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Designing with Micros

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First select a mainframe, there are 5 basic models from which to choose, providing 1, 3, 4, 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.

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The only limitation is your imagination

Front cover shows aerials of Garrigur television station operated by Swiss PTT. Photo: the Hamer-Smith Swiss collection.

IN OUR NEXT ISSUE

Wideband audio amplifier design by Yuri Miloslavskij aims at good transient response using class A circuitry and no overall feedback. Constructional design for multisection tone equalizer is made inexpensive by use of quad opamps and preset controls. Also articles on community broadcasting, an unusual technique for install detecting and analogue computing methods. For details of these see panel on page 85.

Current issue price 50p, back issue if available £1.00, at Retail and Trade Counter, Para Garden, London SE1. Available on microfilm. Please contact editor.

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Digital world

Electronics/Televisions/Radio/Audio

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Voltage & db Ranges
15V, 50V, 150V → 500V fsd
Acc. ±1% ± 1% fsd ± 1V at 1kHz
-100 → -50 → 500
Scale = -20dB to +2dB fsd 1mV/5000.
Response
± 3dB from 1Hz to 3MHz
± 6dB from 4Hz to 1MHz above 500V
TM3B filter switch: LF cut 10Hz,
HF cut 150kHz, 1kHz or 3kHz.
Input Impedance
Above 50mV: 10MΩ < 10pF.
On 50V to 50mV: > 50MΩ < 10pF.
Amplifier Output
150mV at fsd.

<table>
<thead>
<tr>
<th>Type</th>
<th>£130</th>
<th>£145</th>
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<tr>
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<tr>
<td>TM3B</td>
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BROADBAND VOLTMETERS

H.F. Voltage & db Ranges
1mV, 3mV, 10mV → 3V fsd
Acc. ±4% ± 1% at 30MHz
-50 → -40 → 20dB
Scale = -10dB to +3dB fsd 1mV/500.
H.F. Response
± 3dB from 300kHz to 5GHz
± 7dB from 1MHz to 5GHz.
L.F. Ranges
As TM3.
Amplifier Output
Square wave at 20Hz on H.F. with
amplitude proportional to square of input
As TM3 on L.F.

<table>
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<tr>
<th>Type</th>
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<th>£215</th>
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<td>TM6B</td>
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D.C. MICROVOLTMETERS

Voltage Ranges
30V, 100V, 300V → 300V
Acc. ±1% ± 2% fsd ± 1V C2 scale.
Current Ranges
30mA, 100mA, 300mA → 300mA
Acc. ±2% ± 2% fsd ± 20μA C2 scale.
Loc. Range
5μV at 10% fsd, ± 5mV at 50% fsd
100mV at 10% fsd.
Recorder Output
1V at fsd into 1kΩ.

<table>
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<th>Type</th>
<th>£106</th>
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<tr>
<td>TM10</td>
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</table>
DON'T GAMBLE WITH PERFORMANCE
BUY LEVELL VOLTMETERS

A.C. MICROVOLTMETERS
VOLTAGE & dB RANGES
150mV, 500mV, 1500mV...500V fed
Acc. ±1% ±1% fed ± 1µV at 1kHz.
-100 ... -10 dB ± 50dB.
Scale = 20dB / 6dB ref. 1mW / 500Ω.
RESPONSE
± 0.06dB from 1 kHz to 1MHz.
± 0.3dB from 1 Hz to 1MHz above 500µV.
TM3B filter switch: LF cut 10kHz,
HF cut 100kHz, 10kHz or 30kHz.
INPUT IMPEDANCE
Above 50mV: 100MΩ ± 20pF
On 50mV to 50mV: ± 5MΩ ± 50pF
AMPLIFIER OUTPUT
150mV at fed.
type TM3A £130
type TM3B £145

BROADBAND VOLTMETERS
H.F. VOLTAGE & dB RANGES
1mV, 3mV, 10mV...3V fed.
Acc. ±1% ±1% fed ± 1µV at 1kHz.
-50 ... -40 dB ± 20dB.
Scale = 10dB / 3dB ref. 1mW / 500Ω.
RESPONSE
± 0.06dB from 300kHz to 400MHz.
± 0.7dB from 1MHz to 50MHz.
H.F. RESPONSE ± 3dB from 300kHz to 400MHz.
± 0.7dB from 1MHz to 50MHz.
L.F. RANGES As TM3.
AMPLIFIER OUTPUT
Square wave at 20kHz on H.F. with
amplitude proportional to square of input.
As TM3 on L.F.
type TM4A £199
type TM4B £215

