Digital capacitance meter

Colour graphics v.d.u.

Multipath distortion
The only limitation is your imagination

The TM500 series
First select a mainframe, there are five basic models from which to choose, providing 1, 3, 5 or 6 compartments, suitable for benchtop, portable or rackmountable applications. Each mainframe has its own integral power supply and that means just one mains lead irrespective of the number of compartments used. Now you can start to build.

Simply select from the 40 plus instrument modules available, performing a wide range of functions from Power Supplies to Function Generators, Digital Counters, Digital Meters, Pulse Generators and Calibrators the instrument of your choice. Your chosen module is then simply slotted into the selected mainframe, it takes only seconds and they can be changed just as quickly.
Tailor your selection to suit your application.

To find out more clip the coupon, ask your field engineer, circle the enquiry number, write or phone, we'll be pleased to help.

Tektronix

ww-08: FOR FURTHER DETAILS

Front cover shows the process of growing a silicon crystal, from which semiconductor devices will be made. Photographer Paul Brierley.

IN OUR NEXT ISSUE

Weather satellite picture processor. Constructing a device to display side by side visible-light and infra-red pictures from TIROS-N satellites.

Designing with microprocessors. Start of a series to help designers use the micro as a component in electronic systems.

Audio spectrum analyser. Constructing an instrument with manual or automatic sweep and digital frequency display to use with a e.r.o.

Current issue price 50p, back issue price £1.00, at Retail and Trade Counter, Park Garden, London SE1. Available on microfilm, please contact editor.
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Authors and addresses: Excerpts from the Original World Ltd. 513 Madison Avenue, New York, 10022, 2nd class postage paid at New York.

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To find out more clip the coupon, ask your field engineer, circle the enquiry number, write or phone, we'll be pleased to help.

Tektronix

COMMITTED TO EXCELLENCE

Please send full information on the TM500:

Name
Position
Company
Address
Telephone

In our next issue

Weather satellite picture processor. Constructing a device to display side by side visible-light and infrared pictures from TIROS-N satellites.

Designing with microprocessors. Start of a series to help designers use the micro as a component in electronic systems.

Audio spectrum analyser. Constructing an instrument with manual or automatic sweep and digital frequency display to use with a c.r.o.


By post, current issue 60p, back issue of available; £1.00, order and payment to Room CP19, Dorset House, Stamford Street, London SE1 8LU. Telephones: Editorial 0-121-381-6920, Advertising 0-121-381-8329.

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"Comparisons are odorous"

We are often asked by audio enthusiasts how our amplifier compares with so and so's product, and they are surprised when we reply "we don't know, we have never tried!"

It is not that we are unwilling to learn from other people's mistakes, it is simply that at Quad we recognise only one standard for comparisons, namely the original.

What we wish to know is how the output of the equipment under investigation compares with the original signal fed into it.

Over the years we have developed experimental techniques which enable us to investigate the audible contribution of a piece of equipment to a music signal, and as a result we can say with complete confidence that a Quad 405 contributes absolutely no audible degradation to the signal fed through it, and that's as close to the original as you need to get.

For further details on the full range of QUAD products write to:
The Acoustical Manufacturing Co. Ltd.,
Huntingdon, Cambs. PE18 7DB.
Telephone: (0480) 82861.
“Comparisons are odorous”

We are often asked by audio enthusiasts how our amplifier compares with so and so's product, and they are surprised when we reply "we don't know, we have never tried".

It is not that we are unwilling to learn from other people's mistakes, it is simply that at Quad we recognise only one standard for comparison, namely the original. What we wish to know is how the output of the equipment under investigation compares with the original signal fed into it.

Over the years we have developed experimental techniques which enable us to investigate the audible contribution of a piece of equipment to a music signal, and as a result we can say with complete confidence that a Quad 405® contributes absolutely no audible degradation to the signal fed through it, and that's as close to the original as you need to get.

For further details on the full range of QUAD products write to:
The Acousticall Manufacturing Co. Ltd., Huntingdon, Camb. PEI 7DB.
Telephone: (0440) 25881.

“QUAD for the closest approach to the original sound”

QUAD is a registered Trade Mark.
The sound of silence.

We wouldn’t knock our rivals. After all, it was they who inspired us to design and manufacture our own power loudspeaker components for our enclosures. Nobody could supply components to the exacting HH standards of quality, power and performance at any price.

So, our designers started from a clean drawing board and were prepared to defy convention in the construction of a superior power loudspeaker. Our powerful computer calculated optimum cone profiles, whilst our scientists pushed back the frontiers of adhesive technology to develop new construction methods. Then we tested them relentlessly and did our best to destroy these new products (that was the hardest part). Now this range of superior power loudspeakers, crossover networks, “bullet” radiators, compression drivers and horns can be purchased at sensible prices from HH dealers. In their new and convenient packs you will also find an applications book, full of useful hints.

Send for our brochure, so you can convince yourself why our components are superior by following our logical scientific arguments. Then you’ll realise why we never need to knock our “rivals”.

Power to the Performer. HH Acoustics.

The sound of science.

We wouldn’t knock our rivals. After all, it was they who inspired us to design and manufacture our own power loudspeakers…because of the frustration we experienced when trying to obtain power loudspeaker components for our enclosures. Nobody could consistently supply components to the exacting high standards of quality, power, and performance—at any price.

So, our designers started from a clean drawing board and were prepared to defy convention in the construction of a superior power loudspeaker. Our powerful computer calculated optimum cone profiles, whilst our scientists pushed back the frontiers of adhesive technology to develop new construction methods. Then we tested them mercilessly and did our best to destroy these new products (that was the hardest part).

This range of in-house power loudspeakers, crossover networks, "bullet" radiators, compression drivers and horns can be purchased at sensible prices from HH dealers. In their new and convenient packs you will also find an applications book, full of useful hints.

Send for our brochure, so you can convince yourself why our components are superior by following our logical scientific arguments. Then you’ll realize why we never need to knock our “rivals”.

Power to the Performer.

HH Acoustics.
DC POWER SUPPLIES a vast range
suited to meeting both amateur and
professional requirements
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frequency meter, digital capacity
meter

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well introduced on the English market for all our articles and for some lines of our product.

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PATTERN FOR THE FUTURE

The PM 3207 is a tough, general purpose oscilloscope which offers at a low price the quality and technology you expect from Philips Test and Measuring Instruments.

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- 100 kHz-25 MHz in 9 overlapping ranges

Test & Measuring Instruments

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The PM 2517 has set the standard and the pace in Europe for handheld digital multimeters - and still it remains in a class of its own.

Remember, its many important features include full four digits, so on mains voltage readings, for example, you might get 240.3 instead of the 240, which a 3½ digit meter would read.

Some other PM 2517 plus points:
- LED or LCD display
- True RMS readings of AC voltage and current
- Autoranging with manual override
- Optional accessories include temperature and data hold probes

Reader inquiry number 220
15 MHz dual trace
- Auto triggering from either channel with adjustable level between peaks and TV triggering
- 5 mV sensitivity, Y and X (via A input)
- 8 invert facility

Reader inquiry number 221
PM 5519 RF signal generator
- Immediately available as part of a group of Philips Test and Measuring Instruments - still we will be pleased to show you our professional products to show our full range.

- Reader inquiry number 223
PM 4307 WAVE AND FLUTTER METER
- Kt17 controlled oscillator
- Kt18 accuracy and frequency stability
- 350 kHz or 3000 Hz switchable
- Separate 'Drift' and 'Flutter' indication

Reader inquiry number 224
- Built-in 3½ digit counter
- Small RF output at 350 can be attenuated to over 100dB
- Electronically stabilised output level
- Word/letter facility

Reader inquiry number 225
PM 5326 RF signal generator
- 100 kHz-25 MHz in 9 overlapping ranges

Reader inquiry number 226
- PM 2517 multimeter
- PM 3207 oscilloscope
- PM 5319 colour TV pattern generator
- PM 5326 RF signal generator
- PM 4307 wave and flutter meter

All Philips audio and video service instruments are also available from Philips Service Centres. For details see end of PM 2307 section.

Folded advertisement is designed to meet the needs of Philips audiophiles. Dated 1980.
DC POWER SUPPLIES a vast range suiting to meeting both amateur and professional requirements.

MEASURING INSTRUMENTS

Digital frequency meter, digital capacity meter

DC POWER SUPPLIES a vast range suited to meeting both amateur and professional requirements.

MEASURING INSTRUMENTS

Digital frequency meter, digital capacity meter

WE ARE LOOKING FOR AN EXCLUSIVE IMPORTER

well introduced on the English market for all our articles and for some lines of our product.

WWW — WIRELESS WORLD, APRIL 1980

NO WAITING FOR THESE TOP PRODUCTS

The PM 2307 has set the standard and the pace in Europe for hand-held digital multimeters - and still it remains in a class of its own.

Remember, its many important features include full four digits, so on mains voltage readings, for example, you might get 240.3 instead of the 240, which a 3½ digit meter would read.

Some other PM 2517 plus points:

● LED or LCD display
● True RMS readings of AC voltage and current
● Autoranging with manual override

Reader inquiry number 220

15 MHz dual trace
Auto triggering from either channel with adjustable level between peaks and TV triggering
5 mV sensitivity, Y and X (via A input)
0 invert facility

Reader inquiry number 221

100 kHz

1 MHz

10 MHz

100 MHz

PATTERN FOR THE FUTURE

The PM 5519 colour TV pattern generator is already a widely used instrument. As a major manufacturer of Video cassette recorders, and colour television receivers, and the company which has developed the world's most advanced video disk system, Philips have carefully selected the best patterns for aligning and testing these products. With over 20 colour and blue test patterns to choose from it is the most versatile pattern generator on the market.

PM 5519 for British system - versions available for other TV systems
RF signals available in bands B, I, J, F and V
Variable Video Output (with ±10° fixed position)
External video and sound modulation facility
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Reader inquiry number 223

PM 6307 WAVE AND FLUTTER METER

Kryal controlled oscillator
10 MHz source and test frequency
3:500 MHz or 3000 Hz switchable
Separate 'Drift' and 'Flutter' indication

Reader inquiry number 224

All Philips audio and video service instruments are also available from Philips Service Centres (for details see end of PM 3207 section).

Reader inquiry number 225

PM 5126 RF SIGNAL GENERATOR

100 kHz to 125 MHz in 9 overlapping ranges

Reader inquiry number 226

Pye Unicam Ltd
Philips Electronic Instruments Dept
Pye Unicam, Cambridge, England, CB2 1NT
Tel: (0223) 358866, Telex 842721

Test & Measuring Instruments
Finally, you can have all the advantages of DMMs and none of the disadvantages of analogues for about the same price.

Our new 169 is a tough, lightweight, battery-powered digital multimeter for use in the field or on the bench. It is a 5½-digit, full 5-function DMM with respectable 2½% DC accuracy. Its low-parts-count, high-efficiency design keeps power consumption to a minimum for longer component life and fewer failures. MTBF is 20,000 hr. or about 10 years.

All 5 functions are fully protected - 1400V peak on DCV and ACV, 300V on Ω, 2A (250V) on DCA and ACA. The fuse is externally accessible for quick replacement. Extensive vibration stress-testing assures the 169 will stand up to all the mechanical shock and abuse normally associated with tough installations.

Cost-conscious case of maintenance is so thoroughly designed into the 169 that only one calibration adjustment a year is required. That adds up to a cost-of-ownership no other competitive DMM can touch. For example, the 169 needs only one battery change per year at a cost of about £1.50.

When you factor in features like function and range announcement right on the display, auto-zero, auto-polarity, 60% larger display than other DMMs and the easy-to-read, colour-coded front panel, we think you'll get the point.

No analogue meter or DMM can match the price/performance of the new 169. It costs £99 (plus VAT).

For information on the 169 or any Keithley DMM call (0734) 861287 Telex: 847047

Ex stock

For further details

**Lateral Thinking**

"The perfect definitive power amplifier should be designed to be stable and completely undistorted across a full frequency range up to the highest power level with total dependability," we said. Our resolve was to make that ideal a reality.

Thus, our boffins at Cambridge donned their thinking caps and with typical panache, sliced across convention with a radical new solution: MOS-FET technology.

And the result? No thermal runaway, no secondary breakdown. Simplified circuits. Fewer components. Therefore, greater reliability under tough conditions. Whatever your application; variable frequency power supplies, servo motor systems, vibrator driving, or superior audio installations, our new MOS-FET amplifiers will deliver perfect waveforms right up to 50kHz at full power.

Now this technology is available to you, in a 19" rackmount format with models from 150 to 800 Watts, and upwards in multiples, using the X300 frequency dividing network.

So if you're thinking that our thinking was along the right lines, then drop us a line yourself and we'll tell you much more.

**Graduate to the 80's. MOS-FET.**

HBI Electronic, Dept A5, Viking Way, Bar Hill, Cambridge CB5 9EL Telephone: Crafts Hill 60543. Telex: 817515 HH Elec G.
Finally, you can have all the advantages of DMMs and none of the disadvantages of analogues for about the same price.

Our new 169 is a tough, lightweight, battery-powered digital multimeter for use in the field or on the bench. It is a 5-digit, full 5-function DMM with respectable 2.5% DC accuracy. Its low-parts-count, high-efficiency design keeps power consumption to a minimum for longer component life and fewer failures. MTBF is 50,000 hr., or about 10 years.

All 5 functions are fully protected—1400V peak on DCV and ACV, 300V on Ω, 2A (250V) on DCA and ACA. The fuse is externally accessible for quick replacement. Extensive vibration stress-testing assures the 169 will stand up to all the mechanical shock and abuse normally associated with tough applications.

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Ex stock

WIRELESS WORLD, APRIL 1980

Is this the end for Analogue meters?

Lateral Thinking

"The perfect definitive power amplifier should run absolutely stable and completely undistorted across a full frequency range up to the highest power level with total dependability," we said. Our resolve was to make that ideal a reality.

Thus, our fellows at Cambridge donned their thinking caps and with typical panache sliced across convention with a radical new solution: MOS-FET technology.

And the result? No thermal runaway. No secondary breakdown. Simpler circuits. Fewer components. Therefore, greater reliability under tough conditions. Whatever your application; variable frequency power supplies, servo motor systems, vibrator driving, or superior audio installations, our new MOS-FET amplifiers will deliver perfect waveforms right up to 50kHz at full power.

Graduate to the 80's MOS-FET.

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K1000 & K2000 SOLDERING IRONS

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Testing... Testing... Testing...

The New FM/AM 1000s with Spectrum Analyser — we call it the SUPER-S

A portable communications service monitor from IFR, light enough to carry anywhere and good enough for most two-way radio systems tests. The FM/AM 1000s can do the work of a spectrum analyser, oscilloscope, tone generator, deviation meter, modulation meter, signal generator, wattmeter, voltmeter, frequency error meter — and up to five service engineers who could be doing something else!

For further information contact Mike Taylor

FieldTech Ltd

Heathrow Airport
LONDON HA9 1SA

Tel: 01-759 2811

TELEX: 23734 FIELDTEC G

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BEWARE! RADIO ACTIVITY

The new MK III FM tuner

Britain in the Mix 80s

Includes a unique noise detecting circuit

New S94378 2, the last word in crystal detectors with the K94437/4438

Choosing the products to advertise each month can be quite a task at AMBIT, since we try to advertise at least one new product per week. So it is mainly impossible to say at all we would like to see advertising material for — except that we have to advertise for up to date as possible with current events. The major medium for testing out new products hasn't been in our private catalogue system, and we ask that you insert a copy of a 2.5 x 3 in on these questions are we asked can be readily answered in reference to the catalogue

Each part costs 60p, or £1.00 for three current editions.

We also have (and whilst we're at it) a slightly enlarged version of our PRICE LIST, which now includes a large number of quantity listings, and many items not previously listed. The new price list too is a quick reference sheet from our general catalogue — available FREE with a large 2AM 36s price.

As a result of the raising price of oil and the subsequent increase in the cost of wax for Mr Tom Jackson's famous moustache, the Post Office have increased their charges (24p. 45p). Accordingly, our standard overseas charge has been increased to 50p per order (COD).

COMPONENTS

DIGITAL FREQUENCY READOUTS / SYNTHESER SYSTEMS

Ambit has the largest range of digital frequency readouts for various applications in Broadcast and Communications. Prices range from £18.50 for a complete AM/FM broadcast frequency display (Kit of DFM2). Most are detailed in the latest catalogue.

TUNING SYNTHESIZERS

A versatile communications system based on the new TUNING SYNTHESIZER: RADIO CONTROL: TRANSISTORS TBA120S

AMBIT 80414-6 RADIO CONTROL: TRANSISTORS TBA120S

RADIO CONTROL: TRANSISTORS TBA120S

Price - £8.50 each. Our 3SK51 MOSFET replaces the components to advertise each month can be quite a task at AMBIT, since we try to advertise at least one new product per week. So it is mainly impossible to say at all we would like to see advertising material for — except that we have to advertise for up to date as possible with current events. The major medium for testing out new products hasn't been in our private catalogue system, and we ask that you insert a copy of a 2.5 x 3 in on these questions are we asked can be readily answered in reference to the catalogue

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AMBIT 80414-6 RADIO CONTROL: TRANSISTORS TBA120S

RADIO CONTROL: TRANSISTORS TBA120S

Price - £8.50 each. Our 3SK51 MOSFET replaces...
Plan the 80's with the best

K1000 & K2000 SOLDERING IRONS
- 16w Producing 420°C
  (Helping the Save-it campaign)
- PUSH-IN TIPS
- 6 MONTHS GUARANTEE

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ONE HUNDRED PERCENT LEGAL DUTY VINYL COVERED

WWW WORLD, APRIL 1980

BEWARE! RADIO ACTIVITY

The new MX III FM tuner

Sitting under the Droxford

multiband AM/FM tuner

Designed to the latest

INCUSDO

For further information contact

AMBIT

The New FM/AM Spectrum Analysers - we call it the

SUPER-S

A portable communications service monitor from IFR, light enough to carry anywhere and good enough for most two-way radio system tests.

The FM/AM 1000s can do the work of a spectrum analyser, oscilloscope, tone generator, deviation meter, modulation meter, signal generator, wattmeter, voltmeter, frequency error meter-and up to five service engineers who could be doing something else!

For further information contact Mike Taylor

FieldTech Ltd
Highworth Airport
London Hounslow
TW3 3AF
Tel: 01-759 2811
Telex: 23734 FLDTIC G

WW - 86 FOR FURTHER DETAILS

WIRELESS WORLD, APRIL 1980

REFERENCES TO COUNTRIES/FRAMES AND SPECIAL OFFERS MENTIONED IN THIS ISSUE ARE EXCLUSIVE TO THE UK AND ARE SUBJECT TO AVAILABILITIES AND LOCAL PRICING.

Choosing the products to advertise each month can be quite a task at AMBIT, since we tend to advertise at least one new test each week. So it is nearly impossible to do so if we would like to keep them up to date and even current events. The major medium for feeling out new products has been direct mail to our own customer database, and we ask that you insert in a copy of 1, 2, 3 and so on, since many questions we are asked can be neatly answered by referring to these.

Each part costs 8s. or 8s. 6d. for three current editions.

We also have a highly developed version of our PRICE LIST, which now includes a large number of quantity listings, and many items are not generally listed. The new price list has a quick reference front cover to our general catalogues available for 60p, with a large (A4) 50p. index.

As a result of the soaring price of oil and the subsequent huge increase in the cost of wax for the Tom Johnson’s famous Remember, the Font Office have increased their charges. For 48p. Accordingly, our standard cover charge has been increased to 30p. or two times.

COMPONENTS

DIGITAL FREQUENCY READOUTS / SYNTHESISER SYSTEMS

Ambit has the biggest range of digital frequency readout systems for various sections of a four digital, medium range, is also featured and we offer our first 0.126 2SB646A 0.345 2.53 CA3123E 1.61 1.95 1.96

frequency, and detector.

TUNING SYNTHESISER...the first with a range of two part caps for easy, and 3v in one 4.75pr MSL9362/MSL9363:

AMBIT

0.207 2SC2547E 0.391 2SK55 0.368 2SJ48 6.32

also featured, and we offer our first 2SK133 6.32

インダクター/回路の設計はシンプルに、テキストが明確に説明されています。
THE CS1830 30 MHz + Sweep Delay

The CS1830 is a complete new 30 MHz dual trace oscilloscope employing a square format, enraged graticule, PDA tube for accurate bright display. A new feature is the inclusion of calibrated sweep delay with a range of 1x-100 ms and trace bump up to show the delay position. As you can see from close observation of the photograph, the CS1830 has all the facilities you could require in a high performance instrument but for more details, simply ask us for a comprehensive leaflet.

Brief Specification

Rectangle PDA tube 120 x 96 mm. P31 phosphor
Sweepwidth 0-20 MHz
Sensitivity 2mV/cm (20 MHz)
Input R.C. 1 M/23 pF
Rise time 11.7ns

CS1830 only £455 + VAT includes 2 probes

THE CS1575 30 MHz for the VTR Lab

If you are in Video, you need the CS1575

The CS1575 is a dual range 30 MHz oscilloscope designed for the video tape recorder engineer. Video delayed sweep facilities are provided to allow magnification and analysis of any signal in a single video frame together with separation of video odd and even fields. A truly unique tool for anyone concerned with video measurements as well as top specification dual trace wide band oscilloscopes for general lab use. The complete range of video facilities is too great to explain in a small advertisement so why not call us and ask for the full story on the CS1575.

Brief Specification

As for CS1837 except that the sweep delay feature is replaced by comprehensive video sweep delay facilities which allow complete analysis of video wave forms and VTR alignment.

CS1575 only £425 + VAT, includes 2 probes

THE CS1577 30 MHz at 2mV + Signal Delay

The most popular scope in the range

The CS1577 is, without doubt, our most popular oscilloscope and hundreds of satisfied users in all sections of the electronics industry will confirm this. The CS1577 combines a wide bandwidth DC-30 MHz performance with extremely wide trigger bandwidth (DC-40 MHz) and 2 mV sensitivity over the full bandwidth.

Fixed signal delay is provided by a helix delay line which can simultaneously display the phase angle between them and a zero phase calibration display. As you can see from the leaflet, this proves to be a unique feature.

CS1577 only £410 + VAT, includes 2 probes.

THE CS1575 unique dual trace 4 function Audio Scope

The CS1575 is a unique tool for the audio engineer. It features the normal facility of dual scope display with sensitivity to 1 mV/cm but not only can it display the true signal on two channels; it can simultaneously display the phase angle between them and measure the phase angle referenced to a zero phase calibration display. In addition to this, it has a unique independent triggering from each channel to give stable displays even with widely differing input frequencies.

Absolutely indispensable to the professional audio engineer, the CS1575 is now in use all over the world. See it in action for complete details.

CS1575 only £235 + VAT.

AND TWO NEW ADDITIONS TO THE RANGE

PC756 500 MHz COUNTER

10 Hz-500 MHz

60V

Superb instrument

£225 + VAT

For more details and stock delivery contact

LOWE ELECTRONICS

CHESTERFIELD ROAD, MATLOCK, DERBYS.

0629-2430 - TELEX 377482

WW—411 FOR FURTHER DETAILS
THE CS1830 30 MHz + Sweep Delay

THE CS1830 is a complete new 30 MHz dual trace oscilloscope employing a square format, vertical graticles, PDA tube for accurate bright display. A new feature is the inclusion of calibrated sweep delays with a range of 1-100 msec and trace bright up to the delay position. As you can see from close study of the photograph, the CS1830 has all the facilities you could require in a high performance instrument but for more detail, simply ask us for a comprehensive leaflet.

Brief Specification
Rectangular PDA tube 120 x 96 mm. P31 (phase)
Bandwidth DC-30 MHz
Sensitivity
Input R.C. 1:1 - 23 3
Rise time 11.7 ns

THE CS1830 only £455 + VAT includes 2 probes

THE CS1572 30 MHz for the VTR Lab.

If you are in Video, you need the CS1572.

The CS1572 is a dual trace 30 MHz oscilloscope designed for the video tape recorder engineer. Video delayed sweep facilities are provided to allow magnification and analysis of any signal in a single video frame together with separation of video odd and even fields. A truly unique tool for anyone concerned with video measurement as well as top specification dual trace wide band oscilloscopes for general lab use. The complete range of video facilities is too great to explain in a small advertisement so why not call us and ask for the full story on the CS1572.

Brief Specification
As for CS1830 except that the sweep delay feature is replaced by comprehensive video sweep delay facilities which allow complete analysis of video wave forms and VTR alignment.

CS1572 only £425 + VAT, includes 2 probes

THE CS1577 30 MHz at 2mV + Signal Delay

The most popular scope in the range.

The CS1577 is, without doubt, our most popular oscilloscope and hundreds of satisfied users in all sections of the electronics industry will confirm this. The CS1577 combines a wide bandwidth DC-30 MHz performance with extremely wide trigger bandwidth (DC-50 MHz) and 2mV sensitivity over the full bandwidth.

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<td>4 sockets 13A</td>
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Science of the whole

The study of all creation and man's place in it was the only kind of science worthy of consideration, in Tait's view. A school curriculum of sufficiently wide scope for such a purpose would take a little time to construct and a good deal more to practice, but at the conclusion of such a course of instruction a child would be well on the way to becoming a whole person, if not several. Newer to the modern scene, and considerably less ambitious in his requirements, was A. N. Whitehead, who remarked that wisdom is the fruit of a balanced development. In this context, the balance is not between the two specialisations in science or the arts, but between education and training. One must recognise that, to a greater degree now than ever before, specialisation is necessary if potential engineers and scientists are to have a reasonably stable platform on which post-school training can be built. Merciless economics dictates that scientifically-aware youngsters are needed to enable this country to earn its living—ever to stand still, let alone to grow. In the sixth form at school, and even earlier in some schools, the specialisation in science has been promoted for many years, with the result that university and technical colleges have received a steady stream of entrants, well grounded in the relevant disciplines. It is true that there is now a shortage of science teachers of the required level of competence, but that is a separate and more recent issue.

That is all as it should be. But while a pupil should be given a sound base of knowledge for his professional training (and there is no virtue in meaning intended in that pronoun or succeeding ones) the 'balanced development' is unlikely to be obtained by an exclusive study of maths, chemistry, physics and a useful language, even though a token "art" (in the wider sense) may be tacked on for the sake of appearances. If one's entire two years of sixth-form experience is devoted to analysis rather than appreciation in less precise terms of the natural and human condition, the soulless future which many fear and of which some already see the first signs becomes more probable. If a sixth-former has no freedom to view the world in a less calculating way in his last two years of education, there will be even less possibility of his doing so during a professional training at college or university.

Those whose business it is to make recommendations on education are aware of the need for "breadth", but allow it only a symbolic presence in courses of study. For example, a recent article on secondary education, written on behalf of the Council of Engineering Institutions, recognizes the concept of "study in breadth", but goes on to propose a list of five subjects to be taken in a new examination for young people intent on a science or engineering career: the five subjects are maths, English language, physical science, a European language and at least one other "relevant to career choice". The breadth is taken care of "by other supplementary subjects as desired". The whole of human experience outside the sciences is thus lumped together and labelled "supplementary subjects". A tendency to segregate 16-plus pupils, and even younger ones in some cases, into science and arts groups has been evident for years. C. P. Snow's Two Cultures is discernible long before the Second Law of Thermodynamics becomes a matter for discussion, with A-level students encouraged to view those whose interests lie in French literature or History as "unscientific". The breadth is surely not meant to be a training ground for either tradesmen or professionals, but for people. The first aim of 16-plus schooling must obviously be a preparation for a university training, but a sixteen-year-old ought not to have his sensitivity so blocked with a mass of subjects that he cannot also purchase the pleasures of learning about life. Nor should he be allowed to finish his education on a diet of arts alone: no-one should be excluded from the excitement of science. But the balance must be preserved.

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Science of the whole

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The breadth is taken care of by "other supplementary subjects" as the whole of human experience outside the sciences is thus lumped together and labelled "supplementary subjects". A tendency to segregate 16-plus pupils, and even younger ones in some cases, into science and arts groups has been evident for many years. C. P. Snow's Two Cultures are discernible long before the Second Law of Thermodynamics becomes a matter for discussion, with A-level students encouraged to view those whose interests lie in French literature or History as woolly-minded aesthetes. One can only hope that a broader view could now be admired, but when a friendly science teacher with public school experience was asked for his opinion, he said, "Well, they are, aren't they?"

School is surely not meant to be a training ground for either tradesmen or professionals, but for people. The first aim of 16-plus schooling must obviously be a preparation for a university training, but a sixteen-year-old ought not to have his sensitivity so blocked with a mass of unnecessary knowledge that he cannot also perceive the simple pleasures of learning about life. Nor should he be allowed to finish his education on a diet of arts alone: no-one should be excluded from the excitement of science. But the balance must be preserved.

If H. G. Wells is to be believed, human history becomes more and more a race between education and catastrophe...
Digital capacitance meter

Six ranges of 200pF to 20µF full-scale

by Adrian Ryan, (G3VJN)

The article describes the design and construction of a 3½ digit digital capacitance meter, which has six ranges of 195.9pF to 19.999µF full-scale. The maximum error of the instrument is ±1%, determined by the accuracy of the two calibration standards used. Accuracy was mainly limited by the errors in temperature and any drift in capacitance, and it was whilst performing this that the contrast was acceptable in the display that the use of selected resistors with the aid of a 3½-digit digital display was decided upon. The use of using an LCR bridge to select capacitances, I therefore investigated the possibility of designing an instrument to measure capacitance with comparable accuracy and ease of operation to that of my d.m.m.

Design considerations

Fig. 1. Outline of the method of measurement. Gate width is proportional to the numerical value of £x + £y.

The heart of the instrument is shown in Fig. 1. If a positive-going edge is applied simultaneously to one input of a 2-input NAND gate, and via a series CR network to an inverting Schmitt trigger whose output is connected to the other input of the gate, then the output from the gate will be a negative-going pulse whose width is directly proportional to the time constant R2C2. If this pulse is used to gate the input of a counter then, by choosing the appropriate values for R2 and C2 the counter input frequency, the final accumulated count can be made to exactly represent the numerical value of £x + £y. To allow for second range resistors for each range, only two range resistors are used, the intermediate steps being effected by successively dividing the output of the master clock by 10 for ranges 3 and 5, and by 100 for ranges 1 and 2. If the sample period is changed (approximately 1 second) this arrangement will suffice for capacitors up to about 5pF. However, for values below 1pF a longer sample time is required to discharge the capacitor completely but the minimum of 10 periods of the same sample pulse is still required. The master clock is selected by using an LC R bridge as described above.

Design steps

Fig. 2. Circuit to eliminate the effects of stray capacitance. Clock pulses are inhibited for a time corresponding to the value of the stray.

The above scheme will be satisfactory for all values of capacitors for which C4 is not neglected, but the offset produced by the presence of this stray capacitance will become increasingly inconstant at £x + £y increased. I chose to eliminate the effects of C4 by the arrangement shown in Fig. 2. Here, each range the same circuit used to generate the gate pulse is used, the difference being that the output of C4 is used to inhibit a number of periods of the master clock. By varying the ‘set zero’ potentiometer the offset suppression pulse can be made to cancel the zero error produced by the stray capacitance.

The success of the instrument will generally depend on its stability in the face of varying supply voltages and temperature, and in this regard, the Schmitt trigger i.e. if chosen, the NE 74C14 or RCA CD40106 is ideal. The threshold voltages at which switching occurs are defined by the ratio of the on-chip resistors. Thus, these switching thresholds will always be a fixed percentage of the supply voltage. Similarly, since the resistors are fabricated at the same time, whilst their own absolute temperature coefficient may be large, the temperature coefficient of their ratio will be very small. The other major influence on stability is the master oscillator, and the design chosen is that of a conventional Hartley oscillator, using a re-205kHz transistor radio i.f. transformer. With the feedback ratio chosen, no problems were encountered with the thermal noise of the measurement 2N3819 fet. It is a characteristic of well designed LC oscillators that the output frequency is relatively insensitive to supply voltage with comparable accuracy and ease of operation to that of my d.m.m.

Power requirements

The choice of supply voltage for the unit was not entirely arbitrary, but was dictated by maximum count-rate considerations of the MC14553. I have used this device for a number of counting applications, and have obtained samples from many of these ICs, whilst meeting their guaranteed specifications, have had maximum counting rates which were somewhat lower than the ‘typical’ figures given in the data sheets. To avoid problems in selecting devices, a supply voltage was chosen which would ensure sufficient speed margin, even with both a worst-case counter and a worst-case threshold voltage. The choice of the supply voltage for the instrument, I used a re-chargeable nickel-cadmium battery pack, simply because it was available. However, this would be difficult to justify in general, since both the current drain and the duty cycle are low in normal use. Consideration should therefore be given to using a normal 9V dry battery, such as the PP9. Whilst on the subject of power supplies, it is worth noting that certain problems are likely to be encountered if the unit is mains powered. The input impedance on ranges 1 to 3 is very high ±10kΩ – making the instrument sensitive to hum pick-up. The effect is mainly to be observed on Range 1, but is also present on the display driver IC, and after periods of operation, the 14-pin common-cathode.
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Six ranges of 200pF to 20µF full-scale

by Adrian Ryan (63VJN)

The article describes the design and construction of a 3½ digit digital capacitance meter that has six ranges of 195.9pF to 19.99 µF full-scale. The maximum error of the instrument is ±1%, determined by the accuracy of the two calibration standards used.

Accurate measurements are largely dependent on both the voltage or temperature variations, making battery power predictable. No precision components are used in the design, maximum advantage being taken of digital c.m.o.s. integrated circuits to render the use of precision components unnecessary.

