, that the required cartridge position and offset angle are correct to something within \( 1 \)° of error, whereas previously an error of several degrees would have been possible.

**On sale November 18**

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In the first part of this article, the author described the aims and design concept of this economical instrumentation recorder, which employs a modified audio cassette deck with added digital electronics. In this second part, the additional circuitry is outlined.

Having determined the number of channels per track of the tape-recorder, the number of bits per data word, the length of the sync word, and the data and tape-clock frequencies, the digital circuitry could now be designed. Figure 2 shows the main body of the recording circuitry in block form, the heart of which is the block marked ‘control circuitry’. Starting with a crystal-controlled oscillator of 3.2768 MHz, this circuitry outputs clock frequencies, DC and TC, which are divided down and operated on various logic circuits to generate the numerous pulse trains that control the flow and direction of the serial data. The inverse clock outputs, DC and TC, clock the serial data through the various shift registers. In this way, all gates and switches are opened or closed on negative transitions of DC or TC, whilst the serial data advances on positive transitions. A reset pulse is generated every 72 cycles of DC (or 80 cycles of TC) and serves to synchronize the various logic elements of the control circuitry.

An example of some of the pulse sequences produced by the control circuitry is shown in Fig. 3. This illustrates the control of the clock pulses as seen by the two 72-stage temporary registers (store 1 and store 2) and the sync. word buffer. Store 1 is shown being filled with serial data under the control of DC, up to the moment of reset, and then being emptied under the control of TC. Store 2 is shown being emptied under the control of TC up to the moment of the 72nd pulse. Having emptied store 2, the remaining eight pulses of TC, up to the moment of reset, are used to empty the sync. word buffer on the pulse set. Store 2 is then filled with data under the control of DC. In this way, the sync. word is inserted into the data stream every 72 bits or six data words. A frame of data thus consists of one sync. word followed by eight data words, each data word being presented in parallel to serial form. Figure 5 shows the logical sequence of control pulses, RESET, PS, ‘B4’ and DC, together with the DATA READY pulse, which has been serially inserted into the data stream.

The control circuitry also generates four sequences of logic pulses, DC, PS, ‘B4’ and RESET, which go to the preceding stage (Fig. 6) to control the multiplexing of the six analogue channels, the digitalization of the selected channel and its conversion from parallel to serial form. Figure 5 shows the logical sequence of control pulses, RESET, PS, ‘B4’ and DC, together with the DATA READY pulse, which has been serially inserted into the data stream.

The RESET pulse is the same as that referred to earlier and occurs every six data words. Having initially synchronized the analogue multiplexer, its continuous presence checks that the multiplexer is always in its original state at the start of each data frame. PS is the parallel-to-serial control pulse to the 12 bit shift register. When at the logic 1 level, a positive transition at the clock input transfers the data present on the parallel inputs into the register.
When the logic 0 level, positive transitions of DC transfer the data serially through and out of the shift register. The control pulse BA is derived from the control circuit in a similar fashion to PS and occurs, at PS does, once every data word. When BA goes to logic 1, the sample-hold circuit is put into its 'hold' mode via the OR gate. At the same time, it initiates the conversion process of the A-to-D converter and blanks its output. At the start of the conversion and until it is complete the DR pulse of the A-to-D converter goes to logic '1' to keep the sample/hold circuit in the 'hold' mode via the OR gate. Only when the data is ready and DR goes to logic '0' does the sample/hold circuit revert to the sample mode. As it does so, the analogue multiplexer is clocked to sample the next analogue channel.

Because of the sequencing of the RE-SET and PS pulses, the data that is being serially shifted out of the 12 bit shift register immediately after a RE-SET pulse (and during the conversion of the analogue data from channel 1) is the last data word, from channel six, of the previous data frame. The resulting sequence of data words between RE-SET pulses is thus in the order of channels 6,1,2,3,4 and 5. This may be resequenced to the desired arrangement of channels 1,2,3,4,5 and 6 by connecting the two outputs of each channel to the multiplexer, channel 2 to input 1, channel 3 to input 2, and so on.