D.C. MICROVOLTMETERS
VOLTAGE RANGES
30µV, 100µV, 300µV...300V
Acc. ±1% ±1% fed ± 1µV / CIB scale.
CURRENT RANGES
30µA, 100µA, 300µA...30mA
Acc. ±1% ±1% fed ± 2µA / CIB scale.
LOG RANGE
± 5µV at ±1% fed, ± 5mV at ±50% fed.
± 50mV at ±1% fed.
RECORDING OUTPUT
± 1µV at fed into ±1kΩ.
type TM10 £106

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The Hitachi-Denshi Oscilloscopes have been researched and produced by Hitachi Electronics specialists and has resulted in a range of modern Oscilloscopes which feature wider band width, a compact design and light weight.

The circuitry in these new Oscilloscopes combines linear IC's and logic IC's plus modern manufacturing techniques, including automatic component insertion machines, thus ensuring increased stability, improved reliability, excellent performance and an enhanced operating ease.

Just look at these outstanding features:

- Trace rotation system for easily adjusting bright-line inclination caused by terrestrial magnetism.
- X-Y operation, which is very convenient for measuring phase difference of two wave forms.
- TV sync separator circuit facilitates rapid video signal measurements.
- Extra high sensitivity: vertical sensitivity of 1 mV div now available.
- Built in signal delay line for leading edge observation of quick rising wave forms.
- Sweep time magnifier effective for precise measurement: Sweep time magnifying ten times is now possible when one touch operation.

In addition these Oscilloscopes will ensure that very feeble analogue signals can also be measured and any of the line voltages 100, 120, 220 and 240 can be selected by tap changing.

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V-151 15mhz single trace
V-152 15mhz dual trace
V-301 30mhz single trace
V-302 30mhz dual trace

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Measures resistance to 0.01 ohms, voltage to 100 microvolts, current to 1 microamps at lowest ever price!

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- 100g (V), 1µA, 0.015Ω resolution
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- High accuracy achieved with precision resistors, most stable transistors
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- Auto zeroing, auto calibration
- Mains (with adaptors not supplied) or battery operation built-in charging circuitry for NiCads
- Overrange indication
- Hi. Low power ohms, Lo for resistors in circuit, Hi. for diodes

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- Mains lead - 100mm

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Just look at these outstanding features:

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- **X-Y operation, which is very convenient for measuring phase difference of two wave forms.**
- **TV sync separator circuit facilitates rapid video signal measurements.**
- **Extra high sensitivity: vertical sensitivity of 1 mV/div now available.**
- **Built in signal delay line for leading edge observation of quick rising wave forms.**
- **Sweep time magnifier effective for precise measurement:** Sweep time magnifying ten times with one touch operation.

In addition these Oscilloscopes will ensure that very feeble analogue signals can also be measured and any of the line voltages 100, 120, 220 and 240 can be selected by tap changing.

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**V-152 15mhz dual trace**

**V-301 30mhz single trace**

**V-302 30mhz dual trace**
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<td>276-034</td>
<td>LED</td>
<td>2 for 59p</td>
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**Reader inquiry number 220**

- 15 MHz dual trace
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- 1Mv sensitivity, Y and X (via A input)
- 8 invert facility

**THE FUTURE**

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- High accuracy and frequency stability
- 3-150 Hz or 3000 Hz switchable
- Separate 'On' and 'Off' indication

**Reader inquiry number 224**

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**PM 3151 colour TV pattern generator**

**PM 3152 RF signal generator**

**PM 3077 wow and flutter meter**

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Some other **PM 2517 plus points:**

- True RMS readings of AC voltage and current
- Autoranging with manual override
- Optional accessories include temperature and data hold probes

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**The PM 3207**
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- **Auto triggering from either channel with adjustable level between peaks and TV triggering**
- **FM sensitivity, Y and X (via A input)**
- **8 bit facility**

**Reader inquiry number 220**

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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 221**

**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 test system - Philips have carefully selected the best patterns for aligning and testing these products. With over 30 colour and line test patterns to choose from it is the most versatile pattern generator on the market.