A recent project required the selection of a meter, the frequency capacitance and capacitance, and it was whilst performing this chore that the contrast was obtained on the one instrument used. It is seen that the aid of a 3½-digit accuracy is to be had, and the problem of using an LCR bridge to select capacitors. I therefore investigated the

Design considerations

The heart of the instrument is shown in Fig. 1. If a positive-going edge is applied simultaneously to one input of a 2-input NAND gate, and, via a series CR network to an inverting Schmitt trigger whose output is connected to the other input of the gate, then the output from the gate will be a negative-going pulse whose width is directly proportional to the time constant R9C9. If this pulse is used to gate the input of a counter, then, by choosing the appropriate values for R9 and the counter input frequency, the final accumulated output count can be made to exactly represent the numerical value of C9. To obtain a very low leakage current, a BC109B is suitable.

The above scheme will be satisfactory for all values of capacitance for which C9 can be neglected, but the offset produced by the presence of this stray capacitance will become increasingly incommensurate as C9 is reduced. There is a need to eliminate the effects of C9 by the arrangement shown in Fig. 2. Here, much the same circuit used to generate the gate pulse is used, the difference being that the output of IC9, is used to inhibit a certain number of periods of the master clock. By varying the 'set' potential, the offset suppression pulse can be made to cancel the zero error produced by the stray capacitance.

The success of the instrument will greatly depend on its stability in the face of varying supply voltages and temperatures, and in this regard, the Schmitt trigger circuit chosen, the NS 4514 or RCA CD40106 is ideal. The threshold voltages at which switching occurs are defined by the ratio of the on-chip resistors. Thus, these switching thresholds will always be a fixed percentage of the supply voltage. Similarly, since the resistors are fabricated at the same time, within their own absolute temperature coefficient may be large, the temperature coefficient of their ratio will be very low.

The other major influence on stability is the master oscillator, and the design chosen is that of a conventional Hartley oscillator, using a re-wound 45kHz transistor radio i.f. transformer. With the feedback ratio chosen, no problems were encountered in the initial measurement 2N3819.f.e.t. It is a characteristic of well designed LC oscillators that the output frequency is relatively insensitive to supply voltage, and with my unit, varying the supply voltage from 7 to 13V caused the frequency to change by less than 0.2%. An interesting point is that the oscillator frequency is at about 25%. Temperature compensation of the oscillator is achieved by using a display driver IC9, via its blanking input (B) terminal. Thus the over-range indication is provided by the display blanking, for 20, 200, or 2000, depending upon the range selected.

Power requirements

The choice of supply voltage for the unit was not entirely arbitrary; it was dictated by maximum count-rate considerations of the MC14553. I have used this device for a number of counting applications, and have obtained samples from many of these ICs, whilst meeting their guaranteed specifications, have had maximum counting rates which were somewhat lower than the “typical” figures given in the data sheets. To avoid problems with these devices, a supply voltage was chosen that would ensure sufficient speed margin, even with both a worst-case counter and a worst-case threshold voltage applied to the instrument. I used a rechargeable nickel-cadmium battery pack, simply because it was readily available. However, this would be difficult to justify in general, since both the current drain and duty cycle are low in normal use. Consideration should therefore be given to using a normal 9V dry battery, such as the PP9. Whilst on the subject of power supplies, it is worth noting that certain problems are likely to be encountered if the unit is mains powered. The input impedance of ranges 1 to 3 is very high (~10MΩ – making the instrument sensitive to hum pick-up. The effect is mainly to be observed on Range 1, with a large change in the display value. With battery power, however, hum pick-up affects both input terminals equally, and it seems as a common-mode voltage and is rejected. Therefore, unless one is prepared to go to the trouble of providing a low and isolated supply battery power is recommended. In my case, since the mains transformer had insufficient capacity to re-charge the battery pack and power the unit, a mains socket was chosen with an integral switch that automatically disconnects the electronic module during recharging.

Construction

The unit is constructed on two 8cm × 8cm printed-circuit boards with a shielding plate interposed. The plate was included only as a precautionary measure, and there were no problems in constructing this, or in any of the cases. It will be noted that no precision components are called for in the design,
only good quality, high-stability, metal-film resistors for \( R_6 \), \( R_7 \), and \( R_8 \). It should be noted that the connection from the input terminals to the p.c. board should be screened, and not laced in with the wiring loom. Otherwise, construction is uncritical.

Calibration and use

The unit may be calibrated as follows. Apply power, short TP 1 to ground, and observe that the display shows 888. Set \( R_6 \) to mid-travel, and \( R_8 \) to minimum resistance. Select Range 4, and with a 0.1 \( \mu \)F, 1% capacitor connected to the input terminals, carefully adjust the slug in \( L_1 \) for a display of 100.0. Without removing the capacitor, select Range 3 and observe that the display blinks, signifying that an over-range condition exists. Remove the capacitor, select Range 1, and verify that zero error exists. Increase \( R_4 \) from its initial minimum setting, observing that the displayed count reduces, until a small residual error remains. Increase \( R_8 \) until the display reads 1000. Disconnect the capacitor, select Range 3, and verify that zero error remains (approximately 1-2 \( \mu \)F is suitable). Select Range 2, connect a 1000 \( \mu \)F capacitor to the input, and adjust \( R_8 \) until the display reads 1000. If the range switch for the desired resolution.

Certain points should be borne in mind. In order for an accurate reading to be obtained, it is essential that the equivalent leakage resistance of the device under test is much higher than the range resistor. For ranges 1-3, this means that the leakage resistance must be in the order of 100 k\( \Omega \), and for ranges 4-6, at least 100 k\( \Omega \). Both of these requirements are readily met by normal quality components. If the instrument displays anomalous readings between ranges 3 and 4, this would indicate a very leaky component. For example, if a nominal 1800 \( \mu \)F capacitor displays correctly on Range 4, but shows over-range on Range 3, this would be cause for regarding the component with considerable suspicion.

Modifications

After the instrument had been in use for some time, it was noted that it would always stabilize within about a second. This prompted me to replace the power switch with a three-position, centre-off switch with a three-position, centre-off.

- Fig. 3. Complete circuit diagram of the meter. The instrument is built in two boards, equivalent to left and right-hand halves of the diagram.
only good quality, high-stability, metal-film resistors for \( R_4, R_5, R_6, \) and \( R_7 \). It should be noted that the construction from the input terminals to the p.c. board should be screened, and not laid in with the wiring looms. Otherwise, construction is uncrITICAL.

Calibration and use

The unit may be calibrated as follows: Apply power, short TP 1 to ground, and observe that the display shows 888. Set \( R_{29} \) to minimum and \( R_4 \) from the input terminals to the p.c. board should be screened, and not laid in with the wiring looms. Otherwise, construction is uncrITICAL.

In use, it is only necessary to connect the unknown, switch on and adjust the range switch for the desired resolution. Certain points should be borne in mind. In order for an accurate reading to be obtained, it is essential that the equivalent leakage resistance of the device under test is much higher than the range resistor. For ranges 1-3, this would indicate a small residual error remains. If necessary, re-adjust \( R_4 \) and reset Range 2 calibration so that finally, with no capacitor connected on Range 1, the instrument reads 00.0, 00.1 or 00.2, and also displays correctly on Range 2. This complete calibration and adjustment.

Modifications

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*Fig. 4. General timing diagram.*

*Fig. 3. Complete circuit diagram of the meter. The instrument is built in two boards, equivalent to left and right-hand halves of the diagram.*
type, with a locking action on one side and a momentary action on the other to give a push-to-read facility and a continuous-read position. This modification has greatly extended the time between exchanges, and would similarly benefit ordinary dry-cell operation. A second possible modification could be made by those who need to extend the maximum range of the instrument, at the expense of losing the minimum range of 1999pf.

The calibration standards used to calibrate IC 1b will artificially lengthen the time constant and must be allowed for. The non-zero output resistance of IC 1 will reduce the gain. Note that the non-zero output resistance of IC 1 will artificially lengthen the time constant and must be allowed for.

The time constant of the device is 281Q, from its initial value of 7pF for Range 1, 10kQ, lOkQ, to increase as the load increased. The reading at +40°C was -0.7%, whilst at 0°C it was +6.7%, thus demonstrating the high stability of the instrument. With the push-to-read modification incorporated, the unit has indeed demonstrated its utility and ease of operation, and along with the ohms range of my digital multimeter has virtually replaced the LCR bridge. Now, if only there was a convenient analogue of inductance.

References
1. MM0461/4 MM4041 Data Sheet.
3. V. S. Series A MM050 Integrated Circuits, pp. 7-38/7-20.

Fig. 5. Switching for the decimal point.

Marconi and Airbus

Airbus Industrie has chosen a proposal by Marconi Avionics and the German firm of Liebherr Aerotechnik for the microprocessor control of flaps and slats on the new Airbus A310. The system is to provide a high degree of safety (flaps and slats are used in the takeoff and landing phases of a flight) by self-monitoring, by the use of two separate systems of different type and by the provision of a certain amount of autonomy in operation to avoid the effects of crew error. Should a crew member attempt, for example, to close the leading-edge slats at too low an airspeed, or to extend the trailing-edge flaps at too high an airspeed, the controls will prevent the command being carried out.

The microprocessors used are the 8085 and 8080, and are being used to control the flying surfaces and the other in a monitoring function. Different designs are used in the expectation that a software fault would not affect each in the same way.

Marconi are now very experienced in automatic flight control, having supplied the software for the highly-automatic system for the abandoned Boeing VC-14 military transport.

Fig. 6. Power supply.

How serious is multipath distortion?

Effect on sound quality and bit-stream in broadcast reception

by Pat Hawker, Independent Broadcasting Authority

How common is multipath?

There is very little doubt that multipath conditions are responsible for a very significant share of the degradation of broadcast transmissions received on high-quality equipment. Multipath distortion is due to the simultaneous pick-up of direct and reflected signals, and is the counterpart of the well-known "ghosting" on television; however, unlike tv ghosting its effect may not be readily observed by the listener, nor can its effects be readily mitigated by adjusting the antenna or equipment settings. As a result, there has been relatively little investigation of the problem.

The broadcasters have thus felt obligated to attempt to induce the public to make more use of v.h.f./f.m. The many advantages, rather than the few disadvantages, have been stressed little, and the most romantically-sceptical listeners.

But is there not another anomaly in which the multipath effect is expressed as the great hi-f' con? Serious and detectable forms of distortion go unmentioned, either because they are difficult to relate to particular equipments or because the whole subject may still be surrounded by uncertainty, may differ according to particular circumstances, or may be contrary to what might be expected. Multipath distortion, as with v.h.f./f.m. sound broadcasting, mono, stereo and (potentially) "surround sound" is a not so obvious example.

Broadcast engineers for over a quarter-century have recognised that, for good quality reproduction, v.h.f./f.m. offers great advantages over m.f. in terms of full audio bandwidth (up to 15kHz), in much increased dynamic range (and therefore reduced need for compression) and in reduction of the co-channel interference that plague conventional broadcast reception. It has been a major disappointment that all the problems associated with multipath distortion are not solved as easily as in the case of m.f.

In introducing his article "Audible multipath distortion is not a mystery. (Wireless World, November 1977) Peter Baxandall quoted Bertrand Russell: "Some things are believed because people feel as if they must be true, and in such cases an inarticulate faith in the evidence is necessary to dispel the belief."

He showed that much of the advice given to high-fidelity enthusiasts was (still is?): misleading; that popular "reviews" of consumer equipment are not based on evidence of supposed subtleties by evoking "a sense of the wilder and yet wilder pseudo-scientific hypotheses", and that the public is being encouraged to "detect" forms of subjective distortion that defy, and (sometimes) contradict objective engineering measurements; with some manufacturers rising to the challenge must concern levels of distortion that can be detected by all one's most musically-sceptical listeners. But is there not another anomaly in which the multipath effect is expressed as the great hi-f' con? Serious and detectable forms of distortion go unmentioned, either because they are difficult to relate to particular equipments or because the whole subject may still be surrounded by uncertainty, may differ according to particular circumstances, or may be contrary to what might be expected.

Fig. 6. Power supply.

Effects of multipath

For the listener multipath distortion may pass unnoticed on receivers of limited audio bandwidth but on high-quality installations may vary from just perceptible to severe breaking up of the higher audio notes. While often compared to musical distortion, this effect is produced by an otherwise loudspeaker speech coil; it can also cause distortion of sibilants and indeed any to high-frequency instrument notes, such as flutes or high-pitched voices. The Japanese broadcasting organisation, NHK, has recently stated categorically that for v.h.f./f.m. stereo it is one of the major factors which de-
type, with a locking action on one side and a momentary action on the other to give a push-to-read facility and a continuous-read position. This modification has greatly extended the time between exchanges, and would similarly benefit ordinary dry-cell operation. A second possible modification could be made by those who want to extend the maximum range of the instrument, at the expense of losing the minimum range of 199pF. The modification consists of replacing R5, R6, and R7 with the next-lower-decade values, at the same time changing R9, R10, and naturally, R6 with their next-lower-decade values. This would have the effect of making Range 1 199pF and Range 6 199.9pF. Note that the non-zero output resistance of IC2, will artificially lengthen the time constant and must be allowed for. The average output resistance of 15 samples of this i.c. was found to be 2900, ranging from 2160 to 3032. In addition, it was observed that the output resistance was not constant with load, tending to increase as the load increased. For one sample the output resistance was found to remain constant for load resistances down to 10kΩ, and to have increased to 2810Ω from its initial value of 246Ω for a load of 1kΩ. Buffering the output of IC2, with a fast voltage follower would eliminate the problem.

The unit has now been in operation for several months, and no drift has been observed in the displayed values of the calibration standards used to calibrate the instrument. With battery power, the observed values of display voltage amounted to 2.87V for Range 1, and the usual ±1 count in the least-significant digit position for all other ranges. However, as expected, the system is temperature cycled and, using Range 4 with a 1030Ω capacitor at room temperature, the reading at +40°C was -0.7V, whilst at 0°C it was +6.7V, thus demonstrating the inherent instability of the instrument. With the push-to-read modification incorporated, the unit has indeed demonstrated its utility and ease of operation, and along with the ohms range of my digital multimeter has virtually replaced the LCR bridge. Now, finally there was a convenient analogue of inductance . . .

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The microprocessors used are the 8080 and 8085, both being used to control the flying surfaces and the other in a monitoring function. Different designs are used in the expectation that a software fault would not affect each in the same way.

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Fig. 5. Switching for the decimal point.

References
1. M534C14/ M544C14 Data sheet.

Printed circuit boards

A set of two single-sided printed circuit boards is available for £5.60 inclusive of v.a.t. and UK postage from M. R. Siglin at 23 Kayes Road, London NW2.

How serious is multipath distortion?

by Pat Hawker, Independent Broadcasting Authority

According to one broadcaster, multipath distortion is "one of the most difficult problems . . ." (Broadcast, 1979). A recent survey by the Corporation Research and Engineering Department (CRED) showed the viewer could expect to lose a clear signal for as long as 25% of the time, for interfering signals to be just perceptible to severe breaking up of the higher audio notes. While often comparable with the "ghosting" or "shadowing" experienced by the listener, multipath distortion is more difficult to study and not perceptible to the ear. It is due to a delay in the signal reaching the viewer, which creates a phase difference and hence a result- ant amplitude variation with instantaneous frequency, such a display providing an indication of only the relative phase of the harmonics of the audio signal and not the phase difference between the two signals.

The investigations, at a large number
of sites, showed that even on standard receivers there were five sites where at least “just noticeable distortion” was not observed when using indoor aerials; distortion could be reduced by arranging that the a.m. suppression characteristics of the receivers were good and by the use of outside aerials.

It was also shown that distortion becomes more serious as the difference in path length (long-term echoes) increases. The amplitude of reflected signal compared with the direct signal needed to produce “slightly disturbing” distortion on slow piano was found to be about 10% per cent for a path difference of five miles, but only 6 per cent for a path difference of 18 miles. These investigations (before the advent of stereo) were of course confined to monophonic transmissions.

While the results of these investigations were released to set makers and the technical press, the work appears not to have been allowed to lapse; perhaps on the traditional broadcasters’ argument that “the signals all were right leaving us.”

Recently NHK have released some details of an analysis made of multipath distortion in stereophonic reception. It is suggested that although distortion due to multipath propagation is one of the major factors in degrading broadcast sound, its nature and extent have not previously been determined because of the difficulty of analysis by conventional methods.

The NHK engineers have analysed the relationship between the audio distortion and the relevant multipath parameters using a technique which to what fast Fourier transform processing was applied. “In this way,” the report states, “the complicated computation was easily performed and extensive analysis of the distortion was made possible, providing a clear understanding of the nature of the distortion.”

Some of the results obtained for stereo reception are that:

1. The distortion tends to be pronounced if the delay time of the reflected undesired signal (U) with respect to the direct desired signal (D) is comparatively long (thus confirming the BBC experience).

2. The distortion is almost inversely proportional to the D/U ratio if this ratio exceeds 10dB.

3. The phase difference which gives maximum or minimum distortion is not constant but varies with such parameters as delay time, modulation frequency and depth of modulation.

4. Maximum distortion at 15kHz is greater than at lower audio frequencies, and is several times greater than that at 1kHz.

Fig. 3 shows a computed example of the spectrum distribution of the desired output signals at 15kHz modulation. Fig. 4 shows the relationship between the direct desired signal (D) and delay time for various parameters of maximum distortion at 15kHz. This shows clearly that high values of D/U ratio are needed to ensure good sound quality in situations where multipath propagation exist. Indeed the 20-year-old BBC investigation, and more recent NHK investigations of this path on u.h.f. signals in relation to teletext reception, suggest that such high D/U ratios are seldom found unless great care is taken in aerial installation.

Work on digital systems, which are susceptible to both short-term and long-term echoes, has underlined the unanswered question of multipath, even on u.h.f. where highly directional aerials can be used. For example IBA surveys showed that the extent of picking up of interfering signals checked in homes in the Hebburn Bridge service area and 79 per cent in the Abergevenny service area had viable ghosting; perhaps more significantly it showed that in those situations where multipath was sufficiently bad to cause relevant failures, it was not possible to recover the situation simply by swinging or re-adjusting the aerial with the limitations imposed by the space available on a chimney stack.

BBC experiments on multiplexed digital stereo transmission at Pontypike in 1977–78 indicated that while reception quality was very good in many areas, there was considerable Pickup of “black spots” where the bit-stream was seriously corrupted by multipath.

The extent of this problem seems to have surprised those broadcast engineers who have come to have enormous faith in digital techniques, although less surprising to those who have long been concerned with the low bit rates, primarily because the bit-stream can be reliably achieved on h.f. radio circuits.

Sir James Redmond, when BBC Director of Engineering, once recorded as saying of the p.c.m. work: “Our initial experiments have shown that, in heavily built-up areas, multipath propagation problems due to multipath propagation as indeed there are with existing f.m. transmissions. We shall probably have to try other forms of modulation.”

The BBC appears to have experimented using multiplexed radio channels on a wideband f.m. bearer as a further alternative means of establishing a network of separate radio network transmissions with minimal stereo interference. Such systems, it is claimed, would offer a unique opportunity to make radio reception simple and uncorrupted. While this may well be the case, we should surely think very carefully before breaking tradition and introducing a system of radio while still having to maintain m.f./s.m. and v.h.f./f.m. systems.

The investigation by the IBA of the extent of multipath errors led Peter Hutt to express the opinion that the conventional television model is not applicable to the prediction of distortion that are not clearly understood. Whereas the alleged “multipath” signal might be expected to have equal probability of gain or loss (due to the additive or subtractive nature of the reflected signal) across the bandwidth of the vision signal, in fact there appears to exist a strong probability of the presence of a subcarrier loss in typical built-up areas. A direct problem is that investigations into the use of circular polarisation for television as well as sound transmissions. Circular polarisation provides an effective solution of discriminating against reflected signals, since, on reflection, the sense of polarisation is changed. In other words the transmitted ‘left-hand’ anti-clockwise signals become, on a single reflection, ‘right-hand’ circular. Clearly circular-polarised transmission facilities can provide an effective method of reducing multipath distortion. However, very few listeners have circularly-polarised aerials, while many of those with linear polarised aerials will receive the signals on linear polarised aerials (losing a potential 3dB in the process).

The American tv investigations, such as that conducted by the American Telephone and Telegraph and KLOC-TV, California, suggest that ghosting is reduced on circularly polarised signals, regardless of the mode of reception. While circular polarisation is used on virtually all of the IBA’s ILR transmitters, few investigations have been made to ascertain whether or not multipath distortion is reduced in a similar manner. While it is difficult to see any theoretical basis for the American findings, it may well be because of the rotation of the plane of polarisation of v.h.f. signals in built-up areas and where the signals are received indoors.
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using a 4-element Yagi aerial/indicating obtained at a typical site using a correctly frequency separation in kHz between equipment of Fig. 1. Idealised display because of the difficulty of analysis by distortion in stereophonic reception 3.

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Some of the results obtained for stereo reception are that:

1. The distortion tends to be pronounced if the delay time of the reflected undesired signal (U) with respect to the direct desired signal (D) remains comparatively long (thus confirming the BBC experience).

2. The distortion is almost inversely proportional to the D/U ratio if this ratio exceeds 10dB.

3. The phase difference which gives maximum or minimum distortion is not constant but varies with such parameters as delay time, modulation frequency and depth of modulation.

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Fig. 3 shows a computed example of the spectrum distribution of the distorted output signals at 15kHz modulation. Fig. 4 shows the relationship between the direct desired signal delay time for various parameters of maximum distortion (at 1kHz). This shows clearly that high values of D/U ratio are needed to ensure good sound quality in situations where multipath propagation exist. Indeed the 20-year-old BBC investigation, and more recent NHK investigations of the effects of multipath on audio signals show that such high D/U ratios are seldom found even under good signal conditions.

Fig. 5 shows an example of a spectrum distribution of distortion in situations where multipath propagation exist. This shows that the distortion at 15kHz is several times greater than that at 1kHz.

The investigation by the BBC of the effect of multipath on mono errors led Peter Hutt to express the opinion that the conventional theoretical model is no longer applicable to such signals that are not clearly understood. Whereas the associated 'modulation' signal might be expected to have equal proportion of gain or loss (due to the additive or subtractive effects of the reflected signal across the bandwidth of the vision signal, in fact there appears to be a strong proportion of signal and of subcarrier loss in typical built-up areas. A direct comparison of investigations into the use of circular polarisation for television as well as sound transmission. Circular polarisation provides an effective method of discriminating against reflected signals, since, on reflection, the sense of polarisation is changed. In other words the transmitted 'left-hand' (anti-clockwise) signals become, on a single reflection, 'right-hand' circular. Clearly circular polarised transmitted signals and receiving signals provide an effective method of reducing multipath distortion. However, very few listeners have circularly polarised aerials but receive the signals on linear polarised aerials (losing a potential 3dB in the process).

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networks of v.h.f./f.m. transmitters, the upper limit of audio frequencies was fixed by the 'music lines' of the Post Office distribution circuits; this meant that audio frequencies much above 10kHz could not be guaranteed. These circuits also presented problems in handling stereo over distances exceeding about 25 miles. However, in recent years the BBC has introduced its p.c.m. digital transmission system which provides a source of true stereo signals up to about 15kHz throughout the UK. At the same time, the ILR stations are able to provide good quality stereo since the transmitters are seldom more than a few miles from the originating studios.

These developments have increased rather than decreased the importance of multipath distortion.

The current work by both IBA and BBC, to evaluate various matrix systems of 'surround-sound' such as MSC, and using "2", "3", or "4" transmitters, does not appear to have included any practical assessment of the effects of multipath on the different systems, although IBA engineers are hoping to undertake a study shortly using the MSC (Mono-Stereo-Compatible) system.

The possibility of using charge-coupled device delay lines to reduce ghosting on television pictures has been reported and although this technique could be usefully applied to v.h.f./f.m. reception.

Minimising multipath distortion


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path echoes to the extent suggested by the NHK calculations. There are severe practical problems even in attempting to reduce the strength of reflected signals by physical adjustment of the aerial.

The BBC is in its otherwise very useful book [5] "How to get the best out of your stereo" (July 1977) has a para

gaph describing the installation of a new aerial (of sibillants or other high-pitched loud signals) page 10 which suggests: "The directional properties of a carefully positioned multi-element aerial can often be used to reduce the pick-up of the reflected signals and thus reduce or eliminate the distortion. The best posi

tion of the aerial will almost certainly have been the one giving the maximum pick-up. The optimum posi

tion can be found by the owner of the aerial in an arc of about 30 degrees either side of the maximum signal position and selecting the one giving the least distortion within this arc which gives the best listening result."

This, if with respect one may say so, is not so helpful as it may appear. One has the image of a quality conscious listener nipping up to his roof to adjust his possibly large directional outdoor aerial, carefully waiting before doing so for the broadcast of a long piano solo with plenty of high-frequency notes. Life is just not like that. The aerial will almost certainly have been installed (carefully perhaps if not by a rooftop cowboy) and checked to ensure that it is giving the maximum pick-up. The optimum position is almost certainly going to remain a problem - but do we not more awareness of its effects, more knowledge of its practical effects, more thoughts on whether it could be reduced by more use of circular polarisa

tion? Or shall we just continue to walk under the carpets and hope that v.h.f./f.m. can always or usually give a high fidelity reception? Or regard the present系統 as obsolete and direct our thoughts to the layout of aerials into multiple modes of reception such as multiplexed wide-band f.m., or digital systems, or direct broadcasting from satellite at frequencies of the order of 1-2GHz?

which in conjunction with the time

constant of the receiver limiters may indicate a degree of a.m. suppression that differs significantly from that at 5kHz.

What then can be done? Clearly good high, outdoor aerials and good a.m.
suppression can result in a very good result. In bad multipath areas, television

are most certainly not eliminated, the reflected signals being the installation and detects distortion even test cards to guide him. Life is just not like that. The aerial will probably not be removed mountains. Multipath is going to remain a problem - but do we not more awareness of its effects, more knowledge of its practical effects, more thoughts on whether it could be reduced by more use of circular polarisation? Or shall we just continue to walk under the carpets and hope that v.h.f./f.m. can always or usually give a high fidelity reception? Or regard the present system as obsolete and direct our thoughts to the layout of aerials into multiple modes of reception such as multiplexed wide-band f.m., or digital systems, or direct broadcasting from satellite at frequencies of the order of 1-2GHz?

This article describes a design for a memory-mapped, colours graphical display system for use with a microprocessor and a modified colour TV set. Although the unit was designed to operate with a 280 and a modified 14-in Sony portable TV, interface requirements are simple and can be modified for use with other processors and television receivers.

The unit operates with a supply of 5V at 1A and a 16-bit address, eight-bit data, MREQ and WR

signals. It generates R, G, B, black/white and sync signals. The system is suitable for the production of Teletext/ Prestel-compatible unit interfaces. Functional block diagram of a v.d.u. circuit block which operates with 16-bit address, eight-bit data, MREQ, RD and WR signals from microprocessor.

References
1. BBC Research Department investigations into FM broadcast distortion, 1960 (apparently unpublished but circulated to set makers and technical trade press).
7. "WIRELESS WORLD, APRIL 1980"

A supplement to the ITT Instrument catalogue, which is available at any of the 14 U.K. branches of ITT, and at any of the 70 High Street Electronics shops in the country. The software supports a cursor along all 32 control channel which use 31 of the available 32 control signals, or cursor control logic elements are required, or cursor control logic elements are required. Simple hardware requirements: scroll or cursor control logic elements are not required. Simple hardware requirements: scroll or cursor control logic elements are not required. Limiting maximum display flexibility high-speed updating.

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path echoes to the extent suggested by the NHK calculations. There are severe practical problems even in attempting to reduce the strength of reflected signals by physical adjustment of the aerial. The BBC in its otherwise very useful booklet "How to get the best out of stereo radio" (July 1977) has a para-
graph describing the effect of some of the more significant differences between the generator modulated with stereo disc can often be used to reduce the pick-up of the reflected signals and thus reduce or eliminate the distortion. The best posi-
tion of the aerial will be that giving the one giving the maximum pick-up. The optimum posi-
tion can be found by swinging the aerial in an arc of about 30 degrees either side of the maximum signal position and selecting that position within this arc which gives the best listening result.

This, if with respect one may say so, is not so helpful as it may appear. One has the image of a quality conscious listener nipping up to his roof to adjust his possibly large directional outdoor aerial, carefully waiting before doing so for the broadcast of a long piano solo with plenty of high-frequency notes. Life is just not like that. The aerial will almost certainly have been installed (carefully perhaps if not by a rooftop cowboy) and checked to ensure that it performs to the best of its ability. The aerial installation is more likely to be the maximum pick-up. The optimum posi-
tion can be found by swinging the aerial in an arc of about 30 degrees either side of the maximum signal position and selecting the position within this arc which gives the best listening result.

References
1. BBC Research Department investigations into FM multipath distortion, 1969 (unpublished but circulated to set makers and technical trade press).

Literature Received
Course book and cassette with several pro-
grammes containing a training programme for complete beginners to starting. It is based on Style Fm BASIC and the Commodore PET microcomputer. The course book was written by Andrew Colin and is well or-
gained. Course costs £22 from Commodore Business Machines (UK) Ltd, 816 Leigh Road, Trading Estate, Slough, Berks.

Load cells made by Hottinger Baldwin are for use in tension and compression and are rated from 0 to 20,000 lb.

A leaflet on the range of Roborobotic mixing machines for two reams used in the electronic industry is obtainable from Roborobotic Systems Ltd, Houghton Road, South Merton, Swindon, Wilts. SN6 4Fr.

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A leaflet from Bensons Industrial Electrician, 2600 S. Main St., Waukesha, WI 53186.

Hewlett-Packard will run several training courses during 1980 on gas and liquid chroma-
matography, Winsening being one of the centres used. A brochure describing the courses can be had from H.P. at King Street Lane, Winsening, Wokingham, Berks. RG11 XA.

Short-form catalogue from Baker & Baker describes a rather more complete manner than the previous catalogue. The catalogue is a short-form and contains signal analysis equipment. Publish-
er is Baker & Baker (UK) Ltd, 411-415, Cross Lanes Road, Hounslow, Middx, TW3 2AE.

Leaflets specifying the facilities for making

A memory-mapped display system is one in which the read/write memory for the display is shared with a micro-
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<th>Control Code</th>
<th>Function Description</th>
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</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>NULL routine returns carry set</td>
<td>16</td>
<td>P - BLA - black</td>
</tr>
<tr>
<td>1</td>
<td>D - DOT - graphic dot at X, Y (next two characters)</td>
<td>17</td>
<td>Q - RED - red</td>
</tr>
<tr>
<td>2</td>
<td>B - VCT - vector from X, Y, to X1, Y1 (next 4 chars)</td>
<td>18</td>
<td>R - GRN - green</td>
</tr>
<tr>
<td>3</td>
<td>C - CXY - positions cursor to X, Y (next 2 chars)</td>
<td>19</td>
<td>S - VEL - yellow</td>
</tr>
<tr>
<td>4</td>
<td>D - BKX - next colour control sets background</td>
<td>20</td>
<td>T - BLU - blue control</td>
</tr>
<tr>
<td>5</td>
<td>E - EDL - erase to end of line</td>
<td>21</td>
<td>U - MAG - magenta</td>
</tr>
<tr>
<td>6</td>
<td>F - STS - define colour status byte (next char)</td>
<td>22</td>
<td>V - CYN - cyan</td>
</tr>
<tr>
<td>7</td>
<td>G - BELL - externally generated tone</td>
<td>23</td>
<td>W - WHT - white</td>
</tr>
<tr>
<td>8</td>
<td>H - BS - cursor left</td>
<td>24</td>
<td>X - PRT - page to list device</td>
</tr>
<tr>
<td>9</td>
<td>I - TAB - tabulate 8 cols</td>
<td>25</td>
<td>s - YEL - yellow</td>
</tr>
<tr>
<td>10</td>
<td>J - LF - cursor down</td>
<td>26</td>
<td>t - HOME - cursor to home position</td>
</tr>
<tr>
<td>11</td>
<td>K - VT - cursor up</td>
<td>27</td>
<td>e - ESC - routine returns cursor off, carry set</td>
</tr>
<tr>
<td>12</td>
<td>L - CLR - clear screen</td>
<td>28</td>
<td>f - INIT - initialize</td>
</tr>
<tr>
<td>13</td>
<td>M - CLR - cursor to left-hand side</td>
<td>29</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>N - BL - blink</td>
<td>30</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>O - BLO - blink off</td>
<td>31</td>
<td>-</td>
</tr>
</tbody>
</table>

Fig. 1. Display logic converts 16-bit data from memory array into colour signals.

Fig. 2. Memory array and management logic to interface array with microcomputer bus and display logic.
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<td>28</td>
<td>INT</td>
<td>re-initialize</td>
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<td>13</td>
<td>M</td>
<td>CR - cursor to left-hand side</td>
<td>29</td>
<td>CON</td>
<td>cursor on</td>
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<td>14</td>
<td>N</td>
<td>BL - blink</td>
<td>30</td>
<td>COF</td>
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**Fig. 2. Memory array and management logic to interface array with microcomputer bus and display logic.**
used to drive the timing and addressing logic, although any external sync. source may equally be used for this purpose. Addressing logic provides dot and character row-column block pulses at a rate determined by the astable oscillator. The frequency determines the width of the display. It also generates a four-bit line count which increments from zero to 63 in the course of a character row, together with a character column count (0 to 63) and character row count (0 to 63). The row address signal is then fed to the memory array via the memory array and character address decoder. The contents of which is parallelled on to the collector inverter ready for line transmission to the modified TV set where the lines are terminated, buffered and fed to high bandwidth opto-isolators. Isolation is necessary because most television sets have a live chassis. Following the isolators is another buffer and a high-voltage driver transistor operated in common base, the collector of which is paralleled on to the collector of the TV set's internal driver transistors. For interfacing the processor accesses the display memory, the memory management logic will immediately transfer control to the processor bus. The display logic is informed that its incoming data is invalid when the "glitch suppress" line goes active. This causes a small blanking pulse to be sent up and used to squelch any glitches that may be caused by this invalid data. The memory management logic is also responsible for making the 2K X 16 memory array appear like a 4K X 8 array to the bus. This is achieved via the two LS245 bidirectional tristate buffers which are activated alternately to provide the microprocessor with access to one or other half of the 16 bits of data. Address line A0 is used to determine whether the memory address specifies the most significant byte or least significant byte.