Referring back to Fig. 2, it will be seen that a small 2-stage shift register is placed immediately after the switch gating the output from the two storage buffers and the sync. word buffer. This register is included to remove the undesirable change in logic level that might otherwise occur as the outputs from these buffers are switched. Remember, the serial data is clocked out of the buffers on the positive transitions of the clock and therefore changes in the logic level should only occur at these instances. The switch select the appropriate buffer on the negative transition of TC, producing possible logic level changes at the wrong time, and the 2-stage shift register in between the gate and the signalizer.

Miller encoder, The Miller encoder would more correctly interpret these logic level changes. As mentioned earlier, it was decided that the sync word should be 8 bits long and include the sequence 1,0,1,1. In order that the sync word may be recognized on playback and decoding of the serial data it is quite possible for the sync word (sequence to occur within the normal data stream) it is also essential that it includes the sequence 1,0,1. The need for the 1,0,1 and 1,0,1 sequences could be satisfied by a six bit sync. word consisting of 1,0,1,0,1,1. However, since it was necessary for it to be 8 bits long it was chosen to be 1,0,1,1,0,1,0,1.

The need for the sequence 1,0,1,1 can be best explained by examination of the various pulse trains shown in Fig. 6. These are generated during the encoding and decoding of the NRZ serial data and are shown in their correct time sequence. The first row is an example of the NRZ serial data that emerges from the 2-stage shift register of Fig. 2 immediately before encoding. The third row shows a blanking pulse that is generated once every complete data frame (i.e. 80 cycles of TC) and the way through and out and is thus removed. When the first two storage buffers are full of data, the control circuit allows the first buffer to be emptied under the control of DC. A time difference of (2 x 72)/2048, or about 79.6 ms, is thus created between the filling and emptying of the buffers. This time gap has proved to be more than sufficient to absorb the small timing errors produced by the wow and flutter of the tape cassette deck.

Three control pulses, DC, LATCH and (DC/72) are passed from the control circuit of Fig. 8 to the succeeding circuit of Fig. 9, which controls the recovery of the serial data stream into the 12 bit data words, their conversion from digital to analogue form and their final demultiplexing via sample/hold circuits. The serial data first passes through a 12 bit serial-in, parallel-out shift register. At the correct moment, the 12 bits present at the parallel outputs are clocked across to a 12 bit latch. A 1-bit parallel-to-serial recirculates the two parity bits, compares them with the two recorded parity bits and passes the two result in (NO-NO-GO answers to the DE-MUX control circuit. At the same time, the 10 bit data word is converted to an analogue output via the digital-to-analogue converter, which is presented to the inputs of the control circuitry.

Synchronized by the (DC/72) pulse and clocked by the LATCH pulse, the DIG-MUX circuit (which uses sample/hold circuit into its sample mode. If however, the parity checker gives a NO-GO answer on one of its two outputs, the sample/hold circuit is inhibited and remains in its hold mode. Figure 10 shows the sequence of a number of pulse trains controlling the operation of the circuit of Fig. 9. The synchronizing pulse is produced by a bistable triggered by the positive transition of the (DC/72) pulse. Sample/hold pulse, SH, is produced by another monostable triggered by the negative transition of the LATCH pulse. Both sample/hold pulse have pulse lengths of approximately five DC pulses.

Because the bit serial/parallel-out shift register introduces a delay of exactly one data word with respect to the synchronizing pulse trains from channel six six appears at the expected output of channel 1; channel 1 appears at the expected output of channel 2; channel 2 appears at the expected output of channel 3; and so on. This is of no consequence whatever and it is a simple matter to re-label the output channels accordingly.

Speed control circuit

The principle of operation of the speed control circuit is shown in the block diagram of Fig. 11. Ignoring, for the moment, the input to the reference frequency circuit from the 8192 playback electronics of the digital circuitry, it will be seen that a speed control circuit is achieved by means of a phase-locked loop. The frequency produced by the tachogenerator is compared against the reference frequency from the voltage-controlled oscillator (v.c.o.) of a p.i.l. integrated circuit, using the phase-sensitive detector (p.s.d.) in the i.c. The
output from the p.s.d. is fed to the motor drive circuit where it is filtered and amplified to provide the required drive for the motor.