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- **RF** signal available in bands I, II, III, IV and V
- **Variable Video Output** with fixed input position
- **External video and sound modulation facility**
- **Composite sync output for triggering** includes the line frame and blanking pulses to the local TV standard

**Reader inquiry number 223**

**PM 6307 WAW AND FLUTTER METER**
- **Xtal controlled oscillator**
- **High accuracy and frequency stability**
- **150 Hz or 3000 Hz switchable**
- **Separate 'On' and 'Flutter' indications**

**Reader inquiry number 224**

**PM 6307**
- **WAW and Flutter meter**

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And yet the ZX80 is a complete, powerful, full-facility computer, matching or surpassing off-the-shelf personal computers on the market at several times the price. The ZX80 is programmed in BASIC and you can use it to do virtually everything from playing chess to running a power station.

The ZX80 is perfectly straightforward to assemble, using a first or second-hand film. Once assembled, it immediately proves its worth and you're ready to go.

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- Printed circuit board, with ICs sockets for all ICs.
- Complete kit with every IC and other components: all mounted and tested.
- New rugged Sinclair keyboard, matching machine.
- Ready-assembled, tested.
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The Sinclair ZX80 kit includes everything you need to build a complete, powerful, full-facility computer. The ZX80 is programmed in BASIC and you can use it to do virtually anything from playing chess to running a power station.

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<td></td>
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<td>ZX80 Keyboard</td>
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<td></td>
<td>£10.00</td>
</tr>
</tbody>
</table>

Total: £

Please note: all ZX80s are supplied with a complete instruction book. Use the coupon in the catalogue for the earliest possible delivery. All orders must be dispatched in strict order. VAT is charged at the current rate and is included in the price shown.

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Britain's first complete computer kit.

A complete personal computer for a third of the price of a bare board.

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The Sinclair ZX80.

Until now, building your own computer could cost you around £300 and still leave you with only a bare-board kit. That's because the truly advanced, affordable computer has never been available in a kit form.

The Sinclair ZX80 changes all that. For just £30 you get everything you need to build a personal computer at home—PWBs, with ICs mounted on them, an 807 microprocessor, sockets for your own choice of peripherals, a power supply and a printed circuit board, along with the complete instructions needed to read and follow them. And yet the ZX80 really is a complete, powerful, full-featured computer, matching or surpassing other personal computers on the market at several times the price. The ZX80 is programmed in BASIC, and you could not do it more readily if you were playing chess than in writing programs.

The ZX80 is priced at £30, to give you what the computer industry, in a rare instance, calls "value for money." Once assembled, it immediately proves itself to be all that it sets out to be—literally anything from playing chess to programming, to music, to television, to telecommunications, to whatever you can program. For just £30, the ZX80 is a complete personal computer. Quite apart from its price, the ZX80 is remarkable for the extreme simplicity of its design and the range of its capabilities.

The ZX80 is straightforward to program, to assemble. It is pleasantly straightforward to assemble, and it is straightforward to program. It is straightforward to operate. It is a computer. It is a complete personal computer. Quite apart from its price, the ZX80 is remarkable for the extreme simplicity of its design and the range of its capabilities.

Two unique and valuable components of the Sinclair ZX80.

The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptional low price, the ZX80 has two unique components: the Sinclair BASIC interpreter, and the Sinclair teach-yourself BASIC manual. The unique Sinclair BASIC interpreter allows convenient programming advantages; the unique Sinclair teach-yourself BASIC manual makes learning BASIC straightforward.

BASIC is the features of the Sinclair interpreter that allows the man to build a computer himself. The manual is the source of the teach-yourself approach. The ZX80 comes with a conventionally written 12-page BASIC, but with every line explained in the specially-written English text. The book also contains a complete course in BASIC programming. It includes everything you need to know about programming: everything from basic to advanced. The book also contains a complete course in BASIC programming. It includes everything you need to know about programming: everything from basic to advanced. The ZX80 comes with a conventionally written 12-page BASIC, but with every line explained in the specially-written English text.