Interfacing with the microprocessor

The objective is to make the v.d.u. appear to the processor as 4K x 8 bits of static r.a.m., although internally the r.a.m. is arranged as 2K words of 16 bits with each word representing a character. The character code is a 16-bit word. Of the possible 2048 characters only 64 x 26 are used owing to the practical limitation of 26 character rows in a 625-line raster (each character row takes 10 lines per frame). A 16-bit character word length stores the graphic/ASCII code, the three-bit foreground colour field, three-bit background colour field, the flash and graphic flag bits, see Table 2.

The circuit incorporates two character generators, one alphanumeric and one graphic. Bits 0 to 7 are sent to both processors but the value of bits 8 determines which output is displayed. Table 2. 16-bit character word length stores the graphic/ASCII code, foreground fields, flash and graphic flag bits.

<table>
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<tr>
<th>Character code</th>
<th>Status byte</th>
</tr>
</thead>
<tbody>
<tr>
<td>b1, b11, b12, b13, b14, b15, b16</td>
<td>F,G,R,B,C,D,A</td>
</tr>
<tr>
<td>b2, b21, b22, b23, b24, b25, b26</td>
<td>Foreground colour</td>
</tr>
<tr>
<td>b3, b31, b32, b33, b34, b35, b36</td>
<td>Background colour</td>
</tr>
<tr>
<td>b4, b41, b42, b43, b44, b45, b46</td>
<td>Flash graphic flag</td>
</tr>
</tbody>
</table>

However, the processor can only cope with eight bits at a time, so the memory management logic maps all even addresses to character codes and odd addresses to status codes. As far as the processor is concerned each character is defined by two bytes of data in consecutive memory locations.

When the microprocessor accesses the display memory, the memory management logic will immediately transfer control to the processor bus. The display logic is informed that its incoming data is invalid when the "glitch suppress" line goes active. This causes a small blanking pulse to be sent up and used to squelch any glitches that may be caused by this invalid data.

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Interfacing the TV set

This design does not incorporate a PAL encoder because the colour bandwidth of such a device is insufficient for this application. Consequently a personality circuit to interface the main visual display board to the TV is required. Direct interfacing to a TV, used with most teletext systems, improves the legibility of the text but the problem of line-draw sets makes it difficult to implement. The common method of achieving this is to use an isolating transformer. The technique described here employs opto-isolation to connect the R, G, B signals (and an optional t.l.l sync signal) combined with a v.h.f. modulator to provide synchronization.

The scheme is illustrated in Fig. 4.

The technique does not require any track or links to be broken in the set and video output can therefore be superposed on the TV picture. If the set is tuned into the v.h.f. sync. output the picture is blank but synchronized to the v.d.u. and hence the display. If the video output is externally synchronized to an off-air transmission the display may be superposed over that picture. A t.l.l. opto-isolated sync channel is provided along
Circuit design and operation

A sync-generator chip is employed to generate a convenient fully interlacing, comb erase sync. signal which is then used to drive the timing and addressing logic, although any external sync. source may equally be used for this purpose. Addressing logic provides dot and character clocking pulses at a rate determined by the astable oscillator. The frequency determines the width of the character space. It also generates a four-bit line count which increments from zero to nine in the course of a character row, together with a character column count (0 to 63) and character row count (0 to 32). The row and column addresses are passed to the memory array via the memory management logic. This memory array then passes the 16-bit data word to the display logic where it is interpreted by the character generator.

The alphanumeric character generator is the 75428IN which supports upper and lower-case English-style ASCII. It also caters for descendents within a 5 x 10 dot format. The graphics generator contains a 7445 I.C.偶decodes the four-bit b.c.d. line count into a two-bit binary graphic character cell count, and an LS153 which selects the corresponding bit-pair from the memory word for display. The outputs from both generators are fed to the serializing shift register via a two-way data selector, which passes the required data according to the state of the graphic flag bit 15. Bit 14, the flash flag, has the capability of overriding the selection in favour of a black cell if it is set. This depends on the state of the flash rate low frequency clock which determines the flash frequency.

The output from the serializer is used to select either foreground or background colour bits from a six-bit latch loaded from the six remaining data bits 8 to 13. The R, G and B signals thus produced are buffered by an open-collector inverter ready for transmission to the modified TV set where the lines are terminated, buffered and fed to high bandwidth opto-isolators. Isolation is necessary because most television sets have a live chassis. Following the isolators is another buffer and a high-voltage driver transistor operated in common base, the collector of which is paralleled onto the collector of the TV set's internal driver transistors. See Figs. 1, 2 and 3 for the full circuit diagram.

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</tr>
</thead>
<tbody>
<tr>
<td>ASCII code or graphic code</td>
<td>Foreground colour</td>
</tr>
<tr>
<td>b1 b2 b3 b4 b5 b6 b7</td>
<td>3 times</td>
</tr>
</tbody>
</table>

The foreground and background colour bits determine the colour configuration of that character whether it be alphanumeric or graphic, and similarly the flash bit determines whether or not the character is to blink.

In the graphics mode the character cell is divided into eight sections and bits 0 or 7 dictate whether each picture sub-cell is to be displayed in the foreground or background colour e.g.

10001000 111 000 10 represents flashing white "A" on blue background

and 10001001 101 000 01 represents a checked graphic cell of magenta on black.

Photographs show examples of teletext displays including 24 characters reserved for system program, plotting facility from a Basic program, and authors Basic game "shore".

Photographs by University photographic unit.

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The technique does not require any track or links to be broken in the set and video output can therefore be superposed on the TV picture. If the set is tuned into the v.h.f. sync. output the picture is blank but synchronized to the v.d.u. and hence the display. If the v.d.u. is externally synchronized to an off-air transmission the display may be superposed over that picture. A t.t.l. compatible sync channel is provided along...
with the RGB isolation to provide extra flexibility should the u.h.f. link not be favoured.

Teletext and Prestel compatibility

Although the display format is not identical to that specified for Prestel/teletext use, it is compatible. Under the control of a microprocessor, the display can be made to support most teletext/Prestel specifications, certainly the important ones. I have built a compact teletext interface for a Z80 computer system which uses the display system most effectively with a 2K-byte software package to complete this teletext facility.

The previous article (February issue) showed how an n-port analysis technique using the YF matrix could be translated into a simple iterative procedure, which is ideal for small computer circuit analysis.

This article briefly outlines a program based on the YF matrix and then goes on to show the modelling techniques required for accurate analysis of common active and passive circuits. Examples and case studies, including microwave oscillators, power amplifiers and hybrid-m models, show that computer breadboarding of circuits represents a useful and versatile tool for those engaged in electronics, industry, education and at home.

The computer program used throughout this article for circuit analysis is called Dirac. Dirac runs on a Commodore PET, which uses Basic, and occupies 14K bytes of memory. (Earlier versions of Dirac could perform adequate circuit analysis for under 5K bytes. The current Dirac program is considerably more versatile than shown here.) The essence of the procedure that Dirac follows is shown below. Methodology for setting up the YF matrix, the equations for its reduction and the equations for the calculation of the gains and impedances of a circuit were discussed in the previous article, so this article is confined to examining the way Dirac manipulates the YF matrix.

Dirac sets up two matrices, one used to store the real part of the YF matrix and the other the imaginary part.

\[
YF = \begin{pmatrix}
YR(0,0) & \cdots & YR(0,1) & \cdots & YR(0,n) \\
\vdots & \ddots & \vdots & \ddots & \vdots \\
YR(1,0) & \cdots & YR(1,1) & \cdots & YR(1,n) \\
\vdots & \ddots & \vdots & \ddots & \vdots \\
YR(n,0) & \cdots & YR(n,1) & \cdots & YR(n,n)
\end{pmatrix}
\]

In setting up the YF matrix Dirac makes good use of the symmetry it possesses, this being greatest for passive components. By splitting the YF matrix into real and imaginary parts and by always choosing that mode 0 represents the input and node 1 represents the output and node 2 the common rail, the reduction of the YF matrix becomes a few simple FOR NEXT loops i.e.

FOR N=O TO STEP -1
FOR P=O TO X-1
A=\(YR(X,X)\) + \(YR(X,X)\) \(YI(X,X)\)
B=\(YR(Y,X)\)\(YR(Y,X)\)\(YR(Y,X)\)
C=\(YR(Y,X)\)\(YR(Y,X)\)\(YR(Y,X)\)\(YR(Y,X)\)\(YR(Y,X)\)\(YR(Y,X)\)
D=\(YI(Y,Y)\)\(YI(Y,Y)\)\(YI(Y,Y)\)\(YI(Y,Y)\)\(YI(Y,Y)\)\(YI(Y,Y)\)
YF=P\(YI(P,P)\)\(YR(Y,X)\)\(YR(Y,X)\)\(YR(Y,X)\)\(YR(Y,X)\)\(YR(Y,X)\)
YR(P,Q)=\(YF(P,Q)\)\(YR(Y,X)\)\(YR(Y,X)\)\(YR(Y,X)\)\(YR(Y,X)\)\(YR(Y,X)\)
YI(P,Q)=\(YF(P,Q)\)\(YR(Y,X)\)\(YR(Y,X)\)\(YR(Y,X)\)\(YR(Y,X)\)\(YR(Y,X)\)
NEXT Q,P
\]

This will leave the two-port \(Y\) parameters as

\[
YR(0,0) \quad YR(0,1) \quad YR(0,2) \\
YR(1,0) \quad YR(1,1) \quad YR(1,2) \\
YR(2,0) \quad YR(2,1) \quad YR(2,2)
\]

Application of Table 1 of the previous article, now gives the gains and impedances of the circuit.

Modelling technique

Passive circuits are, by and large, straightforward to analyse, as are most narrow-band active circuits. However many common circuits require a more subtle approach. Consider the variation of these parameters, with the minimum of information, see Table 1. What a hybrid-\(H\) model does is trade accuracy for complexity of calculation, which is an excellent exchange for computer analysis. Curves of Fig. 2 show a comparison of measured two-port values as a function of frequency, as compared with the hybrid-\(H\) predicted values. Generally, the hybrid-\(H\) model of the bipolar transistor is good from dc to 100MHz, although variations do exist which are good up to 120MHz.
with the RGB isolation to provide extra flexibility should the u.h.f. link not be favoured.

Teletext and Prestel compatibility

Although the display format is not identical to that specified for Prestel/teletext use, it is compatible. Under the control of a microprocessor, the display can be made to support most teletext/Prestel specifications, certainly the important ones. I have built a compact system which uses the display system compatibility most effectively with a 2K-byte software package to complete this teletext specification.

A double-sided glass-fibre p.c.b. for the colour interface circuit is available from M. R. Sargent at 23 Keynes Road, London NW2 for £18.80 inclusive of v.a.t. and UK postage. Roller turned and drilled board measures 235 x 305mm.

Guide to Broadcasting Stations

Many of our readers have been impatiently awaiting publication of the new edition of this long-established book and will consequently be glad to learn that it is now available. This 18th edition is in the familiar format, listing stations in the long, medium, shortwave and v.h.f. bands, in alphabetical order, by location and by frequency. There are also sections on receivers, aerials, signal propagation, station identification and reception reports.

The book costs £1.25, including postage, and can be obtained from General Sales Department, Room CPIA, Dorset House, Stamford Street, WDI 6EU.

Circuit analysis by small computer – 2

Programming and modelling techniques for common passive and active circuits

by A. S. Beasley, B. Sc. McMichael Ltd

The previous article (February issue) showed how an n-port analysis technique using the YF matrix could be translated into a simple step procedure, which is ideal for small computer circuit analysis.

This article briefly outlines a program based on the YF matrix and then goes on to show the modelling techniques required for accurate analysis of common active and passive circuits. Examples and case studies, including microwave oscillators, power amplifiers and hybrid-h models, show that computer breadboarding of circuits represents a useful and versatile tool for those engaged in electronics, industry, education and at home.

The computer program used throughout this article for circuit analysis is called Dirac. Dirac runs a Commodore Pet, which uses Basic, and occupies 14K bytes of memory. (Earlier versions of Dirac could perform adequate circuit analysis for under 5K bytes. The current Dirac program is considerably more versatile than shown here.) The essence of the technique that Dirac follows is shown below. Methodology for setting up the YF matrix, the equations for its reduction and the equations for the calculation of the gains and impedances of a circuit were discussed in the previous article, so this article is confined to examining the way Dirac manipulates the YF matrix.

Dirac sets up two matrices, one is used to store the real part of the YF matrix and the other the imaginary part i.e.

\[
\begin{align*}
YF &= \begin{bmatrix} YR(0,0) & YR(0,1) & YR(0,2) \\
YR(1,0) & YR(1,1) & YR(1,2) \\
YR(2,0) & YR(2,1) & YR(2,2) \\ \end{bmatrix} \\
&= \begin{bmatrix} YR(0,0) & YI(0,1) & YI(0,2) \\
YI(1,0) & YI(1,1) & YI(1,2) \\
YI(2,0) & YI(2,1) & YI(2,2) \\
\end{bmatrix}
\]

In setting up the YF matrix Dirac makes good use of the symmetry it possesses, this being greatest for passive components. By splitting the YF matrix into real and imaginary parts and by always choosing that mode 0 represents the input and that node 1 represents output and node 2 the common rail, the reduction of the YF matrix becomes a few simple FOR NEXT loops i.e.

\[
\text{FOR } X = 0 \text{ TO } N \text{ NEXT } \text{STEP } -1
\]

Table 1. Hybrid-h > circuit elements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Equation</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_e</td>
<td>( \frac{1}{2} \pi F T )</td>
<td>( \text{ohm} )</td>
</tr>
<tr>
<td>r_h</td>
<td>( \frac{1}{2} \pi F T )</td>
<td>( \text{ohm} )</td>
</tr>
<tr>
<td>C_b</td>
<td>( \frac{1}{2} \pi F T )</td>
<td>( \text{fF} )</td>
</tr>
<tr>
<td>C_c</td>
<td>( \frac{1}{2} \pi F T )</td>
<td>( \text{fF} )</td>
</tr>
<tr>
<td>C_w</td>
<td>( \frac{1}{2} \pi F T )</td>
<td>( \text{fF} )</td>
</tr>
<tr>
<td>Vee</td>
<td>( \frac{1}{2} \pi F T )</td>
<td>( \text{V} )</td>
</tr>
</tbody>
</table>

where \( F \) is the pass-bandwidth product and \( V_{ee} \) is the voltage at which \( V_{ee} \) was measured.

The h parameters are low frequency h parameters, and so are purely real numbers.

Hybrid-h model

The simple approach of using the y or h-parameters of a transistor as given on a data sheet, ignores the fact that these parameters themselves vary with frequency and bias conditions. The hybrid-h model of a bipolar transistor, Fig. 1, provides a way of predicting the variation of transistor parameters, oscillator and v.c.o. design and large signal design.

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The hybrid-h model of the bipolar transistor is good

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Fig. 1. Hybrid-h transistor model can be used to advantage with computer analysis.

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Fig. 1. Hybrid-h transistor model can be used to advantage with computer analysis.
Small-signal oscillator and v.c.o. analysis

Using the YF matrix, from which we ultimately derive gains and impedances, the criterion for oscillation is best viewed in terms of negative resistance. Referring to the diagram below oscillation occurs when $\Re X > 0$ and $\Re R > 0$.

As a more concrete example consider the upper inset diagram in Fig. 3. At 1400MHz the circuit exhibits negative resistance. At lower frequencies the circuit would require positive feedback, but at 1400MHz the feedback is internal to the transistor. The base capacitor has been chosen to maximise the negative resistance. To produce oscillation across a 50ohm load one requires a network which transforms the input resistance such that $R > 50$ohms, at the same time as tuning out the reactance $X$. By choosing a high-Q network, that is one with a rapid change of reactance with frequency, the oscillation frequency will be well-defined. The lower inset of Fig. 3 shows such a network. The curve shows the predicted values of $R$ and $X$, before and after the transforming network is added. From it one would predict oscillation at 1420MHz. The circuit based on this design in fact produced 300 milliwatts at 1500MHz, an error of 3%, but could be tuned from 1100 to 1400MHz via the base capacitor.

A v.c.o. design would proceed along similar lines, except that a parameter would be voltage controlled, and one would need to examine the input impedance as a function of this parameter as well as of frequency, for example by replacing the base capacitor with a varactor.

Provided the transistor operates for the most part in a linear fashion, and that non-linearities occur suddenly, e.g. the transistor being limited by the supply voltage, this model is substantially correct. Power oscillators require a different model which is more akin to the power amplifier design dealt with next.

Power amplifier design

Large-signal design usually involves non-linear operation, e.g. classes AB,BC. When this is the case there is no simple YF matrix to describe the circuit. For power amplifiers we have to limit the analysis to considering only how to get the drive power into the transistor, and the resulting amplified signal out into a load.

As an example take a v.m.o.s. power f.e.t. operated at 100W at 145MHz. To use it one must power-match its output to 50 ohms, see below. The input matching network does much the same job, but the output match is the more important of the two, as the higher power levels on the output can more easily destroy the $100$ f.e.t. by mismatching. The model adopted assumes the output impedance of the f.e.t. is described by

$$V_{S} = \frac{V_{o}}{R_{o}}$$

where $P_{o}$ is the rated output power of the f.e.t. and $C_{o}$ the drain-to-source capacitance. (The f.e.t. input impedance is given on the data sheet.) Fig. 4 shows a network breadboarded on Dirac and the network finally used, the amplifier having 11dB gain when run in class AB.

Economics of small computer analysis

The circuit in Fig. 5 shows a 3rd-order active filter, used as part of a sub-system in a satellite communication system. The filter was designed and checked using Dirac. Having verified the designed circuit would give the required response, the program was re-run using practical resistor and capacitor values. Various practical values had to be tried until an acceptable response was obtained. The exercise in itself gives the engineer a feel for the network, and the relative sensitivity of cut-off frequency etc. to component values.

Finally the filter was breadboarded, and the filter response measured. Figure 6 shows the comparison with the predicted and the measured response. The response was judged close enough to the optimum not to need any adjustment. Hence engineering time and effort had been saved, not to mention possible burnt out components. Rental of the mainframe computer the Company has access to would have cost £30 for the same amount of computing time.

For and against

The YF matrix provides a method of circuit analysis amenable to the computer. Other methods exist, but after a year of experience in industrial R&D the YF matrix has proved superior for all but passive ladder networks. For versatile usage of analysis programs modelling techniques become essential, although modelling ultimately is synonymous with a sound understanding of circuitry.

A small computer analysis does have some drawbacks; bad designs will remain bad designs although confidence in them may grow if the computer says they will work. A similar trap exists regarding computer accuracy — the predicted response of a circuit using $\pm$% tolerance components is rarely better than $\pm$%. As the reliability of the desktop machine determines its running cost, i.e. the service and repair costs, this should be carefully looked at before investing in a machine. Finally, the speed of operation of a desktop machine is often disappointing to those used to a large mainframe; this arises from the use of an interpreter instead of a compiler. Nearly all these drawbacks stem from the use of the cheap desktop machine being a first-generation machine used by first-generation engineers, and so it must be expected that as experience grows the cheap desktop machine will become more established as a common piece of lab equipment.

Acknowledgements. My thanks to the management of McMichael Limited for encouragement in writing these articles, and colleagues in Advanced Projects Division for help in obtaining the material, though any errors are my own.

Correction to part I. The author regrets a row was omitted from matrix YF, in the example on page 40, February issue. The fourth row should read $\begin{pmatrix} \text{Y} 01 \\ \text{Y} 23 \end{pmatrix}$, the row shown being the fifth. We regret the misprints on pages 39, under Fig. 4 the term in $x_1$ should read $-Y_{12}x_1$ and not $-Y_{12}x_1$, and in the matrix form the 1st column, 3rd row term is of course $-Y_{01}$. The second row of the ideal transformer matrix (Table 2) should be deleted.
Small-signal oscillator and VCO analysis

Using the YF matrix, from which we ultimately derive gains and impedances, the criterion for oscillation is best viewed in terms of negative resistance. Referring to the diagram below oscillation occurs when \( jX = 0 \) and \( R = R_0 \).

As a more concrete example consider the upper inset diagram in Fig. 3. At 1400MHz the circuit exhibits negative resistance. At lower frequencies the circuit would require positive feedback, but at 1400MHz the feedback is internal to this transistor. The base capacitor has been chosen to maximise the negative resistance. To produce oscillation across a 50ohm load one requires a network which transforms the input resistance such that \( R = 50\text{ohms} \). at the same time as tuning out the reactance \( jX \). By choosing a high-Q network, that is one with a rapid change of reactance with frequency, the oscillation frequency will be well-defined. The lower inset of Fig. 3 shows such a network. The curve shows the predicted values of \( R \) and \( X \), before and after the base capacitor.

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Large-signal design usually involves non-linear operation, e.g. classes AB, B, C. When this is the case there is no simple YF matrix to describe the circuit. For power amplifiers we have to limit the analysis to considering only how to get the drive power into the transistor, and the resulting amplified signal output into a load. As an example take a v.m.o.s. power f.e.t. operated at 100W at 145MHz. To use it one must power-match its output to 50 ohms, see below. The input matching network does much the same job, but the output match is the more important of the two, as the higher power levels on the output can more easily destroy the \$100 \text{f.e.t.}$ by mismatching. The model adopted assumes the input impedance of the f.e.t. is described by

\[
R = V_{DS} / 2P_{out}
\]

where \( P_{out} \) is the rated output power of the f.e.t. and \( C_{in} \) the drain-to-source capacitance. (The f.e.t. input impedance is given on the data sheet.) Fig. 4 shows a network breadboarded on Dirac and the network finally used, the amplifier having \$10 \text{dB}$ gain when run in class AB.

Comparison of measured and predicted values with a hybrid model of Fig. 1.

Comparing the response of active filter in Fig. 5 shows a 3rd-order active filter, used as part of a sub-system in a satellite communication system. The filter was designed and checked using Dirac. Having verified the designed circuit would give the required response, the program was re-run using practical component values. Various practical values had to be tried until an acceptable response was obtained. The exercise in itself gives the engineer a feel for the network, and the relative sensitivity of cut-off frequency etc, to component values.

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The bandpass amplifier in Fig. 11 extracts possible signals from background noise caused mainly by transients in the circuits. To permit a gain of up to 8000, a narrow pass-band from 0.2 to 0.6 Hz is used with a high-order filter for sharp roll-off. The circuit also has a limited overshoot with a step function as shown in Fig. 12.

The output is displayed by a voltmeter, and an audible signal is provided by amplitude modulating a 500Hz oscillator for positive signals and a 900Hz oscillator for negative signals, as seen in Fig. 13. All of the main timing pulses are generated by the circuit in Fig. 14. The prototype used a variable c.m.o.s. oscillator for positive signals and a 1400Hz oscillator for negative signals, which provide the magnetic field pulses. D and E drive two pulse generators as shown in Fig. 15 which, with a BU 326A non-saturating common emitter output, can supply up to 1.5A. Two transmit coils were used in the prototype because a rugged high-voltage p-n-p transistor was not available at a reasonable price. The regulated power supply is shown in Fig. 16. As well as the capacitors shown, extra decoupling should be provided on each circuit.

Construction of the metal detector is not critical and the prototype was built in modules with jack plugs and sockets for interconnections. Selection of damping resistors for the transmit and receive coils is best carried out with an oscilloscope, although I found that the values chosen were generally in agreement with the theoretical values.

Conclusion

This metal detector is essentially dynamic because it only responds to a target when it is moving in relation to it.

In practice this system is better than the static type because any maladjustments, in connection with the magnetic viscosity effects, are not important with a reasonably uniform ground. Slow variations of amplifier offsets are also unimportant.

Due to magnetic viscosity effects and possible feedback loops, metal detectors need to be tested in operation to determine their sensitivity. A 600 mm radius coil assembly, as shown in Fig. 5, satisfactorily detected a piece of brass 50 mm in diameter at a depth of 750 mm, and a 15 mm diameter brass target at a depth of 50 mm. In both cases a peak transmit current of 1A was used with a rise time of 3ms and a ground speed of 1 m/s.

The regulated power supply is shown in module form with jack plugs and sockets for interconnections. Selection of damping resistors for the transmit and receive coils is best carried out with an oscilloscope, although I found that the values chosen were generally in agreement with the theoretical values.

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The bandpass amplifier in Fig. 11 extracts possible signals from background noise caused mainly by transients in the circuits. To permit a gain of up to 8000, a narrow pass-band from 0.2 to 0.6Hz is used with a high-order filter for sharp roll-off. The circuit also has a limited overshoot with a step function as shown in Fig. 12. The output is displayed by a voltmeter, and an audible signal is provided by amplitude modulating a low pass filter with a supply of 900Hz. To permit a gain of up to 8000, a narrow pass-band from 0.2 to 0.6Hz is used with a high-order filter for sharp roll-off. The circuit also has a limited overshoot with a step function as shown in Fig. 12. All of the main timing pulses are generated by the circuit in Fig. 14. The prototype used a variable c.m.o.s. oscillator with four switched ranges, as shown in Fig. 13. A, the receive interval with a duration of 6x40m and separated from the on pulse by 3. B, a reversing signal for the synchronising pulse by oscilloscope, although 1 found that the values chosen were generally in agreement with the theoretical values.

Conclusion
This metal detector is essentially dynamic because it only responds to a target when it is moving in relation to it.

In practice this system is better than the static type because any maladjustments, in connection with the magnetic viscosity effects, are not important with a reasonably uniform ground. Slow variations of amplifier offsets are also unimportant. Due to magnetic viscosity effects and possible feedback loops, metal detectors need to be tested in operation to determine their sensitivity. A 400 mm radius coil assembly, as shown in Fig. 5, satisfactorily detected a piece of brass 50 mm in diameter at a depth of 750 mm, and a 15 mm diameter brass target at a depth of 50 mm. In both cases a peak transmit current of 1A was used with a Dart of 250 µs and a ground speed of 1 m/s.

WIRELESS WORLD, APRIL 1980

![Diagram](image_url)
Awards and certificates

Are the awards and certificates available to amateur operators who can show evidence of ability to amateur operators who can perform in h.f. and v.h.f. bands. There can be few h.f. operators who could not do without some form of "claiming to have won". It is left to the DXCC (100 countries). But questions arise when every local club begins to issue awards.

One long-time critic of the furiously competitive "dx-chasing" that may be encouraged by awards has been Bill Scarr, GW2S. In his presidential address to the RSGB in 1956 he claimed: "Much more would be achieved if the amateur could shake off his feverish thirst for "dx" which in its most sinist re form can transform him into a scarcely human animal devoid of all sense of time and utterly lacking in consideration for his family or his fellows".

That was 30 years ago but I see from Radio Communication that he is still as critical as ever of such practices, particularly of what he refers to as the new parlour game of "working squares" (squareon a map of the world) to collecting the numbers of railway engines or cigarette cards! For those not convinced by his arguments, the "old-timers" are critical as ever of such practices, particularly mobile stations when the ship is at sea.

RSGB is preparing to make application to the Home Office for the licensing of further batches of v.h.f./uhf. repeaters. I am not sure how I should react to the rumour that one group is applying for the calling "GB3VA".

Again, many years ago Dennis Heighman, GREN, noted the enhancement of signals on frequencies as low as 3 MHz arriving in Clacton along paths during those weather conditions which gave rise to tropospheric ducting. Frequent 815kHz -transmissions from Paris some 30 years ago. The suffix /MA is used by many maritime mobile stations as their international mark in performance in h.f. and v.h.f. bands. There can be few h.f. operators who could not do without some form of "claiming to have won". It is left to the DXCC (100 countries). But questions arise when every local club begins to issue awards.

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Propagation

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If one theory is dented, two others are reinforced. Two years ago E. B. Durling of Mullard Space Science Laboratory in a letter to Wireless World (Letters, April 1978) described the evolving theory of Sporadic E. The metallic particles that cause this phenomenon are probably "metallic atoms that remain in the ionosphere for some time after being flung up by some means or other". The evidence points out these particles do indeed drift slowly in a vertical layer of the atmosphere. For those not convinced by his arguments, the "old-timers" are critical as ever of such practices, particularly mobile stations when the ship is at sea.

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Satellite

NASA has formally agreed to include the first British amateur satellite, USAT as a secondary payload on the Thor-Delta launcher for the Solar Maximum Explorer project, provisionally scheduled for September 30, 1981. USAT is being built at the University of Surrey with additional help from amateurs working in the space industry, the Royal Aircraft Engineers Council etc. The "breadboard" model is due to be completed by August and the engineering prototype to be by the end of this year.

The first Phase I amateur satellite is now due to be put into a highly elliptical orbit about the end of May. A Russian amateur satellite(s) has been predicted for early this year, possibly by the time of writing these notes. The design problem was that a switch didn't exist that could detect a movement of 0.2 degrees, that was free of hysteresis, and imposed no appreciable load on the tracking arm. The criterion of 0.2 degrees was chosen after consideration of rocket eccentricity, as discussed in the earthruits. The ready availability of a p.t.f.e. material, Vydax, which is described later, provided the means of realising a very accurate mercury switch. The principle behind the switch is as follows. Due to its high surface tension, a bubble of mercury of about 0.1mm diameter is an almost perfect sphere. This makes it an ideal target for a horizontally-moving electrode, pro- vided the highly mobile mercury can be held in a stable position. Fortunately, this is easy to do without sacrificing its properties as a target electrode. A mercury sphere of the correct size will easily roll down a p.t.f.e. coated slope of only two degrees, and so can be precisely located at the bottom of a shallow V-shaped trough. A pivoted polepiece can now touch either side of the sphere, and this is the basis for a p.t.f.e. switch with centre-off position.

Fig. 1 shows the layout in diagram form. Freely pivoted electrodes E and F

WORLD OF AMATEUR RADIO

Awards and certificates

Are the awards and certificates available to amateur operators who can show evidence of ability to perform in h.f. and v.h.f. bands? There can be few h.f. operators who could not do without some form of "claiming to have won." It is left to the DXCC (100 countries). But questions arise when every local club begins to issue awards.

One long-time critic of the furiously competitive "dx-chasing" that may be encouraged by awards has been Bill Scarr, GW2S. In his presidential address to the RSGB in 1956 he claimed: "Much more would be achieved if the amateur could shake off his feverish thirst for "dx" which in its most sinister form can transform him into a scarcely human animal devoid of all sense of time and utterly lacking in consideration for his family or his fellows." That was 30 years ago but I see from Radio Communication that he is still as critical as ever of such practices, particularly of what he refers to as the new parlour game of "working squares" (square on a map of the world) to collecting the numbers of railway engines or cigarette cards! For those not convinced by his arguments, the "old-timers" are critical as ever of such practices, particularly mobile stations when the ship is at sea.

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Are the awards and certificates available to amateur operators who can show evidence of two-way contacts with stations in specified areas, countries and even "squares" a help or a hindrance to the hobby? Most of us, even those who seldom seek to acquire the many "parchments," tend to accept them as an inherent part of a hobby that sees great store in its own progress in performance in h.f. and v.h.f. bands. There can be few h.f. operators who did not get a kick from claiming to have "worked all continents" or qualified for the DXCC (100 countries). But questions arise when every local club begins to issue awards.

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That was 30 years ago but I see from "short waves" to collecting the numbers of railway stations. From that time to the present evidence is abundant that there has been a marked reduction in the number of railway stations.

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For several years, many of the most intriguing speculations on the forecasting of sunspot activity have been based on the belief that there was a "Maundre Minimum" during the years 1645-1715 when little or no visible sunspot activity was recorded; a period, as many have pointed out, which coincided with the mini Ice Age in Britain. Much of the evidence for this has stemmed from examination of the naked-eye sunspot records kept over many centuries in China and the Far East. Now, however, a new concept has been challenged by Christopher Cullen in a letter to Nature. He points out that examination of new sources suggests that solar activity continued unabated during the entire 17th century and that the pre-solar sources may either have been inadequate or reflected a period of political chaos and/or simple incompetence. He believes that the new evidence is sufficiently strong to advise that the whole question of the Maundre Minimum "judgment must be suspended."

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are held in exact position by a small magnet G which is attached to the tracking arm so that in the central position neither electrode touches the mercury spheroid. A small displacement of the electrodes caused by movement of the magnet to either left or right causes contact with the mercury and completes a circuit via electrode H. It is worth noting at this point that small vertical movements of the magnet do not affect the electrodes E and F, neither do small fore-and-aft movements. This is all to the good, as movement in these directions can only arise from play in the suspension of the arm.

If the tracking arm over-runs the proper position, i.e. the servo-motor does not correct the displacement quickly enough, then the electrodes E and F will roll the spheroid up the inclined plane. Further electrodes J are implanted in the path of the spheroid to operate a cut-out relay which stops both the turntable and the servo-motor.

The only forces acting on the cartridge with the switch in or near the central position are the minute lateral forces required to press the electrodes E and F into the surface of the mercury, and for this reason the minute lateral forces due to record warp, and groove eccentricity, plus frictional forces from the arm pivot, all of which are probably larger at some stage during the playing of a record than the mere 10 mg needed to work the switch. So this small force can be ignored for all practical purposes.

The force needed to make the switch operate in the over-run position is larger—about 50 mg—but this presents no problem for either cartridge or record surface, and in any case, it is only encountered on the run-out groove at the end of the record, or if some part of the servo system malfunctions.