The purpose of the frequency selector circuit was to enable the cassette tape-recorder to stand alone whilst at the same time providing an input for an external reference.

Very conveniently, the frequency produced by the tachogenerator when the recorder is running at a tape speed of 15in/s is around 455Hz, which is very close to the 455Hz produced by dividing the tape clock of 22,715.5Hz by 50. During the recording process this crystal-derived frequency of 455Hz is therefore used as the reference frequency for the motor speed control. To obtain perfect long-term speed stability on playback, it is necessary to lock the recovered tape clock, from the recorded data, to the crystal-controlled tape clock. It might be thought that all that is necessary to achieve this is to substitute the output from the tachogenerator with that of the recovered tape clock divided by 50. However, this proved not to be the case due to an increased amount of wow and flutter in the actual transport of the tape, with a slightly different frequency content, a satisfactory lock of the p.i. could not be obtained, except by altering its natural frequency (i.e. by changing the filter components). Even when this was tried, the p.i. was not as stable as that in the recording process.

A very satisfactory solution was found, even if it was a little unorthodox, by creating a second p.i. with a very much lower natural frequency. In this second p.i., the crystal-controlled tape clock is compared with the recovered tape clock, after dividing both clocks by 50, via a

p.s.d. The output from the p.s.d. is filtered (determining the loop's natural frequency) and used to control a v.c.o., the frequency output from which is used to provide the required reference for the motor speed control circuit. The lower natural frequency of the second p.i. completely removes the influence of wow and flutter from the recovered tape clock, whilst the higher natural frequency of the first p.i. allows the motor speed control circuit to operate under optimum conditions. Visual and audible signals are provided by both p.i.s to inform the operator what they are doing.

To be continued.
Disc-data separator

Pulses from a floppy-disc consist of clock and data information which must be separated before it enters the controller. Thomas Components now market an i.c. from SMC which carries out this function and replaces they say, over 10 t.t.i. i.c.s. The 8-pin d.i.l. FDC9216 operates from a 5V supply and is t.t.i.-compatible and programmable by 8-bit parallel data with single or double density. An 8MHz clock signal is required by the L-Therm Components Ltd, Thame Park Rd, Thame, Oxon OX9 3DX.

W3307

Accelometer

The A-2351 accelerometer from D. J. Birkall Ltd is a cardiodic version of the A-212 series of transducers originally designed for use on aircraft engines. Low base-amplifiers and stabilisation and long-term repeatability are claimed to be inherent features of the patented Konic element used in the device and specifications include 7cC charge sensitivity, 4.5g weight, 50kHz resonant frequency and ±50% over the specified temperature range. The stainless-steel housing is welded and stud-mounted using a UNF stud and, the price is £190. D. J. Birkall Ltd, 102 Bath Rd, Chesham, Buckinghamshire.
Who ever heard of card frames in plastic?

There's always a first time for everything, and West Hyde are now supplying the brand new Type 92 range of plastic cases by AKA. These versatile enclosures can be used either on their own or together with a purpose-designed card frame and other accessories. Experience has to be seen to be believed. The card frames will accept either Eurocards or 112mm cards and all standard edge connectors. All models are designed with either plain or ventilated sections at the front or back, have the option of pop-up test (some models can be supplied with handles), and are finished in an attractive brown and beige colour.

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Universal tape heads for DOLBY systems (suitable for chrome & metal tapes):

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**Which amplifier?**

L.P. Amplifiers now come in these three basic types, each of which is available with or without heatsink. Having decided the system you want - home Hi-Fi (models HY 65, 80, 105 or 130 for example), you will then decide whether amplifiers housed within a case or heatsink type for better cooling. On our range of smallish amplifiers for building into cabinets will suit. With choice such as this and a brilliant new range of PSU modules, you could very easily have the chance to build the finest audio system ever offered to the constructor.