The ZX80 also comes with a complete manual, which includes all the necessary information and instructions for assembling the ZX80. The manual is also included in the ZX80 kit.

The ZX80 is a complete personal computer. Quite apart from its price, the ZX80 is remarkable for the extreme simplicity of its design and the range of its capabilities.

Your ZX80 kit contains...

- Printed circuit board, with IC sockets for all ICs.
- Operating instructions, including all ICs—all manufactured by selected world-leading suppliers.
- New napped Sinclair keyboard, matched to computer.
- Ready-assembled case.
- Cascaded plug-in memory, including all RAM.
- Complete computer in a complete case, including 256K of RAM.
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Optional extras...

- Options to enable the ZX80 to be used as a full-fledged word-processor, or as a complete typewriter.
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- L10-3C* 0-10V, 3A
- LT30-1 twin output unit 2 x 0-30V, 1A
- L30-2 0-30V, 2A
- LT30-2 twin output unit 2 x 0-30V, 2A
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L30-2 0-30V, 2A
LT20-1 twin output unit 2 x 0 – 30V, 1A
L30-5 0-30V, 5A
L30-10C twin output unit 2 x 0 – 30V, 2A
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L30-10C twin output unit 2 x 0 – 30V, 2A

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fact: there's a Shure cartridge that's correct for your system—and your cheque-book:

V15 Type IV: The perfected & pickup—outstanding high frequency with truly noteworthy performance. Reduced distortion. Unprecedented tracking force. At greatly desirable prices. The M97HE features the innovation-stripping hyperelliptical stylus. 3/4 gram tracking. Overall fidelity is absolutely critical. Just as the world can transcend the limitations of a réalisations, so can our approach transcend the limitations of the hi-fi source of the recording. The M97HE cartridge functions as the source of sound through which the recording is linked with the balance of the hi-fi system—therefore, its role in high fidelity is absolutely critical. Just as the camera can be no better than its lens, so must the hi-fi system in the world can transcend the limitations of a real current. The cartridge represents a relatively modest investment which can audibly upgrade the sound of your entire record playback system. Consult with your nearby Shure dealer who will help you select the Shure pickup cartridge that is correct for your system and your cheque book. We especially recommend that you audition the Shure V15 Type IV. Discriminating critics throughout the world praise this cartridge as the new standard for faithful sound reproduction. It overcomes such ever-present problems as dust, static electricity, and distortion—effects which can audibly upgrade the sound of your entire record playback system.

M7HE: The new model from an entire new line of Shure pickup cartridges, each with its own characteristics. Stable stylus and the unique SLIDE GUARD tone-arm protection system, and available in a range of stylus tip, tracking force, and price. The M7HE features the innovation-stripping hyperelliptical stylus. 3/4 gram tracking. Overall fidelity is absolutely critical. Just as the world can transcend the limitations of a real current, so can our approach transcend the limitations of the hi-fi source of the recording. The M7HE cartridge functions as the source of sound through which the recording is linked with the balance of the hi-fi system—therefore, its role in high fidelity is absolutely critical. Just as the camera can be no better than its lens, so must the hi-fi system in the world can transcend the limitations of a real current. The cartridge represents a relatively modest investment which can audibly upgrade the sound of your entire record playback system. Consult with your nearby Shure dealer who will help you select the Shure pickup cartridge that is correct for your system and your cheque book. We especially recommend that you audition the Shure M7HE. Discriminating critics throughout the world praise this cartridge as the new standard for faithful sound reproduction. It overcomes such ever-present problems as dust, static electricity, and distortion—effects which can audibly upgrade the sound of your entire record playback system.

M95HE—New mid-priced cartridge with distortion-reducing hyperelliptical stylus. Flat response. To 3 grams tracking.

M75OE Type 2—Deluxe cartridge with a system of plate guidance for outstanding high-frequency tracking. Flat response. To 1 1/4 grams tracking.

M70 Series—Moderately priced cartridges with high-fidelity performance. To 3 grams tracking. Broadly or Spherical stylus.