The presence of p.t.f.e. to form a running surface for the mercury is essential, as the high surface tension mentioned earlier would make the spheroid stick to the sides and bottom of the trough. Switches constructed without p.t.f.e. have proved worthless for this application. The Dupont company manufacture a type of p.t.f.e. called Vydxas which is particularly suitable. Vydxas is a stable wax-like polymer available as an aerosol, and when sprayed onto most surfaces forms a semi-transparent, dry, adherent film with an exceptionally low coefficient of friction. The long-term chemical properties are good—it does not decompose or turn gummy, and is unaffected by mercury.

Surface tension also poses problems where the electrodes come into contact with the mercury, and for this reason the electrode tips are sharply pointed.

The electrodes are made of nickel as this is the only commonly available metal with the necessary properties i.e. low solubility in mercury (only 2 x 10^{-3} wt%), strongly magnetic, resistant to oxidation, and easily worked into the required shape. Iron may be a satisfactory material, but has not been tried in practice.

As the regions where the electrodes touch the surface of the mercury are essentially point contacts, with low current-carrying capability, the servo motor cannot be driven directly. A simple circuit for controlling the motor is shown in Fig. 2. In this system, the servo motor runs at the usual preset speed (as discussed in the earlier article) until the tracking arm is 0.2 degrees off station, when the mercury switch will operate and either raise the voltage to the motor or reduce it to zero, depending on which side of the switch the tracking arm is in error.

To prevent oxidation of the mercury, the switch capsule was filled with gas (Propene works quite well and is easy to obtain).

Regarding the mechanical layout, this is very similar to that of the opto-electronic system already described, except that the reference arm is now attached to the lower part of the arm ring, and carries the mercury switch, Fig. 3. The tracking arm carries a miniature magnet over the top of the switch. The reference arm inertia is added to that of the tracking arm in the vertical plane. However, the position is no worse from this aspect than that of the conventional arm, as the extra mass offset by the shorter length of the tracking arm, as previously explained.

Of course, it will not provide a pure reduction in inertia as the opto-electronic system does, but it is envisaged that there are other applications for a switch with these properties, not necessarily in the field of record-players—proximity switching for example.

The switch is not difficult to construct, as the captured diagrams show. It is not necessary to have inclined pivots as shown in the diagramatic representation, as vertical pivots offset by a small distance will perform just as well for all small angles of operation, and are much easier to construct.

Care is needed in handling mercury, which is poisonous by skin absorption and when the vapour is breathed in. Mercury is surprisingly volatile and the long-life characteristics of the vapour work. Should be done out of doors and any spillage cleared up as once and dusted with flowers of sulphur.

### Fig. 2

![Diagram 2](image)

**WIRELESS WORLD, APRIL 1980**

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**Fig. 3**

![Diagram 3](image)

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**Fig. 1**

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The only forces acting on the cartridge with the switch in or near the central position are the minute lateral forces required to press the electrodes E and F into the surface of the mercury, and to overcome the friction of the pivots at A and B. For practical switches the lateral force needed for clean switching is of the order of 10 mg. This is a truly negligible force when one considers that on a conventional arm, needing anti-skating compensation, the force needed to make the switch operate in the over-run position is larger about 50 mg — but this presents no problem for either cartridge or record surface, and in any case is only encountered on the run-out groove at the end of the record, or if some part of the switch suffers malfunctions.

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Care is needed in handling mercury, which is poisonous by skin absorption and when the vapour is breathed in. Mercury is surprisingly volatile and the lung is a large reservoir of mercury. Surface tension also causes the vapour. Work should be done out of doors and any spillage cleared up at once and dusted with flowers of sulphur.

When resin has solidified, knock out brass pattern. File off excess resin to shape shown. A "grumpy disc" attached to an electric drill does this in a few minutes.

Drill these holes to suit gauze of nickel being used. A filler hole 6BA is also made in approximate position shown. Polish switch and all electrodes. Fasten centre electrode to give mercury ball a stable 3-point suspension. Adjust outer electrodes so that they only just project above surface. Araldite all three in place.
According to a paper presented at the Society of Motion Picture and Television Engineers' 14th annual conference in Toronto, digital television is in the immediate future for all but the most remote areas of the United States. Richard Sanders is the head of the Image Science Research Laboratories at Bell Telephone Laboratories in New Jersey, and he and his team have developed an all-digital television system for which they claim to have a number of advantages over the conventional 625-line, 50 fields per second standard. Sanders says that the current trend in camera design for lightweight use, combined with analog and digital technology, will result in the development of a new, more efficient television system. The new system will be able to transmit pictures with higher quality and lower distortion than the conventional system.

Firms also started on laboratory initiatives such as the Edmonton-based Nuclear Energy Institute (ENEI) and the University of Alberta. The latter, in particular, has been able to produce much sharper images than the previous analog systems, and it is expected that this will lead to a more realistic viewing experience. The ENEI has also been developing new techniques for processing the images, which will help to improve the overall quality of the television output.

In order to carry out these processing techniques, practical alternatives to a full 11-bit digital system are being considered. One such alternative is a factor of eight. This second a-d.c. conversion uses a factor of eight, which is very successful in new digital systems, and the information in the field of view can be processed very quickly.

The Scottish electronics industry, which employs about 10,000 people in all, is working on the development of new digital systems. It is hoped that this will lead to a more realistic viewing experience and that it will also be more economical in the long run. The Scottish electronics industry is growing rapidly, and it is expected that it will continue to expand in the future.

Racal gets Decca

After several weeks of speculation about which of the two "giants", Racal or O.E.C., would be the lucky winner of Decca's all share equity offer by Racal worth £103 million, settlement has finally been reached. The deal was decided by Racal Electronics Ltd on 21st June, 1971. The equity offer was backed by a cash alternative of £107 million, which was accepted by O.E.C. shareholders. This alternative amounted to 70p on the basis of 50p per share issued in June 1971.

The speculation about Decca began in the early part of January 1980 after the company's attributable profits fell from £10 million to £1 million in 1979. By contrast, O.E.C.'s best offer of 50p per share from £5.86 million in 1975 to £204 million in 1979. Observers have seen the possible takeover of Decca by Racal as a long-term case of the not-large-enough small company and a too-large-enough large company. The new digital television system, therefore, promises to be a significant step forward for the UK industry.

The city's response to Racal, announced in the British Broadcasting Corporation (BBC) on 21st April, 1971, showed that the BBC management is not being allowed to expand. However, the number of well-qualified schoolchildren dropping out of school in the area is rising. The government is considering how to tackle this problem, but it is clear that the situation will not be solved easily.

The attitude of the British Government stands in sharp contrast to the prompt action taken in Ireland, where, in 1979, the government created more than 500 new academic and technical posts in the universities. In contrast, the recent U.G.C. initiative in the United Kingdom was aimed at providing more means of transfer staff expertise based upon a workforce with a high degree of skill. However, the government has not yet taken full advantage of the excellent chip manufacturing facilities on its own doorstep.

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The speculation about Decca began in the early part of January 1980 after the company's attributable profits fell from £10 million to £1 million in 1979. By contrast, O.E.C.'s best offer of 50p per share from £5.86 million in 1975 to £204 million in 1979. Observers have seen the possible takeover of Decca by Racal as a long-term case of the not-large-enough small company and a too-large-enough large company. The new digital television system, therefore, promises to be a significant step forward for the UK industry.

The city's response to Racal, announced in the British Broadcasting Corporation (BBC) on 21st April, 1971, showed that the BBC management is not being allowed to expand. However, the number of well-qualified schoolchildren dropping out of school in the area is rising. The government is considering how to tackle this problem, but it is clear that the situation will not be solved easily.

The attitude of the British Government stands in sharp contrast to the prompt action taken in Ireland, where, in 1979, the government created more than 500 new academic and technical posts in the universities. In contrast, the recent U.G.C. initiative in the United Kingdom was aimed at providing more means of transfer staff expertise based upon a workforce with a high degree of skill. However, the government has not yet taken full advantage of the excellent chip manufacturing facilities on its own doorstep.

In order to carry out these processing techniques, practical alternatives to a full 11-bit digital system are being considered. One such alternative is a factor of eight. This second a-d.c. conversion uses a factor of eight, which is very successful in new digital systems, and the information in the field of view can be processed very quickly.

The Scottish electronics industry, which employs about 10,000 people in all, is working on the development of new digital systems. It is hoped that this will lead to a more realistic viewing experience and that it will also be more economical in the long run. The Scottish electronics industry is growing rapidly, and it is expected that it will continue to expand in the future.

Change of address

Suppliers of a wide range of semiconductor devices to the electronics industry and consumer markets, Semiconductor Supplies International are now the official Tedtek Semiconductor stockists in the London area. The company, which was formed in 1968 and has an office in Wallington, is now situated in Dawson House, Carnahlton Rd, Sutton, Surrey. A full list of prices and catalogue are available on request.
According to a paper presented at the Society of Motion Picture and Television Engineers' 14th annual conference in Toronto, all-digital telecine machines can be attractive. Richard Sanders is the head of the Imaging Science and Technology department at the University of Edinburgh and he and his team have developed an all-digital telecine machine which is aimed at the professional market. "The system is a 1024 element linear array which scans the film image in sequence and converts it to a signal which could be used for location by a computer," said Sanders. "In addition, the image data can be stored in a computer and used for post-production effects." The system is being used by several film companies, including the BBC.

The trend towards digital telecine is a significant development in the film industry. As film production becomes more complex, the demand for new and innovative technology is increasing. Digital telecine systems offer a number of advantages over traditional methods, including higher image quality, greater flexibility, and faster processing times. As a result, many film producers and studios are embracing digital telecine as a key component of their production workflows.

Digital telecine by 1985

The first practical digital telecine systems were developed in the late 1970s, and by the mid-1980s, these systems had become the standard for high-end film production. Today, digital telecine is an integral part of the film industry, and is used in everything from feature films to television commercials.

The key to the success of digital telecine is the ability to digitize and process film images in real-time. This allows for unprecedented levels of creativity and flexibility in the production process. Digital telecine systems can provide a range of advanced features, including color correction, image enhancement, and special effects.

In conclusion, digital telecine is a technology that is rapidly changing the way that film is produced. As the demand for high-quality, high-definition images continues to grow, digital telecine will continue to play an important role in the film industry.
**Citizens’ Band moves room at Yokohama by English workers in training. Staff are checked for stray capacitance before treasurer is James Bryant, president of the revealed, is the coating of the extrusion with a second linear device field. The item results from a mechanical extrusion of a medium-weight resistance and load to form a simple voltage comes traditional short, medium and long-term “life” problems associated with earlier development of the device is claimed to exhibit extraordinary electrical properties such as a totally neutralized circuit element. The use of the device would be in conjunction with a second non-oxidizing alloy which prevents the progressive degradation of the primary (back) extrusion. This symbiotic analogous overcomes the inherent limitations of traditional short, medium and long-term “life” problems associated with earlier development of the device is claimed to exhibit extraordinary electrical properties such as a totally neutralized circuit element. 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Citizens' Band moves unique device

The lobby for citizens' band radio in the UK is Thea. Treasurer is James Bryant, president of the Citizens Band Association. The new conducting device undergoing extensive environmental tests in the manufacturer's laboratory for a licence for a mechanical extrusion of a medium-weight conductor. Although the full method has not yet been announced, the introduction of a new, more suitable to applications where virtually unimpeded current flow is required. A new company, called Monolog Systems, has been set up in Guildford, Surrey. The company is involved in the design and manufacture of microelectronics to industrial projects and computer systems for industrial applications.

Polytechnic offers course in Rocketry

The Polytechnic of Central London, a subsidiary of the American company Berkeley Technology recently. This was the latest in a series of meetings bringing together specialists from Marconi Space and Defence Systems, EMI Technology, and British Aerospace. A new course of study in Rocketry under the sponsorship of the Federation of Astronautics and Space Industry, will be held at the Polytechnic of Central London, starting at 7.30 p.m. Tom Stonier will be introducing the subject. A member of the National Physical Laboratory will outline the role of the radio frequency electronics engineer and hold a seminar on the nature of radio frequency waves. The course will concentrate on the principles of solid-state technology and microwave communication equipment.

Obituary Cecil Goyder

The death has occurred in Princeton, New Jersey, USA, of Cecil Goyder, who, until his retirement, was concerned with the United Nations communications and broadcast systems for industrial applications. Cecil Goyder's contact was Frank Dillon Bell, Z9AA, of Shag Valley station Wathemoor, where, in 1964, a communications link was erected. Cecil Goyder was also responsible for the design of an early form of phase-locked variable oscillator known as the "Goyder lock."
Amplitude-modulated signals may be grouped into four main types, individual circuits in each group being examined in detail.

The word detector has been in use since the early days of radio and it was an unfortunate choice of term because it is by no means clear what a detector detects. It doesn't detect the presence of a radio signal because an a.g.c. detector is a variable impedance and it doesn't give an output related to unmodulated waveform as in a demodulator or it may be the low forward resistance of the diode as in the a.g.c. detector. Thus a demodulator is an example of a detector but a detector isn't necessarily a demodulator.

Since those early days the number of detector circuits has apparently grown enormously. It is possible to name 30 or 40 a.m. types without great effort. Terms such as forward-conductive diode detector, square-law detector, envelope-detector and product detector are commonly encountered in electronics literature and examination of the various types of detector. The preceding word may describe a number of different features of the detector. For example it may describe:

(a) a component used in the detector e.g. diode detector, grid-leak detector.
(b) a property of the detector e.g. infinite-impedance detector.
(c) the shape of the transfer characteristic e.g. square-law detector.
(d) the originators' names e.g. Foster-Seely detector (to quote an f.m. example).

or, of course, the word detector may be preceded by more than one of these, e.g. product detector which may be used to describe a device which responds to the presence of a particular condition e.g. overmodulation.

It follows that a given detector circuit may be known under a number of different names. For example a diode detector may be described as a linear detector, a differentiator, a carrier detector, a square-law detector and the infinite-impedance detector is sometimes called a reflex detector. Thus the a.m. detector is not so different from its non-a.m. counterpart and it is not so many different types of detector as the multiplicity of terms might suggest.

Circuits used for the detection of amplitude-modulated signals are grouped into four main types, individual circuits in each group being examined in detail.

If the mode of operation of the various a.m. detectors is considered in detail it is found that each conforms to one of four basic modes. There are minor variations in the details of operation for different circuits and these are similar. The four basic types are:

1. those in which the voltage across the load circuit changes to give a reflex detector. There are, therefore, only a few types of the peak value of the input signal.

2. those in which the load circuit is an example of a sampling detector.

3. those in which the detector clamps the peaks of the modulated r.f. input and is charged to a constant potential so that the voltage level of the output varies with modulation frequency.

4. those in which the output stems from the interaction between the side frequencies and the carrier of the modulated r.f. input and is determined by the non-linearity of the transfer characteristic.

We shall now examine this classification in detail.

Sampling detectors

Series-diode circuit

The simplest example of a sampling detector is the series-diode circuit shown in Fig. 1. It is similar to a half-wave rectifier circuit and the capacitor C1 can be called a reservoir capacitor. The charging of the circuit rolls on the rapid charging of C1 through the low-valve forward resistance and the subsequent slow discharge through the high-valve forward load resistor R1.

Diode D1 conducts during positive half-cycles of r.f. input and charges C1 to the peak value of the input signal. Diode D2 conducts during negative half-cycles and the capacitor voltage is cut off and C1 begins to discharge through R1. The ratio of the time constants of C1 to the period of the carrier is however, so chosen that very little of the charge on C1 is lost before D1 begins to conduct on the next half-cycle of input and C1 is charged to the peak value of the input signal. C1 maintains the positive voltage which keeps D1 cut off except for the instant when the input signal changes through its positive peak value. In practice the period of conduction is only a small fraction of the positive half-cycle time.

Thus the load circuit R1C1 is connected to the modulated r.f. source by the low forward resistance of the diode for only a brief fraction of each input cycle and during this time the voltage is 'topped up' to the peak value of the r.f. input. For the remainder of each cycle the diode is cut off, isolating the load circuits from the r.f. input so that the voltage across R1C1 begins a small exponential fall. Thus the diode acts as a switch which is turned on and off by the carrier component of the input signal. This is an example of a sampling process in which the modulated r.f. input signal is sampled once per cycle when it is passing through its positive peak. As the peak value changes at a rate of modulation, the voltage across R1C1 changes to give a waveform made up of a number of 'topping up' intervals separated by exponential falls. These constitute an a.r.f. ripple of small amplitude superposed on the grid-cathode capacitance of the valve and which is easily removed by an r.f. filter to make the output waveform a good approximation of the input signal.

This type of detector is widely used in a.m. receivers and gives a good performance provided that the input signal is large enough to make the diode conductive, i.e. so that it has a low forward resistance and a high reverse resistance. Further, in order that the forward resistance is higher than the reverse resistance it will be found that the detector may be extremely sensitive to the small signal. Better results could be obtained for small input

puts if the diode could be switched by a large bias which is obtained with the carrier component. This is possible using a synchronous detector which is a network which reduces the effect of unmodulated suppressed-carrier a.m. signals: such detectors are described later. In the design of the r.f. input signal is not required to achieve worthwhile gain. If R1 = 47 k, a common value, the voltage across R1 and the detector could be 470 k, giving a gain of approximately 10. This detector performs well by sampling the positive peaks of the r.f. input and the anode (and cathode) current consists of a succession of carrier-frequency pulses which are smoothed to give an approximation of the integral of the carrier-frequency waveform. This type is sometimes referred to as a reflex detector. A. G. C. D. To obtain a similar waveform from the anode, the diode which has therefore a low forward resistance in the cathode circuit connected as shown in Fig. 2. The voltage is turned on by positive swings of the signal applied to the grid and is cut off by negative swings. Thus the capacitor C4 is charged by the low internal cathode impedance of the valve during positive half-cycles and discharged through R4 on negative half-cycles. This is another example of a sampling detector in which the voltage across the diode load resistor R4 is cut off when a.m. transmissions were the only form of radio carrier. The diode circuit has a poor sensitivity to phase, would sample all the positive peaks of the signal input: the reason for this will be made clear in the discussion of the synchronous detector. The reference signal of constant frequency against which it can compare the phase of the r.f. input is provided by a resonant circuit which is the detector is provided with a second input in the form of a constant-

amplitude sinusoidal signal synchronised with the (suppressed) carrier frequency of the modulated r.f. signal.

Synchronous sampling detector. One feasible circuit for a synchronous sampling detector is given in Fig. 4. The single series diode of the prototype a.m. detector is replaced by two diodes and a centre-tapped transformer. Both diodes conduct together to produce the low-impedance output. The r.f. input is connected to the source of modulated r.f. signal to the cathode circuit. The capacitor C1 is a variable capacitance, the reference is placed over the anode and C1 retains its charge. The diodes are non-conducting at the carrier input and not by the modulated r.f. input and thus the carrier amplitude is large compared with the other input signal. The capacitor voltage is therefore taken to be zero when the detector voltage is the time constant of C1 is long compared with the duration of the non-conducting period when the carrier is present. C1 is therefore large, and the detector voltage is the voltage across C1 during the non-conduction period. The capacitor voltage changes by an amount which is proportional to the amplitude of the modulated r.f. signal because of the presence of a particular condition e.g. overmodulation.
Amplitude-modulated signals detected by four main types, individual circuits in each group being examined in detail.

The word detector has been in use since apparently grown enormously. It is possible to name several types of detector, but this is far from being exhaustive. Thus the load circuit $R_{C}$ is connected to the modulated r.f. source by the same circuit of input and $C_{1}$ is charged to a small exponential fall. Thus the diode acts as a switch which is turned on and off by the carrier component of the input signal. This is an example of a sampling process in which the modulated r.f. input signal is sampled once per cycle when it is passing through its peak positive value. As the peak value changes as a result of modulation, the voltage across $C_{1}$ changes to give the required waveform made up of a number of steps of different magnitudes resulting from exponential falls. These constitute an r.f. ripple of small amplitude superposed on the grid-cathode impedance of the valve during positive r.f. peaks and during this time the capacitor is charged to the positive peak value. As this is, of course, the so-called infinite-impedance detector — another unfortunate term because the grid-cathode impedance of the valve, in conjunction with $C_{1}$, gives the circuit some of the properties of an oscillator. When the diode is switched on, it is possible to use an a.m. receiver and gives a good performance. Provided that the input signal is sufficient, it is possible to use a diode detector with less than full-wave rectification and the diode may be a diode detector. The conventional series circuit is replaced by the balanced form of the carrier circuit shown in Fig. 4. The balanced form of the carrier circuit is more effective in rejecting noise and any reduction of the effective input signal is not significant.

Sampling detectors Series-diode circuit

The simplest example of a sampling detector is the series-diode circuit shown in Fig. 1. This is a similar half-wave rectifier circuit and the capacitor $C_{1}$ can be called a reservoir capacitor. The charging of the circuit rolls off the rapid charging of $C_{1}$ through the low-valve forward resistance and the subsequence charging through the high-valve load resistor $R_{L}$. Diode $D_{1}$ conducts during positive periods of r.f. input and charges $C_{1}$ to the peak value of the input signal. While $C_{1}$ is being charged, $C_{2}$ is discharged through $R_{L}$ and the ratio of the time constant to the period of carrier is however, so chosen that very little of the charge on $C_{1}$ is lost before $D_{1}$ begins to conduct on the next half-cycle of input and $C_{1}$ is again charged to the peak value. Since $C_{1}$ maintains its peak positive value which keeps $D_{1}$ cut off except for the instant when the input signal reaches its maximum positive value. In practice the period of conduction is only a small fraction of the positive half-cycle of the input signal. Thus the load circuit $R_{C}$ is connected to the modulated r.f. source by the same circuit of input and $C_{1}$ is charged to a small exponential fall. Thus the diode acts as a switch which is turned on and off by the carrier component of the input signal. This is an example of a sampling process in which the modulated r.f. input signal is sampled once per cycle when it is passing through its peak positive value. As the peak value changes as a result of modulation, the voltage across $C_{1}$ changes to give the required waveform made up of a number of steps of different magnitudes resulting from exponential falls. These constitute an r.f. ripple of small amplitude superposed on the grid-cathode impedance of the valve during positive r.f. peaks and during this time the capacitor is charged to the positive peak value. As this is, of course, the so-called infinite-impedance detector — another unfortunate term because the grid-cathode impedance of the valve, in conjunction with $C_{1}$, gives the circuit some of the properties of an oscillator. When the diode is switched on, it is possible to use an a.m. receiver and gives a good performance. Provided that the input signal is sufficient, it is possible to use a diode detector with less than full-wave rectification and the diode may be a diode detector. The conventional series circuit is replaced by the balanced form of the carrier circuit shown in Fig. 4. The balanced form of the carrier circuit is more effective in rejecting noise and any reduction of the effective input signal is not significant.
The diodes then connect $C_1$ to the source of modulated r.f. for the whole of one half-cycle.

Synchronous anode-bend detector. The anode-bend detector with a short time constant RC combination in the cathode circuit is an example of a sampling detector, the valve being switched from zero to conduction per once carrier period by the positive peak of the r.f. input applied to the grid. The valve could alternately be switched on and off by a carrier-frequency signal applied to the cathode circuit and one type of synchronous sampling detector operates on this principle. It is sometimes called a gated amplifier.

A typical circuit is shown in Fig. 6. The modulated r.f. signal is applied to the grid and the carrier signal, suitably phase shifted with respect to the grid signal and of much greater amplitude, is applied to the cathode. The components of the circuit, known as a 'diode load', are connected to hold the valve cut off except during the negative peaks of the half-cycles of the signals applied to the cathode. When the valve is conducting the anode current takes up a value determined by the amplitude of the signal and the grid at that instant. As the valve is provided with an anode load, corresponding modulation signals can be obtained from the anode.

Clamping detectors

Shunt-diode circuit. In the circuit of Fig. 8 the output of the detector is taken wholly from the reservoir capacitor, but it could alternatively be taken from the load circuit being re-ganged as shown in Fig. 7 to enable one leg of the diodes to conduct during a small fraction of each r.f. input cycle to charge the reservoir capacitor and for this brief period it acts as a short circuit across the output terminals. Thus for the duration of the charging period the output of the detector is zero; this occurs at each of the positive peaks of the input signal. The detector output therefore consists of a version of the modulated r.f. input waveform in which each r.f. cycle is so displaced vertically that all positive peaks touch the zero-volts line as shown in Fig. 8. The mean value of the signal varies with modulation and, if the r.f. ripple is suppressed, consists of the modulation waveform superposed on a negative zero-frequency component proportional to the amplitude of the unmodulated r.f. input.

The action of this form of detector is an example of clamping in which positive peaks of the input signal are clamped at zero volts. The circuit is often used in television to clamp the ripple content in the output but, for a symmetrical modulating signal such as a sine wave, there is no d.c. component. The diodes can be replaced by a shunt-connected bipolar transistor which is switched on and off by the carrier signal applied to the base. The circuit diagram (Fig. 13) includes an RC combination in the base circuit which determines the duration of each clamping period. If the transistor is a symmetrical type the output waveform is symmetrical and the detector output can be minimised.

Additive (non-linear) detectors

In all the detectors so far considered, the reservoir capacitor has played an essential part: it is charged during part of each cycle of carrier components and discharges during the remaining part of the cycle. The shape of the input-output characteristic of the charging device has only a second-order effect.

There is, however, a type of detector in which the shape of the input-output characteristic is all-important because it is in use for most if not the whole of each cycle of input signal. One example of this type is the anode-bend detector in which the valve is biased by a battery as shown in Fig. 14. Detection is achieved because of the valve's response to positive and negative half-cycles of the input signal and is a consequence of the non-linearity of the $I_{V_C}$ characteristic as shown in Fig. 15. Clearly the mean value of the anode current varies with the modulation and the magnitude of the modulation-frequency output depends on the shape of the circuit characteristic. The mean current, and hence the magnitude of the input signal, increases for increasing amplitudes of the input.
The diodes then connect \( C_1 \) to the source of modulated r.f. for the whole of one half-cycle.

Synchronous anode-bend detector. The anode-bend detector with a short time \( RC \) combination in the cathode circuit is an example of a sampling detector, the valve being switched on and off once per carrier cycle by the positive peak of the r.f. input applied to the anode. The valve could alternatively be switched on and off by a carrier-frequency signal applied to the cathode circuit and one type of synchronous sampling detector operates on this principle. It is sometimes called a gated amplifier.

A typical circuit is shown in Fig. 6. The modulated r.f. signal is applied to the grid and the carrier signal, suitably phased with respect to the grid signal and of much greater amplitude, is applied to the cathode. The components \( R_1 C_1 \) and \( R_2 C_2 \) can be omitted. This type of circuit can be used to demodulate the quadrature-modulated colour-difference signals in a colour television receiver. Here the modulated signal has two carrier components in quadrature, each amplitude-modulated by a different signal. The circuit of Fig. 4 can demodulate one of these signals without interfering with the other because, during the time it is sampling the peaks of one signal, the other is passing through zero and so has no effect on the detector output. A second detector with the other carrier is quadrature with that of the first is required to demodulate the second colour-difference signal.

For some applications the components \( R_1 C_1 \) and \( R_2 C_2 \) can be omitted.

The diode conducts during a small fraction of each r.f. input cycle to charge the reservoir capacitor and for the brief period it acts as a short circuit across the output terminals. Thus for the duration of the charging period the output of the detector is zero; this occurs at each of the positive peaks of the input signal. The detector output therefore consists of a version of the modulated r.f. input waveform in which each r.f. cycle is displaced vertically so that all positive peaks touch the zero-volt line as shown in Fig. 8. The mean value of the signal varies with modulation and, if the r.f. ripple is suppressed, consists of the modulation waveform superposed on a negative zero-frequency component proportional to the amplitude of the unmodulated r.f. input.

The action of this form of detector is an example of clamping in which positive peaks of the input signal are clamped at zero volts. The circuit is often used in television in conjunction with the sync tips of a video waveform at a particular voltage. In this application the circuit is known as a d.c. restorer.

Grid-leak detector. One well-known example of a clamping detector which provides amplification is the grid-leak detector alternately known as the leaky-grid or cumulative-grid detector. The circuit diagram of which is shown in Fig. 9. If the grid and cathode of the valve are connected together, the grid-leak detector of which, being supplied between control grid and anode, is amplified by the valve to give a signal input. The anode is suitably clamped at zero volts (so decreasing mean anode current) as input-signal amplitudes increases. The bias is suitable for class-A amplification only for a limited range of input-signal amplitudes. When it is unsuitable the curvature of the \( I_V \) characteristic causes anode-bend detection (in which the mean anode current increases with input-signal amplitude) and the resulting audio signal is in antiphase with that due to grid-leak detection, causing a loss of audio output and distortion.

The r.f. component of the anode current can readily be suppressed by a decoupling capacitor across the anode circuit but it was common practice to provide amplification by positive feedback (called reaction) which greatly increased detector sensitivity.

In an effort to improve the performance of the grid-leak detector it was recommended that a valve with a long grid base should be used and that the anode voltage should be high to further increase the grid base. This made location of the operating point more critical and the required anode potential resulting from anode-bend detection less important. This variant of the grid-leak detector was known as a power-grid detector.

Synchronous clamping detector. Figure 10 gives the grid current/voltage relationship for a synchronous clamping detector. It is much in common with the synchronous clamping detector of Fig. 4 except that, of course, the diodes are arranged to produce a shunt short circuit once per carrier cycle. The diodes and the associated circuits form a balanced circuit chosen to minimize anode current in the detector output and the time and energy content in the output but, for a symmetrical modulating signal such as a sine wave, there is no d.c. component.

The diodes can be replaced by a shunt-connected bipolar transistor which is switched on and off by the carrier signal applied to the base. The circuit diagram (Fig. 13) includes an RC combination in the base circuit which determines the duration of each clamping period. If the transistor is a symmetrical type then minimization of the time content of the detector output can be made.

Additive (non-linear) detectors. In all the detectors so far considered, a reservoir capacitor has played an essential part; it is charged during part of each half-cycle of carrier component and discharges during the remaining part of the cycle. Thus the shape of the input-output characteristic of the charging device has only a second-order effect.

There is, however, a type of detector in which the shape of the input-output characteristic is all-important because it is in use for most if not all the whole of each cycle of input signal. One example of this type is the anode-bend detector in which the valve is biased by a battery as shown in Fig. 14.

Detection is achieved because of the output response to positive and negative half-cycles of the input signal and a consequence of the non-linearity of the \( I_V \) characteristic as shown in Fig. 15. Clearly the mean value of the input current varies with the modulation and the magnitude of the modulation-frequency output frequency depends on both the shape of the waveform and the characteristic. The mean current is proportional to the magnitude of the input signal. There is an alternative method of explaining the operation of this type of detector. When two sinusoidal signals with different frequencies are applied to

...
a device with a linear characteristic, the output has only two components and these are at the frequencies of the two input signals. If, however, two such signals are applied to a device with a non-linear characteristic, the output contains components not only at the frequencies of the two input signals but also at multiples of these two frequencies (harmonics) and at the sums and differences of the various harmonics. The last mentioned are known as difference terms or difference of the various harmonics. The input terminal: it is the difference term of the sum and difference frequencies and are given by

\[ \sin(w_1 \sin t) \sin(w_2 \sin t) = \frac{1}{2} \cos(w_1 + w_2) - \frac{1}{2} \cos(w_1 - w_2) \]

The term difference is thus obtained without the need of non-linearity. There are a number of r.f. mixers and synchronous detectors which use this principle in which, as the identity implies, current is assumed to flow in the device throughout each cycle of both input signals. In all these applications both input terminals control the current through the device and one of them can be regarded as controlling the mutual conductance of the device. The output current is given by

\[ g_{\nu} V_0 \approx (w_1 + w_2) V_0 \]

where \( g_{\nu} \) is the signal applied to the second input terminal and is thus proportional to the product of the two inputs.

One of the earliest devices to be used in this way was the pentode, the two inputs being applied to the control grid and the suppressor grid. The screen grid, being effectively earthed at r.f., prevented any capacitive interaction between the two inputs. A better performance was achieved in the hetrodyne which had an additional screen grid between suppressor grid and anode.

An alternative method of producing a circuit in which two inputs control the same current is by connecting two transistors in series across the supply as indicated in Fig. 16. A number of circuits of this type are in common use, particularly in integrated circuits, and frequently the upper transistor is replaced by a parallel push-pull pair, the input being applied to their bases in push-pull, the output being taken from only one of the transistors. The advantage of using push pull is that the currents of the paralleled transistors are in antiphase so that alternating currents at the frequency of the push-pull input are confined to the push-pull stage and do not stray into the supply circuits or to the lower transistor which controls the current to the push-pull pair.

A third type of multiplicative device is the dual-gate, field-effect transistor. Both gates control the channel current and thus if two signals are applied to the two gates, sum and difference signals are available in the drain current. To conclude this article the classification of a.m. detectors surveyed is summarized in the table.

### Type of detector

<table>
<thead>
<tr>
<th>Type of detector</th>
<th>Classification of a.m. detectors</th>
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| Non-synchronous | series-diode
|                  | shunt-diode
|                  | clamping detector |
|                  | anode-diode with battery bias |
| Synchronous      | diode bridge |
|                  | anode-diode |
|                  | anode-diode with battery bias |
|                  | period, harmonic, power-grid |

### Multiplicative (Product) Detectors

As shown in the previous section one method of achieving a.m. detection is by use of a non-linear device which generates an output at the difference between the frequencies of two components of the input signal. An alternative method is to use a device with two output terminals and which in effect multiplies the two input signals to form the output. This process yields an output at the sum and difference frequencies directly as shown by the identity:

\[ \sin(w_1 \sin t) \sin(w_2 \sin t) = \frac{1}{2} \cos(w_1 + w_2) - \frac{1}{2} \cos(w_1 - w_2) \]

a device with a linear characteristic, the output has only two components and these are at the frequencies of the two input signals. If, however, two such signals are applied to a device with a non-linear characteristic, the output contains components not only at the frequencies of the two input signals but also at multiples of these two frequencies (harmonics) and at the sums and differences of the various harmonics. The last mentioned are known as combination frequencies and are given by

\[ m f_1 \pm n f_2 \]

where \( m \) and \( n \) are integers. The most interesting of the combination frequencies is \((f_1 - f_2)\) the difference frequency. Non-linear devices are often used as r.f. mixers in superheterodyne receivers, the inputs from oscillator and the r.f. circuit being connected in parallel or series and applied to the single input terminal: it is the difference term which is selected from the output of the mixer for amplification in the i.f. amplifier. In an anode-bend detector the input, assumed amplitude-modulated by a single sinusoidal signal, has three components — the carrier, the upper side frequency and the lower side frequency. The difference term resulting from interaction between the upper side frequency and the carrier yields the required modulation-frequency output. But interaction between the upper and lower side frequencies yields an unwanted second harmonic of the modulating signal and interaction between the harmonics of the side frequencies and the carrier yields a complex of other unwanted terms. Thus the non-linearity of the characteristic on which the action of the detector depends inevitably causes considerable harmonic and intermodulation distortion.