**POWER UP TO 480 WATTS SINGLE CHANNEL**

**Which modules?**

In launching eighteen different units all within a stunningly compact cases to help make complete audio systems using L.P. Amplifier modules, we bring the most exciting, the most versatile multi module assembly scheme ever for constructions of all ages and experience. Study the list - we have these modules will combined to almost any audio project you fancy - and remember all L.P. modules are compatible with each other, they connect easily. Modules HY6 to HY13 measure 15 x 20 x 40mm. HY16 to HY77 measure 50 x 20 x 40mm. They are so reliable that all L.P. modules carry a 5 year no quibble guarantee.

**20 POWER AMPS**

**19 FUNCTIONAL MODULES**

**DAWN OF A NEW ERA**

**BIPOLAR Standard with heatsinks**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>MODULE</th>
<th>DESCRIPTION</th>
<th>FACILITIES</th>
<th>CURRENT</th>
<th>REQUIRED</th>
<th>PRICE</th>
<th>VAT</th>
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<tbody>
<tr>
<td>HY6</td>
<td>MONO PRE AMP</td>
<td>Mic/Mag, Cartridge/Tune/Taper/Aux</td>
<td>Plus Volume/Bass/Treble</td>
<td>10mA</td>
<td>£6.44</td>
<td>£5.97</td>
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<tr>
<td>HY7</td>
<td>MONO STEREO</td>
<td>To mix eight signals in one</td>
<td></td>
<td>10mA</td>
<td>£5.15</td>
<td>£4.77</td>
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<tr>
<td>HY8</td>
<td>STEREO MIXER</td>
<td>Two channels, each mixing five signals into one</td>
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<td>£6.25</td>
<td>£5.84</td>
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<tr>
<td>HY9</td>
<td>STEREO PRE AMP</td>
<td>Two channels mag. Cartridge/ Mic/ Volume</td>
<td></td>
<td>10mA</td>
<td>£7.00</td>
<td>£6.57</td>
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</tr>
<tr>
<td>HY11</td>
<td>MONO MIXER</td>
<td>To mix five signals into one</td>
<td>Basic Treble controls</td>
<td>10mA</td>
<td>£7.05</td>
<td>£6.67</td>
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<tr>
<td>HY12</td>
<td>MONO PRE AMP</td>
<td>To mix four signals into one</td>
<td>Basic/Mid range Treble</td>
<td>10mA</td>
<td>£6.70</td>
<td>£6.34</td>
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<tr>
<td>HY13</td>
<td>MONO VU METER</td>
<td>Programme gain LED/override driver</td>
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<td>10mA</td>
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**HEAVY DUTY with heatsinks**

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<th>FACILITIES</th>
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<th>PRICE</th>
<th>VAT</th>
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<tbody>
<tr>
<td>HY26</td>
<td>MONO PRE AMP</td>
<td>Mic/Mag, Cartridge/Tune/Taper/Aux</td>
<td>Plus Volume/Bass/Treble</td>
<td>20mA</td>
<td>£12.19</td>
<td>£11.62</td>
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<tr>
<td>HY27</td>
<td>STEREO HEADPHONE</td>
<td>To drive headphones in the range of 15 - 200</td>
<td></td>
<td>20mA</td>
<td>£12.35</td>
<td>£11.88</td>
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<tr>
<td>HY28</td>
<td>STEREO MIXER</td>
<td>Two channels, each mixing ten signals into one</td>
<td></td>
<td>20mA</td>
<td>£7.59</td>
<td>£7.15</td>
<td></td>
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<tr>
<td>HY59</td>
<td>MONO PRE AMP</td>
<td>To mix input only</td>
<td>Basic/Mid range Treble</td>
<td>20mA</td>
<td>£10.45</td>
<td>£9.88</td>
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<tr>
<td>HY71</td>
<td>DUAL STEREO PRE AMP</td>
<td>Four channels of Cartridge/Mic/Volume</td>
<td></td>
<td>20mA</td>
<td>£10.76</td>
<td>£10.20</td>
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<tr>
<td>HY72</td>
<td>VOICE OPERATED STEREO FADER</td>
<td>12.10</td>
<td>£11.97</td>
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<td>HY73</td>
<td>GUITAR PRE AMP</td>
<td>Two Channels, each with mic/Volume/Bass/Treble/Bass</td>
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<td>£12.25</td>
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<td>HY74</td>
<td>STEREO MIXER</td>
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<tr>
<td>HY76</td>
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<td>HY77</td>
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<td>20mA</td>
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**MONOSET Ultra II, with heatsinks**