If the recent correspondence on displacement current has done nothing else it has drawn our attention to the 'pits that awaits us if we take a mental model as the whole truth about a phenomenon. Under examination is a model in the form of a set of equations and the extent to which it represents a reality. We see immediately that equations are like architects' drawings—precise, quantitative, stating relationships between quantities but stopping somewhere short of a convincing description of an actual building. Like all mental models they lack body. The 'pits that awaits us is what A. N. Whitehead called "the fallacy of misplaced concreteness"—the mistake of attributing reality to what is no more than a construct of the mind. Because there is a word (or symbols) for it, and a corresponding mental picture, we assume it exists as a concrete entity. As for displacement current, our readers may be forgiven if they feel confused by the various statements made about it by its contributors. One author says the fact that the solution of Maxwell's equations is a propagating wave is a result that "is only obtained through the existence of displacement current" and issues the rallying cry "no radio waves without displacement current." A correspondent then asks (presumably thinking of propagation in outer space) "what is displaced in a vacuum?" to which there is no direct answer. And later another correspondent remarks "presumably no one is insisting that everyone must believe that there is any physical reality in a current which is said to flow in empty space when there is nothing to carry it..." The puzzling question is: how are we justified in describing as an electric current something which has no physical reality as a motion of charge? Perhaps the answer is because displacement current exists in one respect anyway as a rational construct of the mind. We can consider this in the light of Kant's "mind contribution" to science—the notion that the mind supplies a priori concepts, independent of all experience (e.g. the truths of formal logic), to which we make our empirical observations conform. (See Kant's Critique of Pure Reason.) When we consider any current intuitively, as a movement of charge in a conductor, its concreteness seems beyond question, especially when we are able to feel the heat or see the light or sparks it produces. But as soon as we try to define it quantitatively, in the way we do as a rate of flow of charge, Q/t, we move into an abstract world; for a rate is not an empirical fact but an a priori concept, independent of all experience, belonging to the realm of logic and mathematics. Current may flow but current strength doesn't; it exists, as a correspondent has pointed out. It is a pure concept, isolated from those realities of practical circuits in which, for example, you also need electrical potential and energy to push round the needle of your ammeter. Similar considerations apply to the rate of change of electric displacement, dD/dt. When a current is shown in the mathematical form of a term in an equation we are not seeing a full representation of a real current but merely a symbol or symbols for one of the physical quantities in the equation, its strength, defined as a rate.

Writers often refer to the "necessity" for displacement current in Maxwell's equations, as if this necessity were itself a compelling proof of concrete existence. But, of course, necessity is not an empirical fact. As Hume showed in his famous analysis of cause and effect, "necessity is something that exists in the mind, not in objects..." (e.g. logical necessity). To confuse a priori concepts such as necessity and rate with physical realities is to be caught in the fallacy of misplaced concreteness.

M97HE: The new model from an entire new line of Shure cartridges—each with exclusive Dynamic Stabilizer and the unique SIDE-GUARD anti-skate protection system, and available in a range of styli tips, tracking forces, and prices. The M97HE features the attention-drawing hypotrochoidal stylus. To 1 gram tracking.

M95HE: Newly priced cartridge with distortion reducing hypotrochoidal stylus. Flat response. To 1 1/2 gram tracking.

M75E Deluxe cartridge with a nude-mounted Biradial 1/2Vz cartridge functions as the source of sound which the recording is linked with the balance of the hi-fi system—therefore, its role in high fidelity is absolutely critical. Just as the camera can be no better than its lens, not even the finest hi-fi system in the world can transcend the limitations of inferior cartridge. The cartridge represents a relatively modest investment which can audibly upgrade the sound of your entire record playback system.

Consult with your nearby Shure dealer or write for further details.

If the recent correspondence on displacement current has done nothing else it has drawn our attention to the pitfall that awaits us if we take a mental model as the whole truth about a phenomenon. Under examination is a model in the form of a set of equations and the extent to which it represents a reality. We see immediately that equations are like architects’ drawings —precise, quantitative, stating relationships between quantities but stopping somewhere short of a convincing description of an actual building. Like all mental models they lack body. The pitfall that awaits us is what A. N. Whitehead called “the fallacy of misplaced concreteness” — the mistake of attributing reality to what is no more than a construct of