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The difference term is thus obtained without need of non-linearity.

There are a number of r.f mixers and synchronous detectors which use this principle in which, as the identity implies, current is assumed to flow in the device throughout each cycle of both input signals. In all these examples both input terminals control the current through the device and one of them can be regarded as controlling the mutual conductance of the device. The output current is given by \( I_0 = \pi v_1 \) approximately (where \( v_1 \) is the signal applied to the upper input terminal) and is thus proportional to the product of the two inputs.

One of the earliest devices to be used in this way was the pentode, the two inputs being applied to the control grid and the suppressor grid. The screen grid, being effectively earthed at r.f., prevented any capacitive interaction between the two inputs. A better performance was achieved in the hexasode which had an additional screen grid between suppressor grid and anode.

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SSG520 SYNTHESIZED SIGNAL GENERATOR

The SSG520 is a synthesized signal generator covering the range 10 to 520 MHz and was designed for test measurement, test and alignment work in the V.H.F and U.H.F bands with particular emphasis on the needs of those servicing mobile communications equipment. It is astonishingly easy to use, exceptionally stable and has remarkably low leakage so it is also proving popular for many other specific or general applications too in broadcast radio and communications research and teaching.

Fast, error-free frequency selection by thumbwheel switches and automatic ranging eliminates the need for a frequency meter and glue synthesis in 100Hz steps brings maximum stability at all frequency settings. What's more the SSG520 needs no re-tuning after a power loss. An optional overdriven crystal version is available for even greater accuracy and stability. Sideband phase noise is better than -110dB/Hz and harmonics are less than 25dB. Any combination of a.m. and f.m. modulation, internal or external is possible. Output is calibrated and automatically levelled over the whole frequency range and the attenuator is quickly set by adjacent 10 and 1dB attenuator switches giving direct reading of dBm and volts and enabling accurate mute/level setting.

A really useful extra feature on the Farrel SSG520 is the SINAD facility. This feature provides a simple, quick and unambiguous method of measuring receiver sensitivity. It may also be used as an alignment aid ensuring the reception of intelligible signals by providing a better band-pass alignment.

If the remote programming option is ordered then all major functions can be controlled via a multipin socket. These include frequency, attenuation, modulation and SINAD meter. A microprocessor based keyboard control unit with IEEE 48 is available at special order.

Reverse power protection is now available as an internal option preventing possible attenuator burn-out for up to 50 watts reverse power. This protection automatically resets when the power signal is removed.

Use this magazine's reply system now to obtain your copy of a six page colour brochure on the SSG520 and we'll send you a useful pocket-size folder of telecommunications data, charts and tables.

NEW!
Transmitter Test Set
See it at
Communications 80

PROGRAMMABLE NOTES FOR KEYBOARD INSTRUMENTS

Regarding Mr. Robson's letter in the September 1979 issue, one way of overcoming the problems with key changes while allowing a "natural" scale to redefine the function of the keyboard. The following is a suggestion to overcome the limitations of current keyboard instruments, which are tuned to an "equal-tempered" scale. The latter is really a compromise, basically due to the fixed number of physical notes available. If we had a much larger number, true musical intervals (i.e. subjectively correct) could be played in any key as facts early keyboard instruments had "split" notes to reduce this problem. For example, A# and G# should strictly be different frequencies, depending on the scale key being played, but have now been "tempered" to give the same frequency (i.e. they are the same physical note), which has become acceptable in modern music. However, if we consider a keyboard generating "intervals" as opposed to absolute frequencies, this situation should not arise. Imagine a keyboard where notes to the right represent positive intervals relative to the last note played, and notes to the left represent negative intervals (the middle note would be the reset required at switch-on. It is analogous to an inertia shaper, as chords have not yet been considered. But for those who are interested, the operation is as follows: the key contacts are labelled S1, S2, ... and must operate in that sequence, but hold the current note in their "hold" capacitors. When a key is pressed, S1, opens and isolates IC1, S2 closes, selecting the interval required (plus/minus or zero) which is added to the previous note from IC4, using the summing amplifier IC4, IC5, 6, 7, summing this new note on IC4, which produces the required frequency from the oscillator. S1 triggers the note envelope shaper, S2 is in the reset required at switch-on.

W. A. Pilling
Chipping
Manchester

C. B. RADIO AND POPULATION DENSITY

R. B. Hooper's letter in your February issue is interesting. He's perhaps forgotten about the density of population here. England comes second, after the Netherlands, with 900 people per square mile. Scotland, from where I write, is No.22 on the world's list, with 170, but even that is heavily concentrated, in its central area. A lot of the rest is mountainous. Victoria, Mr. Hooper's home-state, is Australia's most densely crowded. This happy region has 37 people per square mile, almost the same as Finland! His island-country is itself at the end of the world's list. As it's roughly the same area as the contiguous Europe it can well afford the luxury of citizens' radio, without "mutual interference." With these facts in front of him, Mr. Hooper must realise that the authorities here, with a population of 5,400,500, also have the same problem as the Finns. His island-country is itself at the end of the world's list. As it's roughly the same area as the contiguous Europe it can well afford the luxury of citizens' radio, without "mutual interference." With these facts in front of him, Mr. Hooper must realise that the authorities here, with a population of 5,400,500, also have the same problem as the Finns.

King Canute would have been gratified!
W. C. Richon
Stromness
Orkney

THE INTELLIGENT PLUG

Two points regarding The Intelligent Plug mains communication system described in your December 1979 issue: (a) it could be lethal, (b) it would need a licence, which would not be granted. The problem arises from the 1A capacitor in the transmitter circuit, practically between the neutral and earth lines (commonly the authors state "for maximum safety"). However, if the neutral and earth connections were separated at the wall socket were dirty and not making very good contact, the live mains would pass through the primary of the mains transformer at least, making the neutral wire also live, and then pass through the 1A, making the earth and hence the case and microprocessor live.

The USA, which he quotes, is No. 27 on the list, with 50 people per square mile! Like Australia, its vast area has undoubtedly made c.b. radio both feasible and necessary. In most of the UK one is within easy reach of a telephone. Our communications system has, fairly recently, been extensively modernised and is quick and effective.

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W. C. Richon
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In practice, frequencies have to be generated which are proportions of the previous frequency. This could be done using multiplier circuits or digital techniques, but a simple method which springs to mind is to use a basic synthesizer concept. In these instruments a keyboard generates a linear scale of voltages which control logarithmic voltage-controlled oscillators. Using this idea, the frequency multiplication/division we require is easily obtained by adding/subtracting d.c. voltages. Operational amplifiers can be used for this, as well as for storing the last note played in a sample-and-hold arrangement. The circuit in Fig. 2 (albeit crude) illustrates the basic idea, but has not been tested as it is only a suggestion for those readers with more time and patience to try a feasibility study. It may not in fact be practical due to shifting unless highly stable circuits are used. It is analogous to an inverter based navigation system which is reset only once, and from then on everything is calculated relatively, thus accumulating errors. The instruments may be physically difficult to find space for in this use. The instrument may be physically difficult to find space for in this use. The instrument may be physically difficult to find space for in this use.

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**DISPLACEMENT CURRENT**

The displacement current is no current at all. It is a mathematical phenomenon, or a method to express the fact that an automatic agent needs it to be a current - the flow of charge. It is sensible to talk about "flowing current", but not "displacement current", because the latter is a phenomenon of the second kind (current is an operation on the first kind). We have to distinguish between the two.

The displacement current is no current at all, but it is important because it is the only current that a dynamic system can use to assure the stability of its output. Without displacement current, the system would not be able to maintain its output within the predetermined limits. The displacement current is used to compensate for any deviation from the setpoint, ensuring that the system remains stable and predictable.

**REFERENCES**


The authors reply: With regard to para 1, neither Maxwell nor any other scientist has ever identified more than one form of Maxwell's displacement current, or asserted that dD/dt behavior is simply the "flowing current" or an E-field inside a transmission line, to which the old Maxwell capacitor presents a conditional approximation. But, what kind of a transmission line? Is Maxwell's equation (1) in its existing form

\[
\mathbf{H} \cdot \mathbf{D} = \mathbf{J}_0 + \frac{\partial \mathbf{D}}{\partial t}
\]

with the two Maxwell equations (2) and (3) renamed

\[
\mathbf{E} = \mathbf{J}_0 \times \mathbf{B}
\]

and

\[
\frac{\partial \mathbf{D}}{\partial t} = \nabla \times \mathbf{E}
\]

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importance of all, freedom is never 'granted' (that would be like being dark with the light turned on). It must be taken away by struggle for it. That is one of the main values in political and cultural life, as this is considered as a straightforward transmission of power. All that is really necessary is the frequency use of force - which would probably rule out this new order.

Mr Frost could have added words from Gerhard Weinsteins to his list: 'We should have seen what it takes to struggle for freedom. Also people interested could very well specialize in this - my teacher Henry Thoreau has something to say about it. It is not a question of simply seeing World Wide making a small breakthrough in one's own property; indeed, if it were, you and your co-workers would need a licence!

The word processors and disseminated information techniques used to combat the accompanying degradation of the channel. The struggle is very important to consider that when it is a displacement current, appearing where there are no moving charges. In the accompanying diagram current moves between points A and B or anywhere between the two capacitance plates. The displacement current is no current at all. It is a pure 'flowing current'. It is an agent needs to be a current - the flow of electricity. It is sensible to talk about 'flowing current' and 'displacement current' are objective terms, not works in the conductive path, but the fields, and the fields are created by the charges.

Any awareness that the coming politicalスタッフ's position of transmission historical, can be approximated out of existence. As to para. 2, where Dr Stockman suggests a 'displacement entity', which the Maxwell capacitor presents a conditional approximation. But, what kind of a transmission line? Is Maxwell's equation (1) in its usual hewing? The symbol here, we have been looking at the magnitudes of the fields, and the fields are created by the charges. While the equation D = E field is the maximum that can be avoided.

With regard to para. 3, we object to the quantity D, which equals E, a field as real as E. We do not object to the quantity D, which equals the TTS wave equation. We do not object to the quantity D, which equals the TTS wave equation. But the TTS wave equation is zero at three of the four points where D is written, although at each of those points an electromagnetic signal is successful, along without the benefit of a non-zero D.

Therefore substituting in (6),

\[ V = \frac{1}{\sqrt{2}} \left( E + D \right) \]

Referece

**Seven-segment/b.c.d. encoder**

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\[ V = \frac{1}{\sqrt{2}} \left( E + D \right) \]
WHAT'S SO NATURAL ABOUT e?

In Mr Finlay's interesting article "What's so natural about e?" (December 6, p 490), I would like to ask the reader to look at the graph. Find the distance of the required distance before you look at the graph. More trials soon showed that the value was known that the limiting value of different calculators. (Using Mr Finlay's other values associated with e. This method is easy to understand, but another approach, Mr Finlay wants to avoid this let us draw through the points of contact is parallel to the x-axis. The different curves have this property; the distance of the point of contact is the same for all the curves.

We now want to calculate this distance. The normal procedure would involve differentiating, but as a result of my approach, Mr Finlay wants to avoid this, let us use his values of e. Let us take the graph $y = e^x$, for which $y = 1.1$. At the point of contact for this curve (P in my diagram) $dy/dx = PQ/OQ$. We can have $PQ = 10, OQ = 11$. At $P = y = PQ$. This gives $PQ = dy/dx = (PQ/OQ) = 10$. Dividing each side by $PQ$ we have $\frac{dy}{dx} = \frac{1}{11}$ and $y = \frac{1}{11}$.

The relation between $x$ and $y$ is $y = e^x$ and $x = \ln y$. It is 1 when $x = 0$.

We have $\ln y = 1$. This is our value for $e$ for $y = 1.1$. If we use this for $y = 2$. $\ln y = 2$. This is our value for $e$ for $y = 2.71$. If we use this for $y = 4.14$ for $y = 2.71$.

The equation for $e$ can be written $e = \frac{1}{11}$ and $y = \frac{1}{11}$. In reality, it is $e = 2.71$. This is our value for $e$ for $y = 2.71$. This is our value for $e$ for $y = 2.71$. If we use this for $y = 4.14$ for $y = 2.71$.

This seems an appropriate context to mention an occasion that took me by surprise. I wanted to compare the value of $\pi$ (or resolution?) of different calculators. It is known that the value of $\pi$ is a transcendental number, and when $x = \infty$, $\pi$ is a transcendental number. I was able to show that $\pi$ is a transcendental number, and when $x = \infty$, $\pi$ is a transcendental number. (Halley's Law). Earnest mechanical

the current builds up in an internal resistor connected across a battery, $e^x$ is also linked in for positive values, which may increase its value, $e^x$ is also linked in for positive values, which may increase its value.

Most of us probably think of growth and decay in terms of a time span, like life itself. It may be short-lived (or transient) like a flash of lightning, or almost eternal, like some radioactive decay. Cases governed by the exponential curves of Fig. 17 abound in all the sciences, both natural and mathematical.

In physics, Newton's law of cooling (as in the lounge we have just left the room in familiar heat transfer) governs the exponential nature of cooling processes. Mechanical examples include the rate of fall of a spinning wheel, the build-up of aircraft speed against air resistance, the free decay of vibrations in a musical instrument or an unbalanced machine and the damping of unwanted vibrations in mechanical instruments. The last two remind us of analogous physical processes in nature, especially in atomic and biological systems. Indeed, the exponential shape of growth and decay is to be expected.

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In physics, Newton's law of cooling (as in the lounge we have just left the room in familiar heat transfer) governs the exponential nature of cooling processes. Mechanical examples include the rate of fall of a spinning wheel, the build-up of aircraft speed against air resistance, the free decay of vibrations in a musical instrument or an unbalanced machine and the damping of unwanted vibrations in mechanical instruments. The last two remind us of analogous physical processes in nature, especially in atomic and biological systems. Indeed, the exponential shape of growth and decay is to be expected.
WHAT'S SO NATURAL ABOUT $e$?

In Mr. Finlay's interesting article "What's so natural about $e" (WIRELESS WORLD, April 1980) Mr. Finlay arrives at $y = e^x$ in three different ways. He arrives at $e$ by the method of interpolation, he arrives at $e$ by the method of the compound interest, and he arrives at $e$ by the method of hyperbolic tangents. I will now explore the function $y = e^x$ before it tends to infinity and show you how it is simple to do, the distance is $e$. Though this is simple to do, the justification may not be obvious and since we are trying to explain the importance of $e$, it is better to suggest drawing tangents from the origin to each of the curves. The different curves have this property: the distance of the point of contact from the $x$-axis. This distance is $e$. Though this is simple to do, the justification may not be obvious and since we are trying to explain the importance of $e$, it is better to suggest drawing tangents from the origin to each of the curves. We note that these tangents are parallel to the $x$-axis. The different curves of contact are the same for all the curves. We now want to calculate this distance. The normal procedure would involve differentiation, but as we have reason to do, we will not do so. Let us use his values of $y$. Let us take the graph $y = e^x$, for which $k = 1$. At the point of contact for this curve, $F(y) = P(y) = P(1)$. We have then $F(1) = P(1)$.

EXPRESSING EXPRESSIONS

It is a procedure to express $e$ to be $e$. (In the differentiation, it is equal to a constant, $k = e^x$, $k = e$, $y = k$, $y = e^x$, $k = e^x$, $y = e^x$.) Let the general form be $y = e^x$. The problem then is to find a value, $a$, such that $k = e$.

In Mr. Finlay's Fig. 6, a graph of $k$ is plotted against $a$. The value of $a$ which makes $k = e$ is found. This value of $a$ is $e$. This method is easy to understand, but another method involves another graph: it gives the result from the graphs drawn in Fig. 8.

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Wireless World, April 1980

WIRELESS WORLD, APRIL 1980

horizontally to the right followed by mind vertically upwards, as in Fig. 19.

which looks very simple after what we have seen of sinh and cosh. The complexity of the relationships between sinh, cosh, and exponential functions is something that can result (overdamped, critically damped, underdamped). The hyperbolic cosecant is especially of course therefore likely to be interesting, because it lends us with new type of expansion and therefore a new kind of possibility for working with imaginary numbers.

The meaning of $\sinh x$ and $\cosh x$

Then it is obvious that we have a right-angled triangle with a hypotenuse of length $r$, which is given by $\sqrt{a^2+b^2}$, and the two legs $a$ and $b$ of the triangle, which we represent in the phasor diagram by a vector of length $r$. This is useful because it allows us to express the cosine and sine of an angle of a given magnitude. The sine of an angle is defined as the y-coordinate of the point on the unit circle at an angle of $\theta$ from the positive x-axis, and the cosine is defined as the x-coordinate of the same point.

There are many other sine and cosine problems which look very simple after what we have seen of sinh and cosh. The complexity of the relationships between sinh, cosh, and exponential functions is something that can result (overdamped, critically damped, underdamped). The hyperbolic cosecant is especially of course therefore likely to be interesting, because it lends us with new type of expansion and therefore a new kind of possibility for working with imaginary numbers.

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The first two cases are examples of waves produced by gravity pulling an evenly formed line. A horizontal shape—a catenary (from the Latin catena—chain)—and the others, which have the added complication of an almost horizontal roadway slung below, are pretty near in shape.

The catenary is formed by adding two exponential curves as shown in Figure 17, namely $e^x$ and $e^{-x}$, and halving the result, i.e.

$$y = \frac{e^x - e^{-x}}{2}$$

This curve, shown in Figure 18, is termed `cosh', implying `cos hyperbolic', because it can be defined using a trigonometric ratio from the angle $x$ and with a hyperbolic sine $\sinh x$.

[Figure 17: Some useful exponential curves.]

[Figure 18: More exponential curves. $y = \cosh x$ (left) and $y = \sinh x$ (the catenary).]

Both of these are standard results, and you get two for the price of one. Euler in 1748 stated in formula $\cosh x$ is the six terms of the expansion and that while it was a new function distinguished very weak sensations and to be mercifully protected against especially strong ones. The same law discovered by the 18th century psychologist Weber and Fechner to other senses, too, as of touch or pressure in comparing weights in the two cases.

Earlier I mentioned the shape of a grand piano, determined by the varying radius of its strings, and the interesting comparison between it and the FA Cup rounds as a knock-out competition. The semi-circles of the frets in fingering a finger acts as a concert diagram. The 'rights' are at the ends, the 'lefts' are at the center, and the 'neutral' is at the top, that is, the top note is the neutral note.

This is usually attributed to Euler, that master-builder of series, and so is known as Euler's Trigonometric Identity. Interestingly, though, this formula was not the first to be used for trigonometric identities, as it was published in 1707 by a Frenchman, Roger Cotes, who in 1714 published a theorem on complex numbers which would appear in a moment, so that $e^{ix}$ is the solution we are looking for.

[Figure 19: The meaning of $e^{ix}$ and $j=\sqrt{-1}$.]

Now that last factor alone is not unfamiliar to electrical engineers since with a right-angled triangle with angle $x$ in the $x$-axis, is the general solution $\me^{-x} e^{jx}$, and $\cosh x$ and $\sinh x$ have been tempted to ask her why straightening his clothes line may have been tempted to ask her why the CEGB isn't any more successful with the Grid cables between the pylons, and yet both of them, like the rest of us, have heard of the idea of the catenary. (not to mention tanh!) Whenever we use a trigonometric ratio from the hyperbolic, because it can be defined algebraic. Now $i \cosh x$ is, that is $e^{ix}$.

Many of you will know another identity entided of Eure's theorem.

$$e^{ix} = \cosh x + j \sinh x$$

De Moivre was a Hugenot refugee from France who came to England as a young man in 1685, taught mathematics, became a close friend of Sir Isaac Newton and a member of the Royal Society and its French and German equivalents, worked for a firm of insurance and showed the actuarial profession in the calculations he carried out. Not many sine and cosine problems can be sorted out by turning them into exponential form. In fact many more advanced uses of the formula such as finding the powers of roots of trigonometric functions or the position vectors (call them what you will) in vector space and multiply numbers, or deriving series for accurate calculation of sines and cosines of any angle were presented and useful formulas and Hewlett-Packard procedures for handling complex function calculations, the elements of the matrix, and the realization that the more advanced scientific calculators all simply compute the sine or cosine of the right co-ordinates, which eases this sort of analysis.

In a final fling of history, let us pay credit for the geometrical representations of complex numbers. The earliest useful attempt was published in 1685 by Englishman John Wallis, which used arrows instead of the circle, for the fact and drew perpendicular lines to it as required to erect the x-axis and compare the hole areas at various $x$ co-ordinates.

The last two examples are just one case of the sine function. As a right-angled triangle with the right angle at $x$ and to its exposure effect on a film, the brightness is in fact increasing or decreasing exponentially. It is not unlike the plot of $\cosh x$ or $\sinh x$ as we have seen before.

These are also somewhat diagrams. These are also somewhat represented 'directed line segments' (vectors), for the first time, by reference to two axes, one for 'real' numbers ($x$), and another for 'imaginary' ($y$) numbers, or deriving series for a triangle, similarity 'sines (pronounced shine)', also shown in Figure 18, is made up from half the difference between $\sinh x$ and $\cosh x$ and is the hyperbolic equivalent of sine.

Electrically, sinh and cosh look large but not to scale in the picture. There is another one called Argand and Smith who in 1797 published a paper in a Danish journal, in which he represented 'directed line segments' (vectors), for the first time, by reference to two axes, one for 'real' numbers ($x$), and another for 'imaginary' ($y$) numbers, or deriving series for a triangle, similarity 'sines (pronounced shine)', also shown in Figure 18, is made up from half the difference between $\sinh x$ and $\cosh x$ and is the hyperbolic equivalent of sine.

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Complex Digital Control Systems, by Guthrie, is written in both senses of the word. It is concerned in the main with data-sampling digital control systems, in particular those used in video and disc recorders.

Sensene Marlone was in trouble with the newspapers and popular science publications in the early part of 1980. Many operators spent a lot of time explaining that no atmosphere and Marlone expressed the view that, since identical signals were received at widely separated points on the earth, the most likely explanation was that there was a great distance and possibly well outside the earth, meaning natural sources, of course. This remark was pithily sniped on by Fleet Street, who interpreted it as meaning that pitching Martians were transmitting to us. Marlone denied that he meant anything like that, but it was too late. Sensene was in a dilemma and its initial heap of steam was maintained by Sensene, who found the story too good to worry much about the facts.

A succession of articles appeared, and the chief in one of 3.20 issue (we were then fortimately) contained a piece by Philip Courrey and the report of the presidential address to the Wireless Society of London by A.A. Campbell Swinton, F.R.S. His remarks on the subject went as follows:

"Perhaps it might with advantage be pointed out that the intensity of received wireless signals varies inversely more or less according to the square of the distance between the source and the point of reception; so we suppose the mysterious signals in question originate on the planet Mars, the power of the sending apparatus must be of prodigious dimensions. For instance, if the signals in question are received in London as loudly as those from Paris, the power employed in Mars must be greater than what is used in Paris in the proportion of the square of the distance between Paris and the power employed in Mars. This power is employed in Paris as about 200 HP; so that unless the inhabitants of Mars have improved methods of directional sending greatly surpassing our own, the power used on Mars to give equal effects to those in Paris must be about 60,000,000,000 times as great as in Paris, or say, 120,000,000,000 HP."

This certainly seems a fairly large amount for even Martians to employ for purely scientific purposes, and the use of a Morley key of ample dimensions. Surely a much more reasonable supposition is that the so-called signals come from the sun where natural outbursts of electromagnetic activity exceeding in amount the stupendous horse-power are, it is known, no infrequent occurrence. Indeed, great luminosity is continually radiating into space from the sun in thousand horse-power per square foot of its surface, and its diameter is 90,000 miles there are a great many square feet, and the total horsepower the sun radiates in this way is something altogether enormous. It is thus evident that even comparatively small emissions on the sun’s surface may well cause disturbances on the earth sufficiently frequent to account for the so-called signals."

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24. Ref. 21 Ch. 8, §33 (a).
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Complex Digital Control Systems, by Goldhill, brings home the utility in both senses of the word. It is concerned in the main with data-sampling digital control systems, in particular those used in video and disc recording.

Seneca Marconi was in trouble with the newspapers and popular science publications in the early part of 1906. Many operators had a lot to say about 'Marconi's pretension' and Marconi expressed the view that, since identical 'signals' were received at widely separated points on the earth, the most likely explanation is that there is a great distance and possibly well outside the earth, meaning natural causes, of course. This remark was perversely signed on by Fleet Street, who interpreted it as meaning that 'playful Marciato was transmitting to us. Marconi denied that he meant anything like that, but it was too late.

The controversy was well under way at this point, and its initial head of steam was maintained by many who found the story too good to worry much about the facts.

A succession of articles appeared, and the debate in our April 3, 1906 issue (we were then fortnightly) contained a piece by Philip Carpenter and the report of the presidential address to the Wireless Society of London by A.A. Campbell Swinton, F.R.S. His remarks on the subject went as follows:

"Perhaps it might with advantage be pointed out that the intensity of received wireless signals varies inversely more or less as the square of the distance between the source and the point of reception; so as to suppose the 'mysterious signals in question originated on the planet Mars, the power of the sending apparatus must be of prodigious dimensions. For instance, if the signals in question were received in London as loudly as those from Paris, the power employed in the Marconi equipment in Mars must be greater than what is used in Paris in the propagation of the square of 2,500,000 miles.

The power employed in Mars is about 200 HP, so that unless the inhabitants of Mars have improved methods of directional sending greatly surpassing our own, the power used on Mars to give equal effects in Paris must be about 40,000,000,000 times greater in Paris or say, 120,000,000,000 HP."

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Swiss MINIC TELEPRODUCTOR, L.A.B. (A.P.S.), OX DISCO, which use toroidal transformers, are described below. There are power supplies for use with any one or two of these modules, they are mains and good notese powered either via the Cl or by a battery. Hardware kits are available to build both types and they achieve virtually the same specifications as part of the Cl pre-amp module is now available separately for

Example: C1 pre-amp achieves low distortion and good r.f., rejection and has unbeatable specifications, caters for disc, cassette and 2 or 3 head tape machines and requires only a rough supply of 110v or 220v. Previously restricted to trade and export, C1mc, a photodiode array camera used for automatically detecting 100 undividing cell nuclei similar to the plain circular objects seen in Fig. 1, on each square centimetre of slide.

The scanner signal from a 1-inch integrated Photomatrix Ltd 256 linear diode array and signal processor is shown in Fig 2. The cost effectiveness of the microscope depends in part on the speed at which the cells of interest can be found. It is therefore important to work as close as possible to the limits of acceptable geometric resolution and signal-to-noise ratio of the microscope and scanner combination. Extensive experiments have led to a scanner speed of one scan per 300 ms and a scanned field width of 384

Fig. 1 shows a photograph of a typical field of view from a microscope slide preparation intended for chromosome analysis. The cells of primary interest are similar to the one which is circled in the figure. There the chromosomes are well separated and randomly distributed in an approximately 50µm diameter circle. On average there are about 10 cells of interest, together with about 10,000 undividing cell nuclei similar to the plain circular objects seen in Fig. 1, on each square centimetre of slide.

Improving photodiode camera signals

Shading correction for array scanner used in chromosome analysis

by Daryll K. Green
MRC Clinical and Population Cytogenetics Unit, Edinburgh


**Quantum Electronics**

NEW PRODUCTS — NEW PRODUCTS

Our products are for the 100% user who wants to exercise his ability to experiment with such a wide range of components. We are now — for the first time and in performing such an enormous task that a special price list is required for each of the wide range of components. The wide range of components is available from £45 to £250 or more. The wide range of components are available from £45 to £250 or more.

**PREAMP & POWER AMP KITS**

The circuit described corrects signals for the shading effects which occur in a photodiode array scanner used for detecting stained chromosomes in dividing blood cells. Correction is needed because both the differences in photodiode sensitivity in the array and the illumination shading are greater than the chromosome image contrast. Cost of components is a fraction of the cost of the photodiode array camera.

Most photodiode array scanners show some non-uniformity of photodiode sensitivity. Quite often subjects which are imaged onto any type of scanner are non-uniformly illuminated. Where the illuminating light level is high, giving rise to a high signal-to-noise ratio, and the image contrast is greater than either diode or illumination shading effects, the detection and measurement of subject features with a photodiode scanner presents no problem. The difficulty which prompted the building of the shading corrector described here is the detection of stained chromosomes imaged through a microscope where both the differential diode sensitivity and the illumination shading are for the most part greater than the chromosome image contrast. A circuit for correcting the photodiode signals for these shading effects is explained. The corrected photodiode scanner forms part of a machine used for automatically detecting dividing blood cells on a microscope slide preparation.

The scanner signal from a 1-inch Integrated Photomatrix Ltd 256 linear photodiode array and signal processor is shown in Fig. 2. The cost effectiveness of the microscope depends in part on the speed at which the cells of interest can be found. It is therefore important to work as close as possible to the limits of acceptable geometric resolution and signal-to-noise ratio of the microscope and scanner combination. Extensive experiments have led to a scanner speed of one scan per 300 µs and a scanned field width of 384 µm.

**POWER AMP MODULES AND SUPPLIES**

The scanner corrector forms part of a machine designed to detect and measure the features of any type of subject features with a photodiode scanner. The wide range of components is available from £45 to £250 or more.

Exp. 800. The scanner corrector has been designed to detect cells with a wide range of component sizes and to ensure that all measurements are made with an accuracy of ±10% of the actual dimensions.
microns. The microscope slide is at the same time driven back and forth under the control of a stepping motor at 90° to the scanner direction and at a speed of 3,000 microns per second.

The major component of the non-uniformity of diode array signal voltages arises out of the slide illumination and imaging system (Fig. 3) which comprises a 10W quartz iodine

microscope lamp with the usual condenser, objective and projection eyepiece optics. At each stage in the microscope light path there is a loss of intensity due to the imperfect transmis-

sion of the optical components across the whole field of view. Maximum transmission is usually along the optical axis. A lesser component of signal non-uniformity is the differential photodiode sensitivity, which is specified as 9% by the manufacturers, though in practice only one or two diodes differ in sen-

sitivity from their neighbours by this amount.

The magnitude of signals from large chromosomes exceeds the 5% sensitivity variation of the diodes but is much less than the observed 2:1 illumination variation. Small chromo-

some signals are obscured by both. In the absence of shading correction, therefore, detection of chromosomes and the measurement of their trans-

missivity is very nearly impossible.

Shading correction theory

When there is no object on the microscope slide imaged onto the diode a signal voltage \( V_0 \) is measured. When an object of transmissivity \( T \) is imaged onto the \( N \)th diode a signal voltage \( V_t \) is measured. It follows that

\[
T = \frac{V_t}{V_0}
\]

where \( V_t \) is a constant voltage representing the flat response of a per-

fect system. Comparing these two equations we see that the shading cor-

rected voltage \( V_c \) is given by

\[
V_c = \frac{V_t}{V_0}
\]

Each diode voltage therefore must be multiplied by a factor \( \left( \frac{V_c}{V_0} \right) \) where \( V_c \) is an arbitrary constant voltage and \( V_0 \) is the uncorrected signal voltage for each diode for a clear image field. It will be seen later that \( V_c \) is set to the maxi-

mum value of \( V_0 \) and is relabelled \( E_0 \).

Implementing shading correction

The correction factors \( \left( \frac{E_0}{V_0} \right) \) are held in digital form in a 256-element shift register which is synchronously recirculated with the diode array signals. The number of bits required in each of the shift register elements is roughly determined by the average signal-to-noise characteristic of the diodes. This amounts to about 24.78 milli-

volts in a full saturation voltage of 5 volts, which is one part in 200. An 8-bit binary correction factor is therefore more than adequate and fits in well with a wide range of 8-bit commercial analogue-digital and digital-analogue converters. The value of \( \left( \frac{E_0}{V_0} \right) \) for each diode is loaded into a 256x8-bit static shift resistor which is then recy-

cled synchronously with the original diode signals. The circuit for loading and recycling the correction factors is schematically shown in Fig. 4. Loading the shift register in one scan of the array camera, which in this example occurs in 300 microseconds, would require an approximately 1 microsecond analogue-to-digital conversion for each diode correction factor. Though this is possible it is expensive. For this reason a simple timing circuit is used, such that during a whole scan time of 300 microseconds only one diode correction factor is sampled, converted and loaded into the shift register. Each diode is taken in sequence and an extra scan time is allowed at the end to give the final diode in adequate correction time. The total correction set-up time is therefore 300 \( \times (256 + 1) \) microseconds, which is approximately 77 milliseconds.