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<th>FACILITIES</th>
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<td>Mic/Mag, Cartridge/Tune/Taper/Aux</td>
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<td>£6.44</td>
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<td>HY21</td>
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<td>HY22</td>
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<td>Two channels mag. Cartridge/ Mic/ Volume</td>
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<td>10mA</td>
<td>£7.00</td>
<td>£6.57</td>
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<tr>
<td>HY23</td>
<td>MONO MIXER</td>
<td>To mix five signals into one</td>
<td>Basic Treble controls</td>
<td>10mA</td>
<td>£7.05</td>
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<tr>
<td>HY24</td>
<td>MONO PRE AMP</td>
<td>To mix four signals into one</td>
<td>Basic/Mid range Treble</td>
<td>10mA</td>
<td>£6.70</td>
<td>£6.34</td>
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<tr>
<td>HY25</td>
<td>MONO VU METER</td>
<td>Programme gain LED/override driver</td>
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<td>£5.95</td>
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**POWER SUPPLY UNITS**

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<td>50 mA combinations of HY65/105 series</td>
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<td>HY105/200</td>
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<td>20mA</td>
<td>£12.19</td>
<td>£11.62</td>
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</table>

**FP800 BRIDGING UNIT FOR DOUBLING POWER**

Freely available for L.P. for use with any two power modules of the same type to double the power output. (L.P. power supply, in 100 mA units, will have to be changed to match the new current rating in order to function. It is recommended that the use of power transformers be avoided for L.P. power supplies.)

**FREESTOP FACILITY**

Fits the top of chassis, or into a drilled hole adjacent to the cover. Our freestop can be fitted to any chassis with no extra holes being drilled for the purpose - it is easily fitted to any chassis with no effort being involved.

**ORDER TO USING OUR FREESTOP FACILITY**

Fits on the top cover of any, or into a drilled hole adjacent to the side cover of the chassis. The freestop can be fitted to any chassis with no extra holes being drilled for the purpose - it is easily fitted to any chassis with no effort being involved.

**ALL WITH L.P.'S 5 YEAR NO QUIBBLE GUARANTEE**

For easy mounting we recommend:

**Ringer** Mounting board for modules HY6 - HY13

97 x 182 x 94 V.A.T.

**Ringer** Mounting board for modules HY6 - HY77

99 x 139 x 13 P.S.U.

**AMPLIFIER WITH HEAT SINK**

**PLATE TYPE**

**ELECTRONICS LTD.**

FREEPOST 8 Graham Bell House, Rother Clove, Caterham, Kent CR3 3EP

Available also from: Marshall,thes, Technisches, Multifunctional Electronics, and other selected retailers.

**GOODS BY MAIL ORDER DISPatched WITHIN 7 DAYS OF RECEIVING YOUR ORDER**
LINSLEY HOOD 300 SERIES AMPLIFIERS

These latest designs from the leading board of John Linsley-Hood, represent to the new entertainment system enthusiast, a step towards serious audio conditioning. These versatile amplifiers are designed to meet a wide range of performance requirements and represent a new standard of engineering excellence. Each unit is built to the highest possible standards, with components carefully selected for maximum sound quality. Tests and measurements by leading audiophiles have proven the top quality, extraneous and therefore replaceable. A new feature is a built-in circuit which prevents the amplifier from being damaged once the voltage is turned off. A new feature on the new unit is the front panel controls. All these features add to the high quality of these amplifiers, which are available now at £75 plus VAT.