Detailed circuit

In practice the correction factors \( \left( \frac{E_0}{V_0} \right) \) will always be greater than or equal to unity, which would cause most analogu-

dividers circuits to overflow. There are several ways of overcoming this problem such as the following:

1. Reduce \( E_0 \) by a fraction \( \frac{1}{n} \) to form:

\[
\frac{V_t}{n \left( \frac{E_0}{V_0} \right)}
\]

2. Store correction factors \( \left( \frac{E_0}{V_0} \right) \) and divide diode signals with these factors to form:

\[
V_1 = \frac{V_t}{\left( \frac{E_0}{V_0} \right)}
\]

3. Store correction factors \( \left( \frac{E_0}{V_0} \right) \), then multiply diode signals with these factors and add \( V_0 \) to form:

\[
V_2 = \frac{V_t \cdot \frac{E_0}{V_0} + V_0 = \frac{V_t \cdot E_0}{V_0}}
\]

The actual method adopted is the last of these options. Fig. 5 shows the com-
plete shading correction circuit. Diode zero timing signals occur at the start of each scan and the diode clock signals occur each time a diode video signal is ready for processing. Both pulses are approximately 500ns which is half the duration of each diode signal. The start circuit is designed to begin accumula-
tion of correction factors at the second

Fig. 5. Complete circuit of the shading correction system.
microscope lamp with the usual condenser, objective and projection eyepiece optics. At each stage in the microscope light path there is a loss of intensity due to the imperfect transmission of the optical components across the whole field of view. Maximum transmission is usually along the optical axis. A lesser component of signal non-uniformity is the differential photodiode sensitivity, which is specified as 9% by the manufacturers, though in practice only one or two diodes differ in sensitivity from their neighbours by this amount.

The magnitude of signals from large chromosomes exceeds the 5% sensitivity variation of the diodes but is much less than the observed 2.1 illumination variation. Small chromosome signals are obscured by both. In the absence of shading correction, therefore, detection of chromosomes and the measurement of their transmissivity is very nearly impossible.

**Shading correction theory**

When there is no object on the microscope slide imaged onto the diode a signal voltage $V_i$ is measured. When an object of transmissivity $T$ is imaged onto the $i$th diode a signal voltage $V_i$ is measured. It follows that

$$1 - T = \frac{V_i}{V_0}$$

where $V_0$ is a constant voltage representing the flat response of a perfect system. Comparing these two equations we see that the shading corrected voltage $V$ is given by

$$V = \frac{V_0 - V_i}{V_0}$$

Each diode voltage therefore must be multiplied by a factor $(V_0/V_i)$ where $V_0$ is an arbitrary constant voltage and $V_i$ is the uncorrected signal voltage for each diode for a clear image field. It will be seen later that $V_0$ is set to the maximum value of $V_0$ and is relabelled $V_0$. The total correction set-up time is 300 microseconds only one diode correction factor is sampled, converted and loaded into the shift register. Each diode is taken in sequence and an extra scan time is allowed at the end to give the final diode in adequate conversion time. The total correction set-up time is therefore $300 \times (256 + 1)$ microseconds, which is approximately 77 milliseconds.

**Detailed circuit**

In practice the correction factors $E_i/V_i$ will always be greater than or equal to unity, which would cause most analogue divider circuits to overflow. There are several ways of overcoming this problem such as the following:

1. Reduce $E_i$ by a fraction $T$, store correction factors $(E_i/V_i)$, then multiply the corrected diode signals with a factor $1/T$ to form:

   $$V_i = \frac{V_0}{V_i} = \frac{(E_i/V_i) \cdot V_0}{V_0}$$

2. Store correction factors $(V_i/E_i)$, then divide diode signals with these factors to form:

   $$V_i = \frac{V_i}{E_i}$$

3. Store correction factors $(E_i - V_i)/V_i$, then multiply diode signals with these factors and add $V_i$ to form:

   $$V_i = \frac{V_i}{E_i} - \frac{V_i}{V_i} = \frac{V_i}{E_i} - \frac{V_i}{V_0}$$

The actual method adopted is the last of these options. Fig. 5 shows the complete shading correction circuit. Diode zero timing signals occur at the start of each scan and the diode clock signals occur each time a diode video signal is ready for processing. Both pulses are approximately 500ns which is half the duration of each diode signal. The start circuit is designed to begin accumulation of correction factors at the second scan and the diode clock pulses occur every 1.17 microseconds. The ready pulse occurs approximately 20 microseconds after the convert pulse.
diode zero signal occurring after or during the start button is pressed, thus giving a clean start. Correction factors are then counted and stored in the shift register at the rate of one per scan. When the scan counter is full further diode zero pulses are blocked and the diode clock counter must be coincidently full twice before the correction circuit closes down and correction factors are recirculated in synchronism with the diode signals. Notice that the same amplifier is used to set up \( V_0 \) which is sampled, held and formed into \( V(E_1 - E_0) \) and to produce the final corrected and offset output of \( V_f = V_o \). The final output is zero except when real image features traverse the scanner which in this instance has certain advantages for later signal processing.

Fig. 6 shows the array scanner signal of Fig. 2 after multiplication with recirculating correction factors which were previously set up from a clear image field. The chromosome signals can now be detected and measured by comparison with a fixed threshold voltage.

Although this shading correction technique was brought about by the author's own need to squeeze the last drop of signal out of a relatively cheap form of scanner using a low light level, there must be a host of other image processing problems where it is important to obtain an accurate densitometric measurement of the scanned material. The component cost of this refinement to a standard IPI linear array camera is a fraction of the camera cost and is falling by the month, and all of the foregoing remarks apply equally well to other conventional or C.C.D. linear array scanners.

The author wishes to thank Roy Bayley and Denis Rutovitz for their helpful contributions to this article.

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**Thyristor light controller**

Designs for sound-activated light controls often use zero-voltage switching to reduce r.f.i., but this technique reduces the lamp illumination to on or off. The lighting effect can be improved by providing a level control with a pair of back-to-back thyristors as shown. If the rectified output from a bandpass filter is between the thresholds of the comparators, only one thyristor is triggered and the lamp operates at a reduced brightness. When the output is greater than the upper threshold, both thyristors are triggered and the lamp operates at full brightness.

Sync. pulses are derived from the mains input and ensure that the thyristors are triggered only at the mains zero-crossings.

P. M. Jessop

Sollibull

W. Midlands

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**Improved tone control**

Many audio amplifiers use a Bandall tone control network around a single transistor as shown. With this arrangement the gain is adequate when the controls are flat but, if bass or treble boost is required, noticeable distortion often arises. This problem can frequently be overcome by providing the original transistor with a bootstrap collector load. With an inverted emitter follower, the increase in gain is around 10dB. The base-emitter resistor should be 2k2 and the bias resistors must be adjusted to restore the original d.c. conditions.

G. Hibbert

Blackfriars

Oxford

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**Continuous a-to-d converter**

After several months experience with the a-to-d converter published in March 1979, we have found that timing is less critical if only one output of the MC1407 is used and clocked through two multivibrators in series rather than both outputs each clocked through one multivibrator. The circuit shows a modification from the output of the MC1407 to the counter inputs. Data appearing at the output of the counter is only correct near a specific phase of the clock. For recording the data under certain conditions, such as maximum amplitude, or at specified times, always AND the clock through a variable delay with the sampling pulse, so that correct data is recorded.

J. E. Dahl and J. D. Whitehead

University of Queensland

Australia

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**Circuit Ideas**

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**Remote switch for parallel-tracking pickup arm**

J. Cut two lengths of nickel wire and turn one end of each to a 60° point. Flatten other end in a vice and file square to 1.2in. and 1.3in. Drill a hole to suit gague of wire (e.g. 22 s.w.g.) in flattened portion. Insert short pieces of nickel wire as indicated. Hold both electrodes together by side in a small vice or pliers. Twist into final shape. Glue temporarily with "superglue". Test for electrical isolation.

\[ \text{Continued from page 63} \]

K. Assemble pivot cups in switch case and rear part of lid. Try out electrode assembly for size and freedom of movement. If necessary dismantle electrode assembly and pivot cups and file until acceptable. Introduce mercury ball into trial basis and check that correct action takes place. The electrode assembly can then be permanently fixed with Araldite instead of "superglue". Now remove pivot cups and solder 12in. length of Litz wire to them. Also solder 12in. of Litz wire to three-channel electrodes taking care not to disturb their position. Re-assemble switch, with some rapid-setting Araldite on the lid. This gives you about 3min to manoeuvre the lid. Give a final mechanical and electrical check before gluing on the front part of the lid, using Araldite.

Inject the mercury ball via filler hole with 1ml syringe. Flush with propane gas and plug filler hole with BBA steel screw.

Switch is now ready for testing. If too sensitive, shake mercury out until there is a larger clearance between electrode tips and ball. Excess mercury can be injected to reverse this process.

Finally, fix the completed switch to the lower arm with liberal amount of Araldite.

L. Shape rear pole for magnet by trial and error to give no lateral force on tracking arm over 1° each side of the central position. Radius shown is nominal.

Material: mu-metal transformer laminations.

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**Fig. 6.** The corrected diode array signal for the scan line shown in Fig. 1.
Fig. 6. The corrected diode array signal for the scan line shown in Fig. 1.

diode zero signal occurring after or during the start button is pressed, giving a clean start. Correction factors are then counted and stored in the shift register at the rate of one per scan. When the scan counter is full further diode zero pulses are blocked and the diode clock counter must be coincidentally full twice before the correction circuit closes down and correction factors are then counted.

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Although this shading correction technique was brought about by the author's own need to squeeze the last drop of signal out of a relatively cheap form of scanner using a low light level, there must be a host of other image processing problems where it is important to obtain an accurate densitometric measurement of the scanned material. The component cost of this refinement to a standard IPl linear array camera is a fraction of the camera cost and is falling by the month, and all of the foregoing remarks apply equally well to other conventional or c.c.d. linear array scanners.

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W. Midlands

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J. E. Dale and
J. D. Whiteway
University of Queensland
Australia
Battery charger protection

The rectifiers in an unprotected battery charger can be destroyed by shorting the connecting clips or incorrectly connecting them to the battery. Although a fuse is effective in this way to be replaced to restore protection, this circuit prevents current flow unless a correct voltage is present at the terminals. The s.c.r. is fired by the collector current from the transistor as each half cycle of the rectified voltage rises above the battery voltage. If no voltage is present, due to an open or short circuit, or a low voltage because a 6V battery has been connected, or a wrong polarity, the transistor is not switched on and the s.c.r. does not conduct. Reasonable overvoltages will not cause damage because the base current is well below the maximum rating, and the s.c.r. will become reverse biased. The circuit can be added to an existing charger but the transformer needs an extra 4V to compensate for the voltage drop across the s.c.r. By switching to a lower value of R, together with a lower transformer voltage, the circuit can be used with dual-voltage chargers.

R. H. Bennett
Christchurch
New Zealand

Voltage follower with adjustable zero-offset

In the circuit, R, is bootstrapped by the complementary J.F.E.T. source-followers, so that signal amplitude and waveform are preserved along the track. Therefore, any d.c. level can be selected between the gate-source voltages. Voltage gain is virtually unity and the distortion is negligible. Large-signal bandwidth is several megahertz, which makes the circuit superior to conventional op-amp voltage-followers. Output impedance is high, but this can be reduced by adding a bipolar emitter-follower.

R. D. Smith
Gallowgate
Aberdeen

Divide by three

A circuit idea in June 1978 uses only three l.c.s to provide a divide-by-three circuit. This number can be reduced still further with the circuit shown. A divide-by-six output with an equal mark-to-space ratio is also available at (a) and, by connecting this output to the first flip-flop in the 7492, a divide-by-twelve output at (c) is obtained.

M. Rocha
University of Porto
Portugal

Data channel error recorder

Measurement of bit and block error rates on data communication systems, such as those employed by the Post Office and private service users, is the central function of the DF-64 metering system made by Wandel and Goltermann. The set features a real-time printer which permanently records error rates in a 20 column tabulated print-out, which includes symbols for "no signal" and "out of sync," as well as the identification number for the signal-pulse pattern and error evaluation. Where an optional plug-in timer is used, the date and time in hours and minutes may be recorded and the timer allows print-out intervals to be preset for automatic operation. The equipment also incorporates a winder and receiver section, the seed side being crystal-controlled. After the receive section has synchronized to the correct frequency, the data-channel pulse pattern under test is compared bit-by-bit with the reference sequence to enable bit and block error rates to be derived. Fault tracing on sub-assemblies of data communication equipment is also possible with the DF-64, making use of additional digital and timing signal inputs and comparators located on the back panel; a further connector on the back panel provides positive and negative supplies of 12V d.c. and a 5V d.c. supply. Wandel and Goltermann (UK) Ltd, 40-48 High St, London W3.

D. Bennett
Beaconsfield
Bucks

relay with push-button actuator

Push-button actuation, permitting manual operation of the relay without the need for an energising voltage to be applied, is a new development which Pye Electro-Devices Ltd, quotes as its new range of Series 12 relays. These are general purpose two and three-pole changeover relays, for both a.c. and d.c. operation; they have octal base connections and contact ratings of 16A maximum. Options include tachometric and neon indicators for coil energisation. Mounting sockets complete with retaining clip are also available. Pye Electro-Devices Ltd, Ealing Road, Newmarket, Suffolk.

R. H. Bennett
Christchurch
New Zealand

Programmable v.h.f. receivers

The Bearcat range of programmable receivers, made in the USA by Electro, are now available in the UK from Com-Tek. The receivers are programmable synthesizers with h.f. units permitting monitoring of frequencies in the ranges 66-83MHz, 119-130MHz, 146-148MHz, 148-174MHz, 420-470MHz and 470-812MHz. Bearcat model 220F permits up to 20 channels in any combination of the stated frequency ranges to be keyed in and monitored continuously. Power supplies required are either 24V a.c. or 12V d.c. and prices start at £325. Com-Tek (Mid) Ltd, 906, Alum Rock Road, Birmingham B8 3HD.

T. D. Smith
Gallowgate
Aberdeen

Tool kit

Out of the largest manufacturers of tools for use in electronics applications in the USA, Vaco, are now offering a comprehen-

www.americanradiohistory.com
Battery charger protection
The rectifiers in an unprotected battery charger can be destroyed by shorting the connecting clips or incorrectly connecting them to the battery. Although a fuse is effective, it has to be replaced to restore protection. This circuit prevents current flow unless a correct voltage is present at the terminals. The s.c.r. is fired by the collector current from the transistor as each half cycle of the rectified voltage rises above the battery voltage. If no voltage is present, due to an open or short circuit, or a low voltage because a 6V battery has been connected, or a wrong polarity, the transistor is not switched on and the s.c.r. does not conduct. Reasonable overvoltages will not cause damage because the base current is well below the maximum rating, and the s.c.r. will become reverse biased. The circuit can be added to an existing charger but the transformer needs an extra 4V to compensate for the voltage drop across the s.c.r. By switching to a lower value of R, together with a lower transformer voltage, the circuit can be used with dual-voltage chargers.

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Christchurch
New Zealand

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V.h.f. automatic d.f. set
A portable receiver, indicator unit and antenna array constitute the ADFS-322 V.h.f. automatic direction finder, intended for the location of narrow-band f.m. or a.m. signals in the 148 to 174MHz range. The unit is manufactured by the American O.A.R. Company and is distributed in the UK by Technology Ltd; the receiver/ indicator unit consists of a c.r.t., signal strength meter, internal loudspeaker and 10 plug-in crystal points. A standard Adcock antenna array is fitted for shipboard or fixed-location installations and comprises four vertical dipole elements, a central whip section for sense reference and signal pre-processing circuits, all contained in one integrated assembly. A signal is instantaneously displayed as a relative compass bearing on the circular c.r.t. where it is shown as a thin line trace running from the centre of the instrumented compass head at the outer edge. The makers say that information displayed in this way is easily interpreted, even by inexperienced operators. The circuit technique employed eliminates the need for a manual "sense" function to resolve 180° ambiguity and results in automatic readout of bearings.
Teclimation Ltd, 58 Edgware Way, Edgware, Middlesex.

Composite v.h.f. receivers
The Bearcat range of composite v.h.f. receivers, made in the USA by Electro, are now available in the UK from Com-Tek. The receivers are programmable synthe- nizers, with units permitting monitoring of frequencies in the ranges 66-83MHz, 119-130MHz, 146-148MHz, 148-174MHz, 420-470MHz and 478-512MHz. Bearcat model 228F permits up to 29 channels in any combination of the stated frequency ranges to be keyed in and monitored continuously. Power supplies required are either 24V a.c. or 12V d.c. and prices start at £280 Com-Tek (Mid) Ltd, 506, Alum Rock Road, Birmingham B8 3DX.

Tool kit
Out of the largest manufacturers of tools for use in electronics applications in the USA, Vacut are now offering a comprehen-
The 920B “super case” contains an assortment of tools, 48 in all, including screwdrivers, nutdrivers, pliers, etc., and special tools on two fitted pallets. Storage space is provided in the bottom of the moulded case for meters, power tools and larger items of equipment. The case can be locked and the overall weight, including a full tool complement, is 20 pounds. The tool kit costs £200 plus v.a.t. Toolrange Ltd., 178 perplexes, W306.

**WIRELESS WORLD. APRIL 1980**

A **DC-18GHz Components**

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Since 1967, Merrimac has developed sixty seven different items designed for more than twenty five space and missile applications.

Many other Merrimac signal processing products are specified by all kinds of military aircraft - high reliability has been a common denominator.

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**Write or ring today for details of the dynamic range!**

**WIRELESS WORLD. APRIL 1980**

**Conductive rubber pads**

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<th>8 digit counter/</th>
<th>timer</th>
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</thead>
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| Frequencies from 0 to 10 MHz and periods from 0.5ms to 1hr can be measured and displayed by a new Lascar Electronics 8 digit counter/timer module. Further capabilities of the unit include measurement of frequency ratio between two inputs, time intervals in increments of 6.25ms and operation as a conventional 8 digit totalizer. There are four switched ranges and the display consists of 4n characters made up from red LEDs. The counter operates from a supply of +5V d.c. and controls include store, hold, and reset, while various outputs enable all functions to be monitored externally. A 10MHz quartz crystal controls the timebase, with a temperature stability error of ±0.1 p.p.m. Lascar Electronics Ltd., Unit 1, Thomas Rd, Burnt Mills, Basildon, Essex SS13 4JA. WW308

**Display tube analyser/restorer**

The model 487 c.r.t. analyser / restorer manufactured by the American company B and K/Dynascan Corporation, is intended for the field testing of computer terminal c.r.t.s and for general tests on all types of colour and monochrome display tubes. A “restore” facility is also included which permits the reactivation of tubes which have deteriorated in efficiency due to cathode “poisoning”, and

The same tactile feedback is provided by these silicon conductive rubber pads and they can be cut to requirements using a pair of scissors. O. English Electronics Ltd., 27 Warrigde Rd, Woolwich, London SE18 5NL. WW307

**Miniature photoswitch**

The E3 photoswitch is claimed by the makers, IMO Precision Controls, to be the world’s smallest. The unit has a sensing range of 3m (max) and can switch 4mA when operating from a 3V d.c. supply. Main applications include control of lights and detectors in c.r.t. analyser / restorers. IMO Precision Controls Ltd., 340, Edgeware Road, London W2 1BR. WW310

**Digital readout for antenna rotator**

Claimed by the makers, Monitor, of Canada, as “accurate to one degree”, the DX-3 digital readout module, which is supplied in kit form, can be used to provide visual information on the orientation of a rotatable antenna. The makers also state that the unit may be used as a workbench digital voltmeter and the price is $19 (money order) from Monitor, Box 20, Agincourt, Ontario, Canada M1R 1M4. WW313

Pascali Electronics Limited Havlock House, Green Street, Sandbach, Cheshire CW11 6ER Telephone: (0922) 871418 Telex: 814536

**Shrink-on tubing and terminals**

This range of non-conductive materials manufactured in p.v.c. or polyolefin for use as shrinkable tubing or as shrink-on terminals and covers is available from Suhner Electronics Ltd., Hammersmith, London W6 WRF. WW309

**Flat l.e.d.s**

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8 digit counter/ timer

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Semi-conductive rubber pads are already used extensively on the continent of Europe in keyboard applications, according to G. English Electronics Ltd, and this company is now producing a fully conducting form which is suitable for use in cathode Poisoning and due to cathode "poisoning", and

**Display tube analyser / restorer**

The model 497 c.r.t. analyser manufactured by the American company B & W/Dynascan Corporation, is intended for the field testing of computer terminal c.r.t.s and for general tests on all kinds of colour and monochrome display tubes. A "restore" facility is also included which permits the restoration of tubes which have deteriorated in efficiency due to cathode "poisoning", and

"accurate" and "reliable" readings may be obtained. The instrument is small and portable. The unit has been tested in the UK on various types of computer terminals and has been found to be reliable. The unit has a sensing range of 3m (max.) and can switch 80mA. The counter/timer module, which is supplied in standard form C (single pole/double throw) items of equipment. The case can be locked and the overall weight, including a full tool complement, is 84 lbs 426 lbs 26 lbs 426 lbs. The tool kit costs £360 plus vat. Tt Connexon Ltd, Upton Road, Reading RG2 3AJ.

**Miniature photoswitch**

The E3 photoswitch is claimed by the makers, Hamlin Electronics Ltd, to be the world's smallest. The unit has a sensing range of 3m (max.) and can switch 8mA when operating from a 3V d.c. supply. Main applications include video amplifiers, digital readout for antenna rotator

Clipped by the makers, Monitor, of Canada, as "accurate to one degree", the DX-3 digital readout unit, which is supplied in kit form, can be used to provide visual information on the orientation of a rotatable antenna. The makers also say that the unit may be used as a workbench digital volume meter and the price is £19 (money order) from Monitor, Box 50, Agincourt, Ontario, Canada M1B 5H4.

**Shrink-on tubing and terminals**

The wire is manufactured in p.v.c. or polyolefin for use as shrink-on tubing or as shrink-on terminals and covers is available from Sukner Electronics. Each item, when warmed, will shrink to one third of its original size, creating a snug, oil resistant seal suitable for continuous temperatures up to 120°C. Tubing is available in a range of sizes from 2 to 8 mm, shrinking to bore diameters of between 3 and 33mm with wall thicknesses of 1 to 4mm. Molded cable terminals and connectors are offered in five sizes of seal cap, from 13 to 90mm, three sizes of three-way junction from 38 to 90mm and four sizes of four-way junction from 22 to 90mm. All products are available with or without internal adhesive. Measurements stated are for pre-shrinking bore diameters. A minimum order of 200 units is required by the makers, Sukner Electronics Ltd, Telford Road, Bisect, Oxon.

**Flat i.e.d.s**

Designed as an answer to the problems of high density component packing, the ED-10 range of flat-bodied i.e.d.s, manufactured by Ratra Electronics, measure 0.1in on 0.2in centre to centre. They are available in the standard colours of red, green, orange and yellow. Ratra Electronics Ltd, 279-281 King St., Hammershmit, London W6 9KF.

**Digital readout for antenna rotator**

Clipped by the makers, Monitor, of Canada, as "accurate to one degree", the DX-3 digital readout module, which is supplied in kit form, can be used to provide visual information on the orientation of a rotatable antenna. The makers also say that the unit may be used as a workbench digital volume meter and the price is £19 (money order) from Monitor, Box 50, Agincourt, Ontario, Canada M1B 5H4.
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<table>
<thead>
<tr>
<th>Value</th>
<th>15VA</th>
<th>30VA</th>
<th>60VA</th>
<th>120VA</th>
<th>180VA</th>
<th>300VA</th>
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</thead>
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<tr>
<td>Power</td>
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<td>2x6W</td>
<td>2x6W</td>
<td>2x12W</td>
<td>2x18W</td>
<td>2x30W</td>
</tr>
<tr>
<td>Wires</td>
<td>1.25A</td>
<td>2.5A</td>
<td>5A</td>
<td>5A</td>
<td>10A</td>
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<tr>
<td>Voltage</td>
<td>120V</td>
<td>120V</td>
<td>120V</td>
<td>240V</td>
<td>240V</td>
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</tbody>
</table>

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<th>60VA</th>
<th>120VA</th>
<th>180VA</th>
<th>300VA</th>
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<tbody>
<tr>
<td>2x6V 1.25A</td>
<td>2x9V 2.5A</td>
<td>2x6V 5A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2x15V 0.82A</td>
<td>2x15V 1.25A</td>
<td>2x15V 2.5A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2x15V 0.5A</td>
<td>2x15V 1A, 12V</td>
<td>2x15V 4A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2x20V 0.3A</td>
<td>2x20V 0.75A, 15V</td>
<td>2x20V 1.5A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2x20V 3A, 2x20V 4.5A, 2x20V 7.5A</td>
<td></td>
<td></td>
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</table>

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"EEPROM-4 unit allows 512 characters, etc. £19.75
"EEPROM-4 unit allows 1024 characters, etc. £19.75
"EEPROM-4 unit allows 2048 characters, etc. £19.75
"EEPROM-4 unit allows 4096 characters, etc. £19.75
"EEPROM-4 unit allows 8192 characters, etc. £19.75

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THE POWER AMPLIFIERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Output Power R.M.S.</th>
<th>Distortion Typical at 1KHz</th>
<th>Minimum Signal / Noise Ratio</th>
<th>Power Supply Voltage</th>
<th>Size in mm</th>
<th>Weight in grs</th>
<th>Price + VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY30</td>
<td>15 W into 8Ω</td>
<td>0.02%</td>
<td>80dB</td>
<td>90V</td>
<td>105x50x26</td>
<td>195</td>
<td>£6.34 + 65p</td>
</tr>
<tr>
<td>HY50</td>
<td>30 W into 8Ω</td>
<td>0.02%</td>
<td>90dB</td>
<td>105x50x25</td>
<td>156</td>
<td>£7.24 + £1.09</td>
<td></td>
</tr>
<tr>
<td>HY120</td>
<td>60 W into 8Ω</td>
<td>0.01%</td>
<td>100dB</td>
<td>114x50x85</td>
<td>575</td>
<td>£15.30 + £2.30</td>
<td></td>
</tr>
<tr>
<td>HY200</td>
<td>120 W into 8Ω</td>
<td>0.01%</td>
<td>100dB</td>
<td>114x50x85</td>
<td>575</td>
<td>£18.44 + £2.77</td>
<td></td>
</tr>
<tr>
<td>HY400</td>
<td>240 W into 8Ω</td>
<td>0.01%</td>
<td>100dB</td>
<td>114x100x85</td>
<td>1.15Kg</td>
<td>£37.88 + £4.15</td>
<td></td>
</tr>
</tbody>
</table>

The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm, and provides multi-function equalization for MagnetIc/CeramiC/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control (500 mV out) Distortion at 1KHz<0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5s connect easily in stereo. With easy to follow instructions.

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THE POWER SUPPLY UNITS

<table>
<thead>
<tr>
<th>Model</th>
<th>Output</th>
<th>Distortion</th>
<th>Minimum Signal / Noise Ratio</th>
<th>Power Supply Voltage</th>
<th>Size in mm</th>
<th>Weight in grs</th>
<th>Price + VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSU 30</td>
<td>15 V at 100mA to drive up to five HY5 pre-amps</td>
<td>500 µV</td>
<td>50 µV</td>
<td>90V</td>
<td>105x50x26</td>
<td>195</td>
<td>£6.90 + 0.65VAT</td>
</tr>
<tr>
<td>PSU 36</td>
<td>15 V at 100mA for 1 or 2 HY3's</td>
<td>500 µV</td>
<td>50 µV</td>
<td>105x50x25</td>
<td>156</td>
<td>£7.80 + £1.10VAT</td>
<td></td>
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<tr>
<td>PSU 50</td>
<td>15 V at 100mA for 1 or 2 HY5's</td>
<td>500 µV</td>
<td>50 µV</td>
<td>114x50x85</td>
<td>575</td>
<td>£16.10 + £2.30VAT</td>
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<tr>
<td>PSU 70</td>
<td>250 mA for HY120</td>
<td>500 µV</td>
<td>50 µV</td>
<td>114x50x85</td>
<td>575</td>
<td>£18.44 + £2.77VAT</td>
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<tr>
<td>PSU 90</td>
<td>500 mA for HY200</td>
<td>500 µV</td>
<td>50 µV</td>
<td>114x100x85</td>
<td>1.15Kg</td>
<td>£37.88 + £4.15VAT</td>
<td></td>
</tr>
<tr>
<td>PSU 180</td>
<td>500 mA for HY400 or 2 x HY200</td>
<td>500 µV</td>
<td>50 µV</td>
<td>114x100x85</td>
<td>1.15Kg</td>
<td>£32.03 + £3.45VAT</td>
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<thead>
<tr>
<th>Please supply</th>
<th>Total purchase price £</th>
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<tr>
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<tr>
<td>Please debit Cheque</td>
<td>Postal Orders</td>
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<tr>
<td>Any Field</td>
<td>NAME</td>
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<td></td>
<td>ADDRESS</td>
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<tr>
<td></td>
<td>Signature</td>
</tr>
</tbody>
</table>

www.americanradiohistory.com
While the text is difficult to read, it appears to be a mix of advertising and technical content, possibly related to electronics or computer programming. The text is not clearly organized into paragraphs, making it challenging to extract coherent information. It seems to include product listings, prices, and descriptions, along with some technical terms and numbers that might be related to components or specifications.
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The NEW Marshall's 79/80 catalogue is just full of components

and that's not all...

...our new catalogue is bigger and better than ever. Within its 60 pages are details and prices of the complete range of components and accessories available from Marshall's. These include Audio Amps, Connectors, Boxes, Cases, Bridge Rectifiers, Capacitors, Chokes, Dipoles, Displays, Heatsinks, I.Cs, Knobs, LEDs, Multimeters, Plugs, Sockets, Posts, Publications, Relays, Resistors, Soldering Equipment, Thyristors, Transformers, Voltage Regulators, etc., etc.

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- Completely Portable with Rechargeable Batteries

WIRLESS WORLD, APRIL 1980
**Transistors**

- **Mullard and USA valves**

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**Valves**

- **ECC83**

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Eddystone Radio Limited cordially invites you to view communications and noise measuring equipment on display covering the spectrum 10kHz to 1000MHz.

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NEW LOW PRICES

**S-100 bus (Ittaca Intersystems)**

<table>
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<th>BOARDS</th>
<th>Assembled</th>
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<td>IA1100 Front Panel</td>
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<td>IA1100 Z-80 CPU 4MHz</td>
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<td>IA1090 Video 50Hz/60Hz</td>
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<td>IA1090 2706/2716 EPROM</td>
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<td>IA1170 Single Board Computer</td>
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<td>IA1350 64K Dynamic RAM 5530S</td>
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**All boards come with manuals.**

**DPS-1 Front Panel S-100 mainframe from £695.00**

**Components TUART I/O board**

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<td>Motherboards (George Morrow)</td>
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<td>8 slot active terminations</td>
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<tr>
<td>16 slot active terminations</td>
<td>£45.00</td>
</tr>
<tr>
<td>Miscellaneous floppy disc controller board</td>
<td>£280.00</td>
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</tbody>
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**SOFTWARE**

**EFA** [Technical - CFM Version] £165.00

**DISC CONTROLLER AND 6809 BOARDS NOW AVAILABLE FOR 77-68. SEND FOR DETAILS OF THIS LOW COST RANGE OF KITS**

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**Mother Board**

- 8 bits double sided, plated through hole P.C.B.
- 3.5" x 2.0" set of all components including all ICs, capacitors, fusing parts and ribbon cable with quality control on source material where necessary. £59.60

**8K Static RAM board**

- 8 bits double sided, plated through hole P.C.B.
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**2K ROM board**

- 2 bits double sided, plated through hole P.C.B.
- 3.5" x 2.0" set of all components including all ICs, capacitors, fusing parts and ribbon cable with quality control on source material where necessary. £51.20

**64K RAM board**

- 8 bits double sided, plated through hole P.C.B.
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**59.60**

**PCB size 14.0" x 12.5"**

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- 8K RAM, 2K ROM in 6809, 2K ROM (link select)

- 4K RAM in 8080, 2K ROM (link select)

- 2K RAM in 6502, 1K ROM

- System expandable up to 32K memory.

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- 6809 microprocessor used in this computer with 6502 single board computer.

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**_ACCEPTANCE**

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NEW LOW PRICES

**NEW LOW PRICES**

**S-100 bus (Hitac Intesystems)**

<table>
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<th>SOFTWARE</th>
<th>DISC CONTROLLER AND 6809 BOARDS</th>
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**BOARDS**

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![Image of moving coil preamplifier]

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Heavy Duty Connections

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Spectacular lighting systems. Meetings. Hi-Fi and Video Systems, Recording and Backing Tape Equipment.

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Spectacular lighting systems. Meetings. Hi-Fi and Video Systems, Recording and Backing Tape Equipment.
Remote control is seeing red. Infra red with Ferranti BPW 41.

BPW 41 is the new infra red detection response photodiode, from Ferranti. The important news is that we've built in a narrow band infra red transmissive filter that eliminates the need for separate filters and gives a very selective spectral response. Take a look at the curve, you'll see it peaking at 925 nm.

BPW 41 offers a narrow spectral band width combined with broad directional response, low junction capacitance for fast response, voltage variable response times at 7.5 mm² active area for increased sensitivity and virtual immunity to extraneous visible radiation.

With the kind of improved performance BPW 41 gives you, you could do more with your remote control system. Whatever you're into - cordless telephones, TV channel selectors, toys, remote keyboards for VDU's, security or alarm systems - BPW 41 could solve a lot of your problems.

Pick up the phone (cordsless or not) and ring 061-624 0515 or write to Opto-electronic Marketing, Ferranti Electronics Limited, Fiddes New Road, Chadderton, Oldham OL9 8NP.

FERRANTI Semiconductors
CHROME DIODEX CASSETTES

Limited quantity only. Excellent quality little known and notify. Satisfaction guaranteed.

CBs only. Price per sq. (minimum quantity) £8 inc. VAT & F & P any quantity.

FERRIC OXIDE CASSETTES

Excellent quality Italian, C10,0 only. Price per piece. Low prices. CBs only inc. VAT & P & P any quantity.

This offer only applies while stocks last.

Price of above unit: £14.95 VAT inc.

Plus £1.00 P & P.

Trade and Export Enquiries invited.

Here it is! The brand new 8022A hand-held DMM

OFF THE SHELF DELIVERY ON THESE

Brand new from Fluke Corporation

The most compact 100,000 ohm DMM in the world

Price: £112 Cassettes included VAT inc.

£17.5 Carry and insurance £3

Low cost, autoranging multi-function counter

MODEL 1960A

Low cost, autoranging counter with optional memory.

£175 Carriage and insurance £3

With the kind of improved performance BPW41 gives you, you could do more with your remote control system. Whatever you're into—cordless telephones, TV channel selectors, toys, remote keyboards for VDU's, security or alarm systems—BPW41 could solve a lot of your problems. Pick up the phone (cordless or not) and ring 061-624 0515 or write to Opto-electronic Marketing, Ferranti Electronics Limited, Fieldes New Road, Chadderton, Oldham OL9 8NP.

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FERRANTI SEMICONDUCTORS
OLIVETTI PRINTER & KEYBOARD model Tp 300
with PUNCH & READER. Upper case ASCII with V24 Interface. 240Hz operation.
£125 each

INFRA RED IMAGE CONVERTER model 9066 (CV 144)
1/4" diameter. Requires simple low current 3KV to 6KV supply. Ideal for Infra Red Wide data.
£12.50 each P&P 75p

Infra Red Lamps also advertised

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Infra Red Lamps also advertised

MINIATURE KEYBOARD
Push connectors, 20 pin data type. 100 each P&P 45p.

BLUE THERMAL PAPER
250mm x 330mm. £2 per roll. P&P £1.75.

STEEPING MOTORS
North American Philips. 5 pin 4 Amp. 4 pole. £120 each

POLARAD SPECTRUM
H.P. 25-1000 MHz. £15 each.

TELEQUALIZER SERVICE SCOPE MINOR
£35 each.

TRANSITOR INVERTER
110V AC. 1 Amp input. Requires a 3000V 50Hz output. £250 each

KEYBOARD PAD
£10 per 100 (ex-stock). Made of tough rubber, with extreme thickness. £1.50 each.

US NOT LOSS 75S
Many offer. Inspection by appointment.

400KW GENERATOR
3 phase 440V 50Hz. Crated, worth £2,500.

LONG LEAD UP TO 2500MHZ
good quality. 1.25 for £1. P&P £1.50 each.

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Many offer. Inspection by appointment.
Interface Components Limited
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TELEPHONE BOX 2297 2297, TELEX 102798
Write, telephone or call. Access or Barclayscard accepted

WW—901 FOR FURTHER DETAILS

You will not be too late

For most of the bargains listed in the newsletter reprinted below, even though it is the JAN./FEB. issue, because the part of the newsletter with the items in short supply is not reprinted. However, you will receive the whole of our MARCH/APRIL newsletter if you send us an order this month and as an extra inducement we will send you our MAY/JUNE newsletter direct. It is printed, which is usually about two months before it can appear in this magazine.

The writer did not have a copy of the AMERICAN RADIO HISTORICAL NEWSLETTER when he began this column, but the writer received a reply by return, from the Society, confirming that they were still publishing the newsletter. The writer's comments on some of the items in the newsletter are based on his own experience and knowledge of the products.

The writer has been asked to comment on the AMERICAN RADIO HISTORICAL NEWSLETTER, which is published in the USA, and is available at a subscription rate of $10 per year, for the first year only. The writer's comments are based on his own experience and knowledge of the products.

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J. L. Linsley Hood
High Quality
Cassette Recorders

LINSLEY HOOD CASSETTE RECORDER 1

LINSLEY HOOD CASSETTE RECORDER 2

We are the Designer Approved suppliers of kits for this excellent design. The Author's guarantees the engineering design of the kit. Advanced features include: High quality VFL improves appearance and removes the need for the cassette transport to be set back behind a narrow finger trapping slot. Easy to new included FREE as part of the complete kit at metalwork make this a most satisfying kit to build. Also included at no extra cost is our PCB .

SUPER BARGAIN OFFER
LENCO FPR CASSETTE DECK

For those who missed our recent bargains CTs we are now offering to be built as a DIY EPLP Kit for £4.80 plus VAT, plus VAT, plus VAT. Our usual professional standard. The kit contains complete manuals plugging into a player supply means it all can be fitted as your master tape has been maintained with the existing metal work to a customer of the design. Hand built by our usual professional standard. The kit contains complete manuals plugging into a player supply means it all can be fitted as your master tape has been maintained with the existing metal work to a customer of the design. It has been designed and engineered but even our detailed instructions will give our more modest clients the confidence to keep a kit that if we was available EPLP Kit for £4.80 plus VAT.

STUART TAPE CIRCUITS

These circuits are just the thing for converting that old valve tape deck into a useful transistorised recorder. Total system is a full three head recorder with separate record and replay sections for simultaneous off tape monitoring. We also stock the heads. This kit is our latest designs. We would not therefore recommend it to beginners. Reprints of the recent designs. We would not therefore recommend it to beginners. Reprints of the recent designs. We would not therefore recommend it to beginners. Reprints of the recent designs. We would not therefore recommend it to beginners. Reprints of the recent designs. We would not therefore recommend it to beginners. Reprints of the recent designs. We would not therefore recommend it to beginners. Reprints of the recent designs. We would not therefore recommend it to beginners.
LINSLEY HOOD CASSETTE RECORDER 2

Our new improved performance model of the Linsley Hood Cassette Recorder incorporates our VFL 910 vertical form mechanisms and circuit modifications (recently enhanced performance). Brand NEW! Flutter less than 0.1%. Product No. FFR 230.

LINSLEY HOOD CASSETTE RECORDER 1

The Linsley Hood 4-Track Cassette Recorder features the following extra features. Ultraslim low and of the art 0.75m wide. Can be built in any format. Full 60 gram mini head. Tape transport with micro switching. All standard cassette form factors. Linsley Hood compact for maximum portability, but with added features. Complete with 30-40% more parts,平原 output. Mechanical output fully protected. Record interlock prevents recording of unwanted material. True low noise level ensures high quality recording. The Linsley Hood circuits and the quality of the components used make this new 4-Track model competitive with units of much higher cost than the modest £28.00 VAT all for the compact kit.

SUPER BARGAIN OFFER LENDO FFP CASSETTE DECK

For those who missed our recent bargain, we now offer them, while they last, at only £9.99 plus VAT. For those who would normally cost about £25 but we are now able to offer them, while they last, at only £9.99 plus VAT.

BAILEY 30 WATT AMPLIFIER

We have now completed our redesign of the popular amplifier to make it as easy to assemble and test. Complete with motor speed and thermal stability. All these desirable and useful features added to the excellent performance model of the Linsley Hood amplifiers are complete modules plugging into a chassis module with additions made at the side. The chassis module has been manufactured with our usual professional standard and will be delivered complete. Full test. Send for full details of kit.

LINSLEY HOOD 20-WATT AMPLIFIER

Advanced new cost-effective amplifier of impeccable specification from the "master" of recorders. Published in the January and February issues of Hi-Fi News. We are supplying full kits to our usual professional clients. Microswitch input facility if required. Offer Brand New Lenco FFR Decks.

STUART TAPE CIRCUITS

These circuits are put the thing for converting that old tape deck into a useful serviceable unit. We have found that this kit has been built and tested with our usual professional standard and the result has been very good. We will not give the detailed instructions that we give our more usual clients. But we will do our best to help you. All parts of the original three decks. £59.99 plus VAT.

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PDP 11/04 9-slot 5¼ Processor with 16kW MOS and DOLLY Interface. BRAND NEW SUPPLUS £3600.00

PDP 11/10 5¼ Processor with B&W Core and Asynchronous Interface £1850.00

PDP6E Series Modules — large banks of options module with option cores. CPU boards, etc. all at reduced prices.

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• Microprocessor-controlled terminal. IBM Character set. The Texas Instruments Terminal.

NEW ASCII KEYBOARDS — NEW LOW PRICES

Mail Order Total.

KBBT 56-station ASCII Keyboard mounted on 120-200 line keyboard. £35.00

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KBBT 701 Plastic enclosure for KBBT 700 or 965MF. £12.50

KBBT 702 Steel enclosure for KBBT 756 or KBBT 765MF. £25.00

KBBT 2360 Spare ROM Encoder. £12.50

KBSF 156 Pin edge connector for KBBT 656MF. £25.00

DC 512 DC board. £5.00

KBBT 71 11-station ASCII Keyboard including numeric/teletype centre control, mounted in steel enclosure. £55.00

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PERK S国产 ASCII Keyboard for PET. Complete with PET interface, built-in power supply and steel enclosure. £45.00

Discounts available for quantities

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MODULAR ONE SERIES VDUs

For further details and large new stocks of the fabulous Linsley Hood circuits. The quality of the components used makes this LINSLEY HOOD AMPLIFIER

MM11P 16kW Parity Core — BRAND NEW SUPPLUS £995.00

PR11 High Speed Paper Tape Reader complete with UniBorg Controller. £1850.00

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**CENTRONICS P1 PRINTER**

- Free set up and testing on delivery.

**FERRANTI COMPUTER KEYBOARDS**

- **£25** inc VAT
- 10 Ink Line Printer.
- **Our Price** £195.00
- **Free** VAT
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**CENTRONICS P1 PRINTER**

- Free set up and testing on delivery.
### BSR DE LUXE AUTOCHANGER
- Price: £17.10
- 1016 Series
- Includes 374 Inc.
- Has all the features of BSR models
- Good sound quality

### HEAVY METAL PLINTHS
- £4.50
- £6.00
- Suitable for most BSR or Garrard decks
- Offers a solid and sturdy base

### BSR SINGLE PLAYER
- £192.3
- Has a 4-speed variable speed control
- Suitable for all types of records

### TWO SPEED BUDGET MODEL £16
- Suitable for 33⅓ and 45 rpm records

### GARRARD MINI CHANGER CC10A
- £85
- 2-speed manual changer
- Easy to use and maintain

### ELAC HI-SPEAKER 8cm. TWIN CONE
- £5.95
- Uses ELAC's new 8cm. Twin Cone driver
- Ideal for small spaces

### LOW VOLTAGE POWER Pack for MODELS Ready-made. Various models. Will supply 400W. Write for details.
- £7.95
- Suitable for use with BSR and Garrard decks

### POTENTIOMETERS
- 80 Ohm Coax
- £5.95
- Potentiometers are essential for volume control

### OPUS COMPACT SPEAKERS
- £9.95
- Excellent value for money
- Suitable for use with any Hi-Fi system

### LOW VOLTAGE ELECTRICALS
- £8.95
- Suitable for use with low-voltage electrical systems

### GOODMAN'S RUBBER UPHOLSTERY BASE COVER
- £9.95
- Provides a secure fit for your furniture

### VAT RATE
- 15% on total order value

### SPECIAL OFFER
- 10% off all orders

### TECHNOMATIC LTD.
- 17 Burnley Road, London NW10
- Offers a wide range of components and accessories

---

### HIGH QUALITY

#### JVC DECK
- £35
- High-quality audio equipment

#### RCV SOUND TO LIGHT KIT Mk. 2
- £18
- Converts audio signals into light signals

#### "MINOR" 10 watt AMPLIFIER KIT
- £25
- Ideal for small systems

#### RCV STEREO PRE-AMPS
- £25
- Excellent for high-quality audio

---

### TEAC VENIERED TEAK VENEERED GROUP 100
- £35
- Suitable for use with record players

### TEL. (01)-421 1000
- Offers a wide range of components and accessories

---

### TECHNOMATIC LTD.
- Offers a wide range of components and accessories

**VAT**
- 15% on total order value

---

### RADIO COMPONENT SPECIALISTS
- 337 WHITESTONE ROAD, CROYDON
- Offers a wide range of components and accessories

---

### WIRELESS WORLD APRIL 1980
- Offers a wide range of components and accessories

---

### TECHNOMATIC LTD.
- Offers a wide range of components and accessories

---

### TEL. (01)-421 1000
- Offers a wide range of components and accessories

---

### WIRELESS WORLD APRIL 1980
- Offers a wide range of components and accessories

---

### TECHNOMATIC LTD.
- Offers a wide range of components and accessories

---

### TEL. (01)-421 1000
- Offers a wide range of components and accessories
BAMBER ELECTRONICS

AC ADAPTOR (Battery Charger 1 20 vac input, 5-8va at 200 mA output, USA type mains plug to 5-8v 5-8w jack plug. Brand new £1.50)

A.C. ADAPTOR (Battery charger 1 117 vac input, 5-25v at 100 mA output, Brand new £1.50)

VARICAP TUNER HEADS. 6 button type. 2%K to 10% with AC & DC & Instant Indicator. Brand new £1.00 each.

SCREWS. Pack of nut, bolt, washers, tags, self tap screws. BRASS 6-8G 5-8H metric. Sold by weight. £2.00 per 500g

VOLTAGE CONVERSIONS. Two types: 100V to 117 vac input, 117 vac input, 117 vac input, 117 vac input

A.C. ADAPTOR (Battery charger 1 117 vac input, 5-25v at 100 mA output, Brand new £1.50)

JAYBEAM STARBEAM UHF taps etc. Mixed BA & metric . LOW VOLTAGE ELECTROLYTS. Pack

ERSIN MULTICORE SOLDER. Modern pye westminster "M

5.8vdc. at 2.5 mm jack plug. Brand new & boxed tubes

TUBES for £1.25.

PYE WESTMINSTER "M

Model 9502. Rotation speed 1 rpm, gear ratio each. Ring your requirements or selected & 12 for £8.00.

BZY93C75 Large also fitted with mounting units type M U 1 deflection coil type BNC ECC81 PA BOARDS WITH LM309K 5v Regulator BC158 PNP Silicon 2N3819 fet. 3 for £1.00.

AT26808/23 B band (will tune high FILTER 2955 CG Op only)

0784/10 P MULTIPLIER/DRIVER PCB

Type 3H - DEPT. W.W., 5

WE also stock JAYBEAM T.V. and Radio 3 conductor wire for economy, pinpoint

HEADS, £1.00. £1.00.

SOp. £25p.

Rectifiers, 1 Type 746 with dials, tin ex-equip.

WELLER cordless soldering irons Model No. W500, 15watt ECA accessories available. (See 1980 Catalogue) .

ASSEMBLY TOOLS & METAL TOOLS.

WELLER instant heat guns Model No. 81 2.25mV at 9,000mm, 2.25mV at 9,000m
We now stock a full range of CASIO watches and calculators at all discount prices. Please see 29tp for details and prices of watches or calculators or both.

A selection of items below from our 1980 catalogue, the products we stock are by AEG, Weier, Dornier, Selenia, Wartburg, BAE, Pye, Viking, Wartburg, Jena, Amphenol, and others. Send £3.15 and you will receive our catalogue plus free 6-monthly shopping updates. Simplicity, reliability, and accuracy. Each item with a brief description.

WELCOME. Tuesday-Saturday 9.30 am-5.30 pm.

Functional design, rugged construction and total versatility make it first choice for telecommunications.

A programme of continuous product development has led to a range of over 50 models, all available at highly competitive prices. This coupled with our quality assurance scheme ensures that we maintain the leader position we enjoy today.

If you are looking for a VHF/FM antenna, Model WC1 00 £25.47 plus VAT.

VERSATOWER range of telescopic and tilt-over towers cover a range of 25ft to 120ft (7.5M to 36M).

Prepared for Wind Speeds from 85mph to 117mph conforming with CP3 Chapter V, part 11.

SEE US ON STAND 3L40 AT COMMUNICATIONS '80

VERSATOWER BY PROFESSIONALS FOR PROFESSIONALS

The VERSATOWER range of telescopic and tilt-over towers cover a range of 25ft to 120ft (7.5M to 36M).

Designed for Wind Speeds from 85mph to 117mph conforming with CP3 Chapter V, part 11.

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TRAILER mounted or static, the VERSATOWER solves those difficult problems of antenna support, access and ground level maintenance.

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### LOW COST SCOPES AND FUNCTION GENERATORS

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>E566C</td>
<td>£125.00</td>
</tr>
<tr>
<td>E566D</td>
<td>£160.00</td>
</tr>
<tr>
<td>E566E</td>
<td>£200.00</td>
</tr>
</tbody>
</table>

**Features:** Linear 8" CRT, 30MHz bandwidth, 100ms/div sweep, 12 memory channels, 32 normal levels, 32 trigger levels, 32 trigger sources, 16 trigger delay settings.

**Details:**
- **Type:** Digital storage oscilloscope.
- **Input Impedance:** 5MΩ.
- **Sweep:** 10μs to 100ms.
- **Trigger:** Auto, manual, external.
- **Functions:** Level, delay, delay, memory.
- **Accessories:** Carry case, documentation.

*Contact: Catronics Ltd, Waltham House, Woodford Green, Essex. Telephone: 0170 682 405.*

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### DISPLAY APPOINTMENTS VACANT

- **Salary:** £16.00 per single col. centimetre (min. 3cm).
- **Line advertisements (run on):** £3.50 per line, minimum three lines.
- **Contact:** Replies should be addressed to the Box Number in the advertisement (W.W.'s Wireless World, Dorset House, Stamford, London SE1 9LU)
- **Phone:** Mike Thraves 01-281 8508.

**Classified Advertisement Rates** are currently zero rated for the purpose of VAT.

---

### DESIGN & DEVELOPMENT ENGINEERS

- **Are you seeking an opportunity to work on advanced test gear employing the latest analog and digital techniques?**

If so, join Redifon and work on a number of exciting projects associated with the design and development of equipment for production line testing of our future colour TV receivers.

Effective testing plays an important part in ensuring that the finished product reaches the high quality levels necessary for success during the 1980s.

To increase the scope and flexibility of our testing, new equipment will be microprocessor-controlled. Even if you only have limited knowledge of digital techniques this opportunity will provide you to learn the mysteries of microprocessors and their application to testing complex electronic sub-assemblies.

Applications are invited from engineers with a creative ability to work in a congenial and stimulative

---

### Radio Communications

**Electronic Engineers and Software Designers**

**Mid-Sussex—S. London**

To join our expanding R&D Laboratories covering a wide range of RF spectrum, from LF to VHF. Equipment includes transmitters and receivers for mobile and land-based use, radio transceivers and radio monitoring remote computer-controlled systems.

Electronics Engineers should have experience in transmitter or receiver design, analogue or digital circuit design, microprocessor applications. Software Designers should be experienced Programmers, with an interest in control, signal processing or navigational software.

Attractive salaries are complemented by excellent prospects and generous benefits.

Contact: David Bird, Redfon Telecommunications Limited, Brookhill Road, Wensworp, London, S.W.18. Phone: 01-874 7831 (reverse charged).

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- **Accessories:** Carry case, documentation.

*Contact: Catronics Ltd, Waltham House, Woodford Green, Essex. Telephone: 0170 682 405.*
**CATRONICS LTD. (Dept. 24) COMMUNICATIONS HOUSE CHELMSFORD ROAD WATLINGSTON, SURREY SM5 9BG Phone: 01-669 6700 Mon. - Fri. 9 a.m. - 5 p.m. & Sat. 9 a.m. - 1.15 p.m.**

**LOW COST SCOPES AND FUNCTION GENERATORS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Price</th>
<th>Vat</th>
<th>Price inc. Vat</th>
</tr>
</thead>
<tbody>
<tr>
<td>X5024</td>
<td>100K Hz, 1MHz sweep, £25.00</td>
<td>£25.00</td>
<td>5%</td>
<td>£25.00</td>
</tr>
<tr>
<td>X5025</td>
<td>100K Hz, 1MHz sweep, £27.50</td>
<td>£27.50</td>
<td>5%</td>
<td>£27.50</td>
</tr>
<tr>
<td>X5026</td>
<td>100K Hz, 1MHz sweep, £32.50</td>
<td>£32.50</td>
<td>5%</td>
<td>£32.50</td>
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<tr>
<td>X5027</td>
<td>100K Hz, 1MHz sweep, £35.00</td>
<td>£35.00</td>
<td>5%</td>
<td>£35.00</td>
</tr>
<tr>
<td>X5028</td>
<td>100K Hz, 1MHz sweep, £37.50</td>
<td>£37.50</td>
<td>5%</td>
<td>£37.50</td>
</tr>
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</table>

**Radio Communications**

**Electronics Engineers and Software Designers**

Mid-Sussex - S. London

To join our expanding R&D Laboratories covering a wide range of R.F. spectrum, from L.F. to V.H.F. Equipment includes transmitters and receivers for marine and land based use, radio networks and radio monitoring remote computer/controlled systems.

**Salaries up to £8,000**

Electronics Engineers should have experience in transmitter or receiver design, analog or digital circuit design, microprocessor applications. Software Designers should be experienced Programmers with an interest in control, signal processing or navigational software.

Applicants are invited from engineers with a creative ability to work in a congenial and stimulative environment at our Engineering Centre at Chinnor, Oxfordshire. We have vacancies at senior and intermediate levels offering opportunities for career advancement. Salaries are obviously commensurate with qualifications and experience, but will be extremely attractive to those engineers whose present employment background is such that they can make a significant contribution to the performance of our R&D teams.

The usual big company benefits, such as pension scheme, free life insurance, 5 weeks holiday, choice of lease periods, sports facilities and assistance with relocation expenses are offered for these posts.

If you are interested in these challenging positions and would like more details or wish to discuss the matter in depth, please write or telephone -

Mr. H. Brearley, Head of Technical Services, Rediffusion Consumer Electronics Ltd., Fullers Way South, Chessington, Surrey. KT9 1HJ. Telephone: 01-397 8431

**DISPLAYED APPOINTMENTS VACANT: £6.00 per single col. centimetre (min. 3cm).**

**LINE advertisements (run on): £1.50 per line, minimum three lines.**

**Advertisements accepted up to 12 noon Friday, March 24th for May issue, subject to space being available.**
GOVERNMENT OF DUBAI
DUBAI RADIO & COLOUR TELEVISION
TELEVISION ENGINEERING DEPARTMENT
Applications are invited from suitably qualified Engineers with several years proven experience in the field of Television Engineering to fill future vacancies in the Engineering Division of Dubai Radio & Colour Television.
This young and expanding broadcasting service has been equipped with the most modern, sophisticated and up-to-date broadcast equipment, and candidates will be expected to be familiar with all aspects of modern analogue and digital circuit techniques employed throughout their respective fields.

STUDIO ENGINEERS (Two)
To be responsible to the Chief Engineer for the maintenance of all equipments within the Television Studio complex. Candidates should have some knowledge of Memory Modular Lighting Systems, used extensively throughout the Studios. All Studios are equipped with EMI 2005 Cameras and Richmond Hill Laboratories Camera Desks. LD1 14 Cameras are used for electronic news gathering.

TRANSMITTER ENGINEERS (Two)
To be responsible to the Chief Engineer for the maintenance of VHF and UHF medium and high power transmitters and ancillary equipments. Candidates should be familiar with routine testing procedures to ensure the continual good performance of equipment under their control. Extensive use is made of SHF microwave links, and candidates should be familiar with the operation and testing of such equipments. Applications, which will be treated with strictest confidence, should be sent accompanied by C.V. and U.K. telephone contact to:

Chief Engineer Television
Dubai Radio & Colour Television
PO Box 1695, Dubai, United Arab Emirates

The Contracts will be for two years and full details of conditions will be available at the preliminary interviews to be held in London in mid March. Salaries will range from PDS 12,000- PDS 14,000 tax free depending on experience.

UNIVERSITY OF SURREY
DEPARTMENT OF MUSIC & ELECTRONIC TECHNOLOGY
for Senior Technicians in Mobile Recordings
Salary up to £3,500 p.a. from 1 April 1980 under review. Interested applicants must have a higher education qualification and be experienced in the technical aspects of mobile recording equipment.
Candidates should have experience in collaboration with the Lecturer in Recording Techniques on the Television Course, and should have radio-technical training in portable television recording equipment.
The successful candidate will take part in studio operations and will be responsible for the maintenance of studio and location equipment, and will be expected to.

ROHDE & SCHWARZ
RONALD C. WARD
& IHC TELECOMMUNICATIONS

HILLINGDON AREA HEALTH AUTHORITY
MEDICAL PHYSICS DEPARTMENT
MOUNT VERNON HOSPITAL AND AREA WORKS DEPARTMENT
Applications are invited for:

2 TECHNICIAN POSTS
(MEDICAL PHYSICS TECHNICIAN III)

The holder of the first post will assist in the planned preventative maintenance, and first line call-out servicing, of all equipment. The appointee will be on the Area Works Establishment but seconded to work in the Physics Department Workshops.

The holder of the second post will join the team of electronic and mechanical workshop staff responsible for the technical support of the Regional Radiotherapy Centre and the Medical Physics Department. The team is being expanded because of the installation of a new Linear Accelerator.

Qualifications for both posts: O.N.C., H.N.C., H.N.D. or equivalent and three years experience as a Medical Physics Technician IV, or its equivalent. Salary scale £4605 rising to £5962 plus £388 London Weighting per annum.

Application forms and further particulars from Personnel Department, Ext. 388.

The Engineering Recruitment Officer.

Technical Assistants

Like a challenge?

A stimulating future awaits you if you can prove yourself capable of being trained as a BBC Television Engineer. Joining as a Technical Assistant is the first step along this road, and you may now exist for you to become a team member of an expert operations and maintenance team working in one of the four principal Technical Departments in Television which comprise Studios, News, Video Tape Recording and Outside Broadcasts.

In each of these areas you will be engaged on operational or maintenance work and will receive full training whilst at work with the BBC Engineering Training Centre at Evesham, which will equip you to qualify as a BBC Engineer within approximately 2 years. Most of the jobs are shift working and involve a 12 hour day, 7 days a fortnight shift pattern.

We are looking for young people with a good general education - O'Levels in English, Maths and Physics essential, A Levels in the latter two subjects preferred, alternatively an O.N.C. in Electronics, OR Part I & G Telecommunication Courses (No. 272). In addition you should be able to relate your theoretical knowledge to practical application. You must be at least 18 years old and have normal hearing and colour vision.

Minimum starting salary £400 per month (including London Weighting). May be higher for candidates with exceptional qualifications. Extra payments for weekend and shift working.

For full details and an application form, please complete and return the coupon below, enclosing a self-addressed envelope at least 9" x 6" to The Engineering Recruitment Officer, BBC, Broadcasting House, London W1A 1AA, quoting reference 80.E.4016/WW.
GOVERNMENT OF DUBAI
DUBAI RADIO & COLOUR TELEVISION
TELEVISION ENGINEERING DEPARTMENT

Applications are invited from suitably qualified Engineers with several years proven experience in the field of Television Engineering to fill future vacancies in the Engineering Division of Dubai Radio & Colour Television.

This young and expanding broadcasting service has been equipped with the most modern, sophisticated and up-to-date broadcast equipment, and candidates will be expected to be familiar with all aspects of modern analogue and digital circuit techniques employed throughout their respective fields.

STUDIO ENGINEERS (Two)

To be responsible to the Chief Engineer for the maintenance of all equipments within the Television Studio complex. Candidates should have some knowledge of Memory Modular Lighting Systems, used extensively throughout the Studio. All Studios are equipped with EMI 2005 Cameras and Richmond Hill Laboratories Miver Desks. LDK 14 Cameras are used for electronic news gathering.

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UNIVERSITY OF SURREY
DEPARTMENT OF MUSIC
SONIC TECHNICIAN
for BBC Mobile Recordings

Salary up to £4000 p.a. from 1 April 1980 under review.

Applications are invited by 14 April from candidates with a professional recording equipment in the Music Department's sound complex.

The successful candidate will take part in studio operations and will be responsible for the maintenance, repair and location of studio studio equipment. The post is for a period of two years. The successful candidate will work in collaboration with the Lecturer in Recording Techniques on the Television Course, and should have radio of recording industry experience in either studio production, installation, testing and maintenance of professional recording equipment, a working knowledge of all aspects of modern analogue and digital circuit techniques employed throughout their respective fields.

Candidates with professional qualifications and experience in the music industry are required to apply.

Applications should be sent within 14 days quoting reference OR 105 to: The Secretary, University of Surrey, Guildford, Surrey GU2 5XH, or by telephone on Guildford 71281 extension 776.

HILLINGDON AREA HEALTH AUTHORITY
MEDICAL PHYSICS DEPARTMENT
MOUNT VERNON HOSPITAL AND AREA WORKS DEPARTMENT

Applications are invited for:

2 TECHNICIAN POSTS

(MEDICAL PHYSICS TECHNICIAN III)

The holder of the first post will assist in the planned preventative maintenance, and first line call-out, servicing, of all medical equipment. The appointee will be on the Area Works Establishment but seconded to work in the Physics Department Workshops. The holder of the second post will join the team of electronic and mechanical workshop staff responsible for the technical support of the Regional Radiotherapy Centre and the Medical Physics Department. The team is being expanded because of the installation of a new Linear Accelerator.

Qualifications for either post: O.N.C., HNC, HND or equivalent and three years' experience as a Medical Physics Technician III, or the equivalent. Salary scale £4605 rising to £5962 plus £338 London Weighting per annum.

Applications forms and further particulars from Personnel Department, Ex. 388.

ROHDE & SCHWARZ

Independent concern represented in 80 countries

SENIOR TEST AND CALIBRATION ENGINEERS

With a background in RF and microwaves experienced in analogue, digital techniques, logic and microprocessor control & EE.

also vacancies exist for

TEST & CALIBRATION ENGINEERS

with knowledge of one or more of the above techniques.

Experience an advantage in a Performance related bonus scheme. A Training scheme is also available.

Write or phone to:

Mr. A. St. Audry, extension 43

Technical Instruments & Communications Department

aveley electric ltd

Roebuck Road

Chertsey, Surrey KT19 1LP

01-397 8771

WIRELESS WORLD, APRIL 1980

Technical Assistants

Like a challenge?

A stimulating future awaits you if you can prove yourself capable of being trained as a BBC Television Engineer. Joining as a Technical Assistant is the first step along this road, and vacancies now exist for you to become a trainee member of an expert operations and maintenance team working in one of the four principal Technical Departments in Television which comprise Studios, News, Video Tape Recording and Outside Broadcasts.

In each of these areas you will be engaged on operational or maintenance work and will receive full training whilst at work with the BBC Engineering Training Centre at Evesham, which will equip you to qualify as a BBC Engineer within approximately 2 years. Most of the jobs are shift working and involve a 12 hour day, 7 days a fortnight shift pattern.

We are looking for young people with a good general education – O'Levels in English, Maths and Physics essential, A Levels in the latter two subjects preferred. Alternatively an O.N.C. or HNC in Electronics, OR Part I, C & G Telecommunications Course (No. 271). In addition you should be able to relate your theoretical knowledge to practical application. You must be at least 18 years old and have normal height and colour vision.

Minimum starting salary £4080 p.a. (including London Weighting). May be higher for candidates with exceptional qualifications. Extra payments for weekend and shift working.

For full details and an application form, please complete and return the coupon below, enclosing a self addressed envelope at least 9" x 6" to The Engineering Recruitment Officer, BBC, Broadcasting House, London W1A 1AA quoting reference 80.E.4016/WW.

WIRELESS WORLD, APRIL 1980
Installation and Maintenance Engineers
for shipborne electronics equipment

Marconi Avionics at Welwyn Garden City are leading the world in the development of complex shipborne digital signal processing equipment and we now require additional electronics engineers, men and women, to join teams in the following specialist areas of our Project Services Department.

Ship Fitting

In this area responsibilities will cover all aspects of shipfitting from an early stage in design, including definition of the interfaces between the signal processors and other on-board equipment; installation specifications; connector schedules; participation in installation; setting to work and acceptance testing to customer satisfaction.

Maintenance

This covers in-service maintenance and post-design servicing with some involvement in setting to work and acceptance testing activities. While these positions are based at Welwyn Garden City, travel will be necessary throughout the UK and possibly overseas.

A high level of practical skill is required together with experience of working on computer-based equipment, possibly as an electronic Technician/Vicar in the Services. An ONC/HNC qualification or equivalent in-service training would be preferred.

Good salaries and an attractive range of benefits will be offered.

Write with details of experience to Rod Cook, Marconi Avionics Limited, 26-28 The Hydeaway, Welwyn Garden City, Herts. Telephone Welwyn Garden 28511 extn. 15.

Please quote reference MAW 8002.

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ELECTRONICS ENGINEERS
Careers in Oil Exploration

We are looking for young electronics engineers with degree or equivalent qualifications to join our marine seismic acquisition company.

This is a field position, with the successful applicants joining the technical crew of one of our exploration vessels for on-board training in seismic techniques. They will start as Assistant Technicians with a salary of £7,000 plus p.a. and one month's leave after each 2 months on the crew.

The seismic industry offers an interesting career with worldwide travel and rapid promotion for the right person.

Sepal Geophysical is a member of the Seafar group, which has seismic processing centres in Houston, Dallas, Calgary, London, and land exploration in North America.

Please write with full curriculum vitae to:
Keith Byne
Seafar Geophysical (UK) Ltd
Turnbull Building
Great West Road, Brantford
Middlesex, TW8 9HT
or telephone: 01-565 3273
quoting reference 7102.

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RF Engineers

London & Exeter

£6,000-10,300

Multitone lead the world in the design and manufacture of sophisticated radio paging systems.

Continued success in this advanced technology industry has led to expansion in all sectors of our operation.

This overall growth creates the need to expand our development potential by appointing the following:

Transmitter Development Engineers

Based at our modern plant in Exeter, you'll be responsible for the development of AM, PM & FM transmitters in the 25MHz to 520MHz utilising the components of today's technology.

Development Engineers

Working in our well-equipped Research and Development Laboratories, you'll be actively involved in the design of miniature personal communications systems.

This will entail integrating RF technology with 'state-of-the-art' control devices.