HART ELECTRONICS LTD
86 High Street, Bletchley, Redhill, Surrey RH1 4PA Godstone (0883) 843221

IBM 1593 GOLFBALL PRINTER

Realistic with microfilm sheeting mechanism. 80% of the ball can be fed to a golf cart or a golf cart, in or out of the paper, with the paper, and the paper in the paper. The printer is available now at £75 plus VAT. It has a large range of interchangeable modules and displays for the printer's interface, and is available now at £75 plus VAT.

DANAVOX ARE ALWAYS COMING UP WITH SOUND IDEAS.

STETOClip JUNIOR 60 HEADSET
STETOClip LIGHTWEIGHT HEADSET
SENIOR STETOClip HEADSET
STETOClip GEMINI HEADSET
STETOMIKE HMT 808

STANDARD & SUB-MINOR EARPHONES
PLASTIC EARHANGERS
DANAMIC FIDELITY EARSET

STETOTUBE HEADSET & SOUND PLUG
DANASOUND HEADSET

INDUCTIVE LOOP AMPLIFIER TYPE 36A
FIELD STRENGTH TESTER FS1

The Danavox policy has always been one of constant improvement.
Our refinement, development and research has enabled us to offer an advanced range of components and accessories for dictation machines, tape recorders, tele-communications, hearing aids and electro-acoustic equipment. All our products are built with care and precision. And all carry the Danavox guarantee.

For more information about any Danavox product, contact John Carter.

DANAVOX (Gt. Britain) Ltd.,
1 Cheyne Walk, Northampton, NN1 5PT
Tel: (0604) 36351 Telex 312395
<table>
<thead>
<tr>
<th>Product Code</th>
<th>Description</th>
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<td>EPROM EMULATOR PROGRAMMER</td>
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<tr>
<td>P4000</td>
<td>EPROM PRODUCTION PROGRAMMER</td>
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<td>UV141</td>
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<td>UV148</td>
<td>EPROM ERASERS</td>
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<td>GP INDUSTRIAL ELECTRONICS LTD</td>
<td>UNIT 6, TOTNES INDUSTRIAL ESTATE, TOTNES, DEVON TQ9 9XL, TEL: (0603) 863295, TELEX: 423896</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Crotech Instruments Limited
5 Nimrod Way, Elgar Road, Reading, Berks, RG2 0EB.

WHAT PRICE PERFORMANCE FROM CROTECH? Not a lot - you'll like it!

**NEW**

**TYPE 3030**
- DC-15MHz Bandwidth
- Triggered and automatic sweep
- 200m/div or 2000m/div sweep speeds
- Rectangular CRT
- Compact and lightweight
- BUILT-IN COMPONENT TESTER £145*

3030 and 3131 just two models in the range, reflect the Crotech philosophy of building-in extra performance. Both scopes offer the full specification you expect and demand. But now the extra: both feature a Component Tester which displays the characteristics of active and passive components either in or out of circuit. This benefit extends both instruments beyond the limits of a normal scope. The price, well, what speaks for itself.

For details telephone Reading (0734) 866945 and ask for our full catalogue.

**TYPE 3131**
- DC-15MHz Bandwidth
- 200m/div or 0.2m/div.smallest scale
- "C" CRT
- Triggering to 35MHz
- 200mV Calibration signal
- X-Y Operation
- BUILT-IN COMPONENT TESTER £230*

**METALFILM RESISTORS**
1% Tolerance, 1/4 Watt

**SCREEN 99**
Suitable for the cleaning of all types of screens, including data terminals and TV Screens.

**VASELINE SPRAY 701**
For use in communications engineering and construction of antennas. Proven successful as corrosion-inhibitor for cable clamps, connecting screw nuts etc. Application from spray can with satisfactory results clean and simple. Distributed by:

Special Products Distributors Ltd.
81 Piccadilly, London, W.1
Tel: 01-433 9555

**NEW KONTAKT Sprays**
for the Electronics & Electrical Industries

**KALTRON 601**
A new probe for Magnetic Recording Units. Kaltron 601 has an extremely low surface tension finally reaching the cleaning of magnetic sound heads leaving no deposits or other trouble. It is chemically pure (99.9%) - non conductive - non-flammable.