When you join Multitone, you'll be given early project responsibility and enjoy a stimulating working environment where individual achievement is a basic objective.

We'll offer you an excellent initial salary in the range of £6,000 — £10,300, according to qualifications and experience.

Fringe benefits include pension and life assurance plans, assistance with relocation where appropriate and, for the London vacations only, local housing may be available and flexible working hours.

If you're looking for better rewards and a brighter, more challenging future, come to Multitone.

Please write to, or better still telephone, Brian Young at the address below.

Personnel Department
Multitone Electric Co. Ltd.,
6-28, Underwood Street, London, N.1 7.T. Tel: 01-253 7611
Installation and Maintenance Engineers for shipborne electronics equipment

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This covers in-service maintenance and post-design services with some involvement in setting to work and acceptance testing activities.

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A high level of practical skill is required together with experience of working on computer-based equipment, possibly as an electronics Technician/Fitter in the Services. An ONC/HNC qualification or equivalent in-service training would be preferred.

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Please write to, or better still telephone, Brian Young at the address below.

Personnel Department
Multitone Electric Co., Ltd.,
6-28, Underwood Street, London, N1 7JT. Tel: 01-253 7611
URGENTLY REQUIRED
TRANSMITTER ENGINEERS

SHORT WAVE, MEDIUM WAVE
LOW & HIGH POWER

We have several vacancies for U.K. based installation engineers for overseas projects in AFRICA and the FAR EAST with periods at manufacturing plants in the U.S.A.

For further information please telephone TONY OWERS

Would previous applicants please reconfirm their interest

PERSONNEL & ELECTRONICS LTD.

Triumph House, 1096 Uxbridge Road, HAYES, Middlesex UB4 8OH
Tel: 01-573 8333, Telex: 934271

NEW APPOINTMENTS

ARMY

Applications are invited from suitably qualified former British Armed Services NCOs to fill the following contract appointments in the Oman Army:

WOI

YEOMAN OF SIGNALS

Ref. No. 51

WO

FOREMAN OF SIGNALS

Ref. No. 51J

SGTS

TERMINAL EQUIPMENT TECHNICIANS

Ref. No. 5IN

SGTS

RADIO TECHNICIANS

Ref. No. 5IP

SGTS

TELECOMMUNICATIONS MECHANICS

Ref. No. 5IQ

Prefered age limit — 45.

Unformed appointments. 3 year contracts, unaccompanied, starting emoluments equivalent to approx. £4000 (WO), £5000 (WOI) or £6000 (SGTS) p.a. at current exchange rate tax free, terminal gratuity approx. £4000, state accomodation and services fee. 7 days paid leave per year, 2 weeks Christmas and Easter leave (SGTS) and sick pay scheme.

For further details write, giving brief details and experience, to the appropriate reference at Personnel Officer (N.R.) AIRWORK LIMITED.

Airwork Limited
Bournemouth (Hurn) Airport
Christchurch Dorset BH23 6EB

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Mobile Radio Communications Development Engineers

We are Europe's leading exporters of two way radio communications systems and as such can offer you the chance to work on exciting new development projects in one of the best equipped laboratories in the Country.

If you have experience in one or more of the following, and would like to work in a dynamic company, please contact us now!

- Hand portable or mobile equipment design, AM or FM, in the VHF or UHF range
- Transmitter and receiver design
- Digital control, Encoding and Decoding
- Low power microprocessors and RF synthesizers

You should be educated to degree/HND level, and have at least 3 years relevant design experience.

Benefits include 25 days holiday, first class Pension and receiver 'design, work on exciting new projects in one of the best equipped laboratories in the Country.

Basic / Controller development projects in one of the best equipped laboratories in the Country.

Salary: £8,200.

Applications including curriculum vitae and the names of two professional referees should be sent for the attention of The Personnel Officer, Pye Telecommunications Limited, St. Andrews Road, Cambridge CB4 1DW. Tel: Cambridge 61222.

Put us to the test
For a challenging electronic career.

In the last 50 years Kelvin Hughes have played an increasingly vital role in the development of radar and sonar to their present level of sophistication.

As the marine division of Smiths Industries—an important large company with multiple interests in new technology—we now supply the equipment and instrumentation needs of commercial and naval fleets all over the world.

Our small production runs, often to stringent ministry specifications, make extremely heavy demands on our testing standards. To enhance our facilities we are currently looking for a Test Equipment Design Engineer, who will also be responsible for test documentation.

You should be a fully-qualified man or woman capable of circuit design in both analogue and digital techniques. Ideally you will be able to hack your Electronic HNC, or degree with an interest in, or experience of Basic/Controller Computer applications for semi-automatic test methods.

We will support your competitive salary with the generous range of personal benefits appropriate to a progressive company.

Please write with brief personal and career details to: Lesley Backland, Kelvin Hughes, New North Road, Haslade, Wold, Essex. Or phone 01-500 1020.

University of York Department of Chemistry
Chief Electronics Technician (Grade 7)

A unique role for the area of Chief Electronics Technician. The person appointed will have general overall responsibility for all work carried out by two other technicians in the area; this may be the management of staff involved in the maintenance of sophisticated computer controlled instrumentation and electronic equipment. The postholder will also be responsible for the liaison with other technical staff to the design and construction of new equipment, modifications to existing equipment and maintaining up-to-date documentation to a high level of accuracy but in a rapid time.

Salary on Grade 7 £5,397-£5,996 under negotiation.

Applications including curriculum vitae and the names of two professional referees should be sent for the attention of The Personnel Officer, University of York, York, HU9 7BJ.

Applications are invited for suitably qualified former British Armed Services NCO's to fill the following contract appointments in the Oman Army.

WO1 - YEOMAN OF SIGNALS
Ref. No. 51
WO2 - FOREMAN OF SIGNALS
Ref. No. 51I
SGT - TERMINAL EQUIPMENT TECHNICIANS
Ref. No. 5IN
SGTS - RADIO TECHNICIANS
Ref. No. 5IP
SGTS - TELECOMMUNICATIONS MECHANICS
Ref. No. 5IQ

Preferred age limit — 45.

For further details write, giving brief details of qualifications and experience, quoting the appropriate reference, to:

Personnel Officer (M.R.)

Airwork Limited
Bournemouth (Hurn) Airport
Christchurch. Dorset BH23 6EB

Wireless Electronics B.V. import, export, wholesale dealer and retail dealer in communication equipment, based in Alkmaar, is looking for an:

Electronics Engineer

Digital Computerotechnics for Holland

We are growing fast, both at home and abroad, and this continuing expansion means that we need an Engineer who will work world-wide for new interesting products that fit in our sales policy. At this moment we are one of the most important companies in the field of communication, microphone, antennas, etc.

We are constantly looking for new products for the initial market for consumer and industry.

Applicants should have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently, they must have a thorough technical education speak English, French and German fluently.

If you are challenged by the offer, please apply in writing giving details of age, education, experience and qualifications to:
**Radio Technicians Work in Communications R&D and add to your skills**

At the Government Communications Headquarters we carry out research and development in radio communications and their security, including related computer applications. Practically every type of system is under investigation, including long-range radio, satellite, microwave and telephony.

Your job as a Radio Technician will concern you in developing, constructing, installing, commissioning, testing, and maintaining our equipment. In performing these tasks you will become familiar with a wide range of processing equipment in the fields of microwave range, involving modern logic techniques, microprocessors, and computer systems. Such work will take you to the frontiers of technology on a broad front and widen your area of expertise — positive career assets whatever the future brings. In the rapidly expanding field of digital communications, valuable experience in modern logic and software techniques will be gained.

Training is comprehensive: special courses, both in-house and with manufacturers, will develop particular aspects of your knowledge and you will be encouraged to take advantage of appropriate day release facilities.

You could travel — we are based in Cheltenham, but we have other centres in the UK, most of which, like Cheltenham, are sited in environmentally attractive locations. All our centres require resident Radio Technicians and can call for others to make working visits. There will also be some opportunities for short trips abroad, or for longer periods of service overseas.

You should be at least 19 years of age. Hold or expect to obtain shortly the City and Guilds Telecommunications Technician Certificate Part I (Intermediate), or its equivalent, and have a sound knowledge of the principles of telecommunications and radio, together with experience of maintenance and the use of test equipment. If you are, or have been in HM Forces your Service trade may allow us to dispense with the need for formal qualifications.

Registered disabled people may be considered.

Pay scales for Radio Technicians start at £3900 per annum, rising to £5300; and promotion will put you on the road to posts carrying salary scales also opportunities for overtime and on-call work, paying good rates.

Get full details from our Recruitment Officer, Robin Robin, on Cheltenham (0262) 21691, Ext 2269, or write to him at GCHQ, Oakley, Priors Road, Cheltenham, GL52 5AJ. We will invite suitable applicants (expenses paid) for interview at Cheltenham.

---

**Diagnostic Programmers**

Burroughs Machines Ltd. at Croydon are currently engaged in designing and developing a new range of microprocessor based terminals. Our continuing expansion has created opportunities for applicants with a good knowledge of hardware and software, and preferably with an active interest in microprocessors. Using these skills you will develop diagnostic routines and programs for our Systems Support Personnel and Evaluation and Quality Assurance Departments.

Ideally you will be qualified to HND/degree level in electronics, or you should have considerable related experience. In either case we offer a progressive environment with good future prospects.

Salary will relate to individual experience and circumstances but will not be a limiting factor. Relocation expenses will be given where necessary.

For further details please contact:

Don Buckland,
Product Reliability Manager,
Burroughs Machines Ltd.,
512, Purley Way, Croydon,
Surrey, CR0 4NZ. Tel: 01-686 0355.

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**Communications Foremen**

**Libya**

Occidental, one of today's most progressive and rapidly expanding international oil companies, requires communications experts to supervise the installation, maintenance and repair of communications equipment in the field production areas in Libya, including VHF/AM/FM equipment, HF-SSB Transceivers, LF radio beacons, TDM alarm systems, teleprinters etc.

Candidates must have at least five years' experience in installation, maintenance and repairing radio, teleprinter, telephone etc. systems, some of which should be at supervisory level.

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**DXYLIBYA**

**DAX**

A limited number of permanent/contract, high paying career-opening appointments for experienced Technicians U.K. or U.S.

Send CV/Letter of Application and recent photograph to:

DK LTD (WA) 26 Queen Victoria Street, Reading, Berks.

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**Medical Electronics Technician**

To be resident in the Department of Psychiatry at the University of Reading and to take charge of electronics work, instruct the students on the theory and practical application of the equipment, and construct wide range of apparatus. This should already be done by the day students. Experience in advanced digital and computerized medical equipment is required. The work is varied and interesting and will provide good background to a career in a developing field. Start £4200 per annum.

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**General Advertisements**

For fuller details and application form please apply to:

John James
Personal Officer
John Holland (P.L.) Ltd.
Newhouse Laboratory
Newhouse Road, Bovington
Hampshire.

HPR 3 OLI.
Diagnostic Programmers

Burroughs Machines Ltd. at Croydon are currently engaged in designing and developing a new range of microprocessor based terminals. Our continued expansion has created opportunities for applicants with a good knowledge of hardware and software, and preferably with an active interest in microprocessors. Using these skills you will develop diagnostic routines and programs for our Systems Support Personnel and Evaluation and Quality Assurance Departments.

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Don Buckland,
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Candidates must have at least five years' experience in installation, maintaining and repairing radio equipment. The system which you will be supervising is of a super-visor level.

Please send your resume with full personal and work experience to Patricia Cannon, Occupancy, Occidental of Libya Recruiting, 16 Palace Street, London SW1 5BG. Tel: 01-828 5000.

Radio Technicians

Work in Communications R&D and add to your skills

At the Government Communications Headquarters we carry out research and development in radio communications and their security, including related computer applications. Practically every type of system is under investigation, including long-range radio, satellite, microwave and telephony.

Your job as a Radio Technician will concern you in developing, constructing, installing, commissioning, testing, and maintaining our equipment. In performing these, tasks you will become familiar with a wide range of processing equipment in the high and microwave range, involving modern logic techniques, microprocessors, and computer systems. Such work will take you to the frontiers of technology on a broad front and deepen your area of expertise - positive career assets whatever the future brings.

In the rapidly expanding field of digital communications, valuable experience in modern logic and software techniques will be gained.

Training is comprehensive: special courses, both in house and with manufacturers, will develop particular aspects of your knowledge and you will be encouraged to take advantage of appropriate day release facilities.

With the outstanding success in marketing a new range of airborne and high-speed video telecommunication equipment we need to employ a group of video service engineers. Full production training will be given in either America or Japan to a suitably qualified or trained person.

The successful applicant will probably be aged between 25 and 35. A Company car will be provided; after a probationary period, as extensive travel within the UK will be necessary.

We pay top rates and the salary will be commensurate with experience and ability. We offer 4 weeks holiday, free life assurance, sick scheme and free canteen facilities.

For further details and application form please apply to:

John Jones
Personal Officer
John Holland (P.I.) Ltd
Newhouse Laboratory
Newhouse Road, Bovington
Hampshire
Hants. HP3 0EN
Radio Officers

When the ship comes home, why not settle down?

We're the Post Office Maritime Service and we have everything in a job that you'd want: the kind of work you're trained to do, good pay, job security and all the comforts of home where they really count - at home!

Vacancies exist at several coastal stations for qualified Radio Officers to carry out a variety of duties that range from Morse and teleprinter operating to traffic circulation and radio telephone operating. And for those with ambition, the prospects of promotion to senior management are excellent.

You must have a United Kingdom Maritime Radio Communication Operator's General Certificate or First Class Certificate of proficiency in Radio-telegraphy or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic. Preferably you should have some sea-going experience.

The starting pay at 25 or over will be about £5,381 after 3 years service this figure rises to around £20,875. If you are between 19 and 24 your pay on entry will vary between approximately £4,229 and £4,937. Overtime is additional, and there is a good pension scheme, sick-pay benefits and at least 4 weeks’ holiday a year.

For further information, please telephone Kathleen Watson on Freephone 228 or write to her at the following address:

IT Maritime Radio Service Officer (WWA),
ISK 1.1.2, Room 643, Union House,
St. Mark's Le-Grand, London E1CA 1AR.

Post Office Telecommunications

To 6500 p.a.
MIDDLESEX

We make an extensive range of environmental test systems, covering every application from strain measurement to the vibration of vehicles and buildings.

If you are:
- self-motivated and self-reliant;
- qualified to HNC or equivalent in electronics / Radio and TV, and also interested in mechanics;
- experienced in analogue and digital work;
- then we can offer you a wide variety of testing and control systems.

Application form may be obtained from the Personnel Manager.

SNAVTEST LIMITED
Sarstall Road
Grenford, Middlesex UB6 7AA
Tel. 81-998 1552

For further details etc.

Radio Officers

When the ship comes home, why not settle down?

We’re the Post Office Maritime Service and we have everything in a job that you’d want: the kind of work you’re trained to do, good pay, job security and all the comforts of home where they really count – at home!

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For further information, please telephone Kathleen Watson on Freefone 2359 or write to her at the following address:

H M Maritime Radio Service (W2W),
ISK 1.1.2, Room 643, Union House,
St. Mary Axe-Grand, London EC3A 1AR.
Radio Technicians / Communications Systems Engineers

Good communications systems are vital to the oil industry. And increasingly, the industry relies on our client to design, install and maintain those systems – which is why they require Radio Technicians and Communications Systems Engineers.

There are vacancies in the North Sea oilfields and overseas for Technicians with experience of HF, MF, VHF and UHF, and Engineers with Tropospheric scatter, Multiplex and Microwave experience to HNC level and above.

The work is interesting and varied and the rates of pay are excellent – over £11,000 p.a. for Engineers working in the North Sea (2 weeks on/2 weeks off). Radio Technicians receive a basic salary of £8,000+ p.a. with substantial offshore allowances/field breaks. Overseas posts offer very attractive earnings along with tax concessions.

Additionally, our client has vacancies for Systems Design Engineers (ideally qualified to Degree/HNC level) and for a Communications Systems Sales Engineer to promote the sales of the Company’s Services in selected geographical areas.

The company is based in E. Anglia, with sites in Aberdeen and Lerwick. Where relocation is necessary, our client will make a generous allowance to assist with removal and expenses. As providing a temporary accommodation allowance.

Please reply in confidence to:
BARTLETT, RAY & JARVIS LTD.

If there is any company to whom you do not wish your reply to be forwarded, please mark that Company’s name clearly on the outside of your application envelope.

Take your pick

HF-VHF-UHF

Microwave Optics & Acoustics

A challenging and full career in Government Service.

Minimum qualification — HNC.

Starting salary up to £6,737.

Please apply for an application form to the Recruitment Officer (Dept.sww), H.M. Government Communications Centre, Hanslope Park, Milton Keynes MK19 7BH.

DEVELOPMENT ENGINEERS

To work on the design of new broadcast TV studio products. Applicants should have some knowledge of television system techniques and be qualified to HND or Degree level.

TEST ENGINEERS

At senior and intermediate level to work on our range of advanced broadcast television studio products, including colour and monochrome television studio cameras.

Applicants should have an up-to-date knowledge of digital and linear circuit techniques gained from experience working on television studio equipment, radar equipment or similar sophisticated products and qualified to HND, HNC or equivalent level.

SYSTEMS ENGINEER

You would be involved in all stages of product management on the design and building of studio and mobile TV systems and should be prepared for occasional world-wide travel. The appointment requires someone with a background in this type of work, or in the operational side of television with the ability to take charge of people and deal with problems in the field on your own initiative.

Employment benefits include excellent salary, generous holidays, free life and health insurance, pension scheme, subsidised meals and relocation expenses.

Please apply for further details and application forms to Jean Smith at the address given below.

WIRELESS TECHNICIAN

Applications are invited for one post of Wireless Technician in the Scottish Home and Health Department.

LOCATION:
The post is in Inverness.

QUALIFICATIONS:
Candidates must hold an Ordinary National Certificate in Electronic or Electrical Engineering or a City and Guilds of London Institute Certificate in an appropriate subject or a qualification of a higher or equivalent standard.

EXPERIENCE:
3 years' appropriate experience.

STARTING SALARY:
£3,300, scale maximum (£5,530).

Applications should have sound theoretical and practical knowledge of Radio Engineering and Radio Communications equipment in HF, VHF and UHF bands. The work involves installation and maintenance of equipment located at considerable distance from headquarters. A clean driving licence and ability to drive private and commercial vehicles are essential.

The appointment is unestablished initially but there is prospect of an established (i.e. permanent) appointment after 1 year’s satisfactory service.

Application forms and further information are obtainable from Scottish Office Personnel Division. Room 110, 16 Waterloo Place, Edinburgh EH1 3DN (quote ref. PMPTS) 2/2/80 (031-556-8400, Ext. 4317 or 5072).

Closing date for receipt of completed application forms is 18 April, 1980.

WIRELESS WORLD, APRIL 1980

All the others are measured by us...

At Marconi Instruments we ensure that the very best of innovative design is used on our range of communications test instruments and A.T.E. We have a number of interesting opportunities in our Design, Production and Service Departments and we can offer attractive salaries, productivity bonus, pension and sick pay schemes together with help over relocation.

If you are interested to hear more, please fill in the following details.

Name __________ Age __________
Address ____________

Telephone Work/Home (if convenient)

Years of experience __________

Present salary __________

Qualifications __________

Present job __________

Return this coupon to John Prodger, Marconi Instruments Limited, FREEPOST, St. Albans, Herts.

AL4 ORR. Tel: St Albans 59292

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Electronics R&D

Join us in the forefront of technology
Good communications systems are vital to the oil industry. And increasingly, the industry relies on radio technicians and communications systems engineers.

There are vacancies in the North Sea, oilfields and overseas for technicians with experience of HF, MF, VHF and UHF, and engineers with tropospheric scatter, multiplex and microwave experience to HNC level and above.

Applications are invited for one post of Wireless Technician in the Scottish Home and Health Department.

QUALIFICATIONS:
Candidates must hold an Ordinary National Certificate in Electronic Engineering or a City and Guilds of London Institute Certificate in an appropriate subject or a qualification of a higher or equivalent standard.

STARTING SALARY:
£3,500, state maximum (£5,500).

Applications should have sound theoretical and practical knowledge of radio engineering and radio communications equipment in HF, VHF and UHF bands. The work involves installation and maintenance of equipment located at considerable distance from headquarters. A clean current driving licence and ability to drive private and commercial vehicles are essential.

The appointment is unestablished initially but there is prospect of an established (i.e. permanent) appointment after 1 year's satisfactory service.

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If there is any company to whom you do not wish your reply to be forwarded, please mark that Company's name clearly on the outside of your application envelope.

Radio Technicians / Communications Systems Engineers

Scottish Home and Health Department

Wireless Technician

Applications are invited for one post of Wireless Technician in the Scottish Home and Health Department.

LOCATION:
The post is in Inverness.

QUALIFICATIONS:
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EXPERIENCE:
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Closing date for receipt of completed application forms is 18 April, 1980.

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ELECTRONICS SALES  
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Electronic Engineers

Salaries up to £7,000

Livingston Hire

Not in Europe--by any measure

Livingston Hire Limited, Shirley House, 27 Camden Road, London NW1 0DN. Telephone 01-980 3342

Electronics Engineers

Applicants must have a good all round knowledge of electronic test equipment. Engineers with experience of the following equipment type are particularly invited to apply:

- R & R Test Equipment including Spectrum Analysers, Analyser Equipment (B & K, C.E.L., etc.)

While academic qualifications are desirable, emphasis will be placed upon Generally suitable applicants will have had balancing your directly related experience.

The vacancies are internal and based at our modern, fully equipped premises in N.W. London.

The work will be interesting and varied and will involve a wide range of sophisticated electronic systems associated with a product, employing the most up to date techniques, including the latest microprocessors.

Ideally, applicants will be qualified to C&G, HNC, or equivalent level, have had several years' experience of radio communications equipment and be familiar with both analogues and digital circuits, using the most up-to-date techniques, including microprocessors.

We are currently establishing small teams within our Laboratories to carry out development, test and field trials on military communications equipment from our wide range of sophisticated electronic products. It is essential that these teams are well balanced and we are looking for people who have initiative to start:

Write or telephone to David Kennedy

SENIOR TEST ENGINEERS

The work will be extremely varied, including the development, evaluation, debugging, design and proving field trials of advanced radio communications equipment, with associated anaologue and digital circuits, using the latest techniques, including microprocessors.

Salaried positions will be offered to suit qualifications and experience. Tony Czapp, Technical Resourcing Office, Plessey Aeronautics and Communications Limited, Manor Road, Leigh, Lancs, Tele: (0503) 46861 ext. 411.

If you feel you can meet our requirements please write or telephone now, with brief details of qualifications and experience. Tony Czapp, Technical Resourcing Office, Plessey Aeronautics and Communications Limited, Manor Road, Leigh, Lancs, Tele: (0503) 46861 ext. 411.

TOS TOP JOBS IN ELECTRONICS

Posts in Computers, Medical, Consumer, etc. U.K. to P.O. F. Free service.

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Electronics Engineers

Salaries up to £7000

Livingston Hire, Livingstone road company of sophisticated electronic test equipment, currently require the following electronics engineers.

SALES ENGINEERS (Internal and External)

Sales engineers are required to join our developing sales team.

We want people with a wide knowledge of proprietary test and measuring equipment and an intelligent appreciation of its applications.

We offer the opportunity for people who have initiative to join us.

Write or telephone to David Kennedy

Mr./Mrs./Miss - -

Tel: 01-579-2282 (24 hour answering service)

Stuart Tait, Lansdowne Appointments Register, Design House, The Mall, London W1 SL.

Our clients would like to interview the following.

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For an established company with a large and well-known client base we require a senior sales engineer with experience in electronic test and measuring equipment.

DEVELOPMENT ENGINEERS

We are seeking three development engineers, and need people with wide knowledge of electronic test and measuring equipment and an intelligent appreciation of its applications.

We offer the opportunity for people who have initiative to join us.

Write or telephone to David Kennedy

Mr./Mrs./Miss - -

Tel: 01-579-2282 (24 hour answering service)

Stuart Tait, Lansdowne Appointments Register, Design House, The Mall, London W1 SL.

Our clients would like to interview the following.

ENGINEERING CO-ORDINATOR

Due to expansion and reorganisation, Telecommunications and Research Ltd., have a vacancy for a qualified electronic enginner to be based at their Telecommunications Department near Oxford.

The position offers interesting and varied work covering many aspects of electronic engineering including electronic test equipment, audio and video tape recorders and players, film projectors, radio and tv networks, and computer controlled information storage and retrieval systems.

The successful applicant will have a wide variety of theoretical and practical knowledge and practical working experience in one or more of the above fields, and must be willing to visit T.S.R. installations in the U.K. and abroad.

Duties will include liaison with manufacturers of specialist products, trouble shooting, consultation of spare parts lists, the selection and supervision of installation/maintenance contractors and the control of T.S.R. maintenance budget.

Good salary and terms and conditions, 27-35 hour, 5-day week. A company car is provided.

Apply to: The Engineering Manager, T.S.R. Systems, Units 7/8, Station Road Industrial Estate, KIDINGTON, Oxford. Telephone Kidlington 6190.

LINTECH INSTRUMENTS LIMITED

Electronic Systems Engineer/Product Champion

Electrical know-how, modern electronics and expert knowledge of electronic equipment is required for this position. Applicants must be prepared to work closely with a group of engineers and technicians. The position is primarily based at the company's manufacture and test plant near Oxford, though some trips to the United States and the Far East may be necessary. A car will be provided.

Applicants are required to have:

- A high level of electrical knowledge
- Experience in modern electronics
- Expert knowledge of electronic equipment
- The ability to work closely with a group of engineers and technicians

Applicants must be prepared to travel extensively in the United States and the Far East. A car will be provided.
Opportunities for VHF/UHF Service Engineers

You won’t believe it until you see it – so you’d better come and have a look.

Do you have experience working on VHF/UHF telecommunications equipment? Then a bit of a cheapskate perhaps – not enough interesting work to do, even less prospects? Then it’s time for a move. We’re the market leaders in radio telephony and voice and data systems – in fact the competition’s not even in sight. We need service engineers in both London and Luton to help us maintain them, to help you do the job there’s a bank of test equipment that will knock your eyes out! And that’s just the beginning! The Company’s spending approximately two million pounds on modernisation programmes which include the installation of a new micro-computer based paging system and the complete modernisation of the existing control centres to accommodate intercommunication between car and office.

If you’ve got City & Guilds that would be an advantage though it’s not absolutely necessary. Or perhaps you’re in training or on the move and would like to get into telecommunications.

We’re a car to go with the job – filled with a radio telephone so you can keep in touch. Salary negotiable depending on experience as is an initial familiarisation course on the existing equipment and the opportunity to go on other courses. If you want to gain additional experience, in fact about eighteen months from now you could be on the way – to a more senior job in the Company. Sounds too good to be true – then come and see for yourself. Get in touch with Peter Lyons who will arrange to show you around – that way we’ll both have a feel for what we’re getting into.

Ring or write to: Peter Lyons, Air Traffic Control Services Division, 18 Lambeth High Street, London SE1. 01-834 9000.

![Image](www.americanradiohistory.com)
Republic of Botswana

Telecommunications Engineer

Up to £10,550 plus allowances

Candidates should be qualified as Radio Engineers (eg. HNC, C & G Electrical) and have several years' experience in the installation and maintenance of ground navigation aids (VOR/DME/NOB), airborne communication system (VHF/HF) and communication equipment used for fixed telecommunication networks (Radio telephony) HF transmitters. Duties will include the installation and maintenance of radio equipment and on-the-job training of staff of the Civil Aviation Department. Salary includes a substantial tax-free allowance reviewed annually paid under Britain's earnings programme. Basic salary attracts 25% tax-free grant. Benefits include free passages, generous paid leave, children's holiday visit passages and education allowances, appointment grant and interest-free car loan.

The terms on which civil and public servants may be released if selected for appointment will be subject to agreement with their present employers. For full details and application form write quoting MA22/WD.

MOTOROLA (SUISSE) S.A.
Semiconductor Group

MOTOROLA has a vacancy in its central consumer applications laboratory in GENEVA for

2 ELECTRONIC ENGINEERS

To work on system design in close cooperation with customers at the European level. The successful candidates will work together with IC design groups and marketing, to create new circuit concepts using Motorola products. Customer support and system extensions will also be part of the job. Education to degree standard or equivalent in Electronic Engineering and a good command of the English language is required.

SENIOR APPLICATIONS ENGINEER (Radio & TV)

The engineer we are looking for will have had a minimum of 3 years’ experience in the design of Radio and TV circuits. A knowledge of digital techniques would be a definite advantage.

SENIOR APPLICATIONS ENGINEER (Microprocessors)

An engineer with extensive experience of microprocessor (both hard and software) design is required, to support the design of consumer oriented control systems in the TV, radio and domestic appliance industries. Opportunities for travel exist with both of the above positions. If you are interested in joining a rapidly growing division of a major international company, and can satisfy the above conditions, please send your Curriculum Vitae to:

Tel: 022/99.14.17 (LEONARD G. MURDOCH) MOTOROLA (SUISSE) S.A. 1938 CH-1211 Geneva 20, Switzerland

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- TRANSMITTERS & RECEIVERS
- SPARE PARTS
- ELECTRONIC & COMPUTER EQUIPMENT
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- CIRCUIT BREAKERS & RELAYS
- FUSIBLE LINKS
- CONNECTORS & PLUGS
- SPIEGLER CIRCUITS LTD.

We purchase all types of Electronic and Mechanical Equipment and Surplus Stocks.

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V.W. -q for further details

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Republic of Botswana

Telecommunications Engineer
Up to £10,550 plus allowances

Candidates should be qualified as Radio Engineers (eg. HNC, C & G) with at least 3 years' experience in the installation and maintenance of ground and marine radio systems. The successful candidate will be required to work closely with the service department at the client's main base and will be expected to visit clients' remote sites, usually by helicopter. This is a permanent position and the successful candidates will take up the position after 3 months' notice period.

Job description:
- Experience in the installation, maintenance and repair of radio systems, including aerials, transmitters and receivers.
- Ability to work in a team and to prioritise tasks.
- Good understanding of technical specifications and equipment.
- Good oral and written communication skills.

SENIOR APPLICATIONS ENGINEER (Radio & TV)

The engineer we are looking for will have had a minimum of 3 years' experience in the design of Radio and TV systems.

A knowledge of digital techniques would be a definite advantage.

Applications are invited from qualified engineers with a minimum of 3 years' experience in the design of Radio and TV systems, preferably with experience in the design of satellite communication systems. The successful candidate will be expected to work closely with the service department at the client's main base and will be expected to visit clients' remote sites, usually by helicopter. This is a permanent position and the successful candidates will take up the position after 3 months' notice period.

Interested? Please write or telephone Peter Anderson, Personnel Assistant, The Wellcome Research Laboratories, Langley Court, Beckenham, Kent BR3 6DS, or reply to Box No. 31010.

We are a person to join a small group offering engineering support to research workers in pharmacology and related departments.

The work involves the maintenance and development of electronic equipment and systems, and training of staff of the Radio Engineer.

Applicants should have a good educational background. Technical qualifications to HNC level. They will be practical people who enjoy solving problems and underpinning constructional projects. Experience in analogues and digital electronics is essential together with ability to use a lathe and milling machine.

We are looking for experienced engineers to join a small group offering engineering support to research workers in pharmacology and related departments.

We offer a person to join a small group offering engineering support to research workers in pharmacology and related departments.

The work involves the maintenance and development of electronic equipment and systems, and training of staff of the Radio Engineer.

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杨广，上海新大陆电子有限公司，上海市浦东新区张杨路701号，邮政编码：200120。

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**P.O. Box 3, Ralves, Essex SS6 8LR.**

**P.O. Box 3, Ralves, Essex SS6 8LR.**
To see how Multicore Oxide-Free Solder Creams offer you higher profits—just watch

Applications don’t come much more critical than digital watch manufacture. Here, discrete deposits of Multicore Oxide-Free Solder Cream are screened onto the PCB. A precision job, with no risk of operator error or fatigue. And, a convenient temporary adhesive for the positioning of components.

Solder-flow is accomplished by simply passing the units over a hot plate. Fast. No oxide to contend with. No dirty residues. This manufacturer says Multicore Oxide-Free Solder Cream has reduced reject rate substantially and offers superior soldering quality.

ordinary solder creams cannot match this profitable performance. Here’s why...

...because ordinary solder creams or pastes contain rosin-based flux mixed with solder powder produced by atomisation. This means that every particle of the powder is covered with a layer of oxide—slowing down the soldering process, leaving a dirty flux residue and causing solder globules to stick to the flux and possibly fall loose into the equipment after shock or vibration. But, Multicore have developed a very special method of producing solder powders that are virtually oxide-free.

These can be used in cream form – comprising an homogeneous stable mixture of pre-alloyed powder and flux, designed specifically for hybrid microcircuits, PCB’s and critical component joints.

When heated, Multicore Oxide-Free Solder Creams melt and flow as quickly and cleanly as rosin-cored solder wire, leaving a pale clear flux residue without solder globules. The inherent quality of Multicore Oxide-Free Solder Creams make them the ideal specification for almost any application calling for low cost yet high reliability.

They are available in a wide range of combinations of solder alloys, fluxes, particle sizes, flux contents and viscosities—often replacing solder preforms.

However, if you have an application that specifically requires preforms, remember that Multicore supply a wide variety of those as well.

Multicore Solders Ltd are Ministry of Defence, Registered Contractors and on Qualified Products List QQ-5-571E of U.S. Defense Supply Agency for solder creams and preforms.

For full information on Oxide-Free Solder Creams or any other Multicore products, please write on your company’s letterhead to:

Multicore Solders Limited,
Maylands Avenue, Hemel Hempstead, Herts. HP2 7EP.
Telephone: Hemel Hempstead 3636. Telex: 82363.