It can be used on energized electrical installations and also for equipment, e.g., video units, tape recorders, data processing systems etc.

Also NEW

**PRINTS**
Suits chassis for use with type wheel printers, matrix printers and printer's. Can also be used for cleaning normal typewriters.

**RADIATION DETECTORS**

**METALFILM RESISTORS**
1% Tolerance, 1/4 Watt

**PRINTS**
Suits chassis for use with type wheel printers, matrix printers and printer's. Can also be used for cleaning normal typewriters.

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Also NEW

**PRINTS**
Suits chassis for use with type wheel printers, matrix printers and printer's. Can also be used for cleaning normal typewriters.
The technology at the heart of the new portable synthesizer is the PolySyn, which brings to the reach of the general instrument the expandable polyphonic synthesizer. By brilliant design work and the use of high-quality components, PolySyn is capable of producing a wide range of musical effects, from simple waveforms to complex sounds. This compact yet powerful device is able to provide a rich and diverse variety of musical expressions, making it an ideal choice for a wide range of applications, from stage performances to studio recordings. Whether you are a professional musician or a hobbyist, the PolySyn is designed to meet your needs and exceed your expectations, offering an exceptional value for the money. Take your music to the next level with the PolySyn – the ultimate in portable synthesis.
### VALVES

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<td>£123</td>
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<tr>
<td>EFGH</td>
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<td>£456</td>
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<tr>
<td>IJKL</td>
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### VALVES AND TRANSISTORS

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<td>Valve A</td>
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<td>IJKL</td>
<td>Valve C</td>
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### Field Telephones Type "J"

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<tr>
<td>EFGH</td>
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<tr>
<td>IJKL</td>
<td>Telephone C</td>
<td>£789</td>
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</tbody>
</table>

### FOTOLAK

**Positive Light Sensitive Aerobic Lacquer**

- **Purpose**: Used in industry for prototype work
- **Properties**: Provides a clean, smooth finish
- **Uses**: Suitable for electrical, mechanical, and electronic applications

**Components**

- **Solder Paste**: Ideal for printed circuit boards
- **Resin**: Fast drying, tough, and heat resistant
- **Epoxy**: High strength and low shrinkage

**Application Methods**

- **Spray**: For large areas or complex shapes
- **Brush**: For small areas or intricate details

**Features**

- **Environmentally Friendly**: Low voc
- **Long Shelf Life**: 6 months
- **Fast Drying**: 2-4 hours

### New Branded Valves

- **Model A**: Suitable for industrial applications
- **Model B**: Ideal for home use
- **Model C**: Designed for automotive use

**Specifications**

- **Voltage**: 12V DC
- **Current**: 5A
- **Operating Temperature**: -40°C to 125°C

### Zener Diodes

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<td>IJKL</td>
<td>Diode C</td>
<td>£789</td>
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### Wirewound Resistors

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<tr>
<td>IJKL</td>
<td>Resistor C</td>
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### Line Output Transformers

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<tr>
<td>EFGH</td>
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<td>£456</td>
</tr>
<tr>
<td>IJKL</td>
<td>Transformer C</td>
<td>£789</td>
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</tbody>
</table>

**Contact Details**

- **Colomor Electronics Ltd.**
  - Address: 170 Goldhawk Rd., London W12
  - Tel: 01-740 0695 or 01-749 3934
- **Fotolak**
  - Tel: 01-749 3934
  - Address: 170 Goldhawk Rd., London W12

**Additional Information**

- **Ordering Information**: Minimum order quantity 250 units
- **Lead Time**: 4-6 weeks
- **Delivery**: Standard delivery 3-5 working days

---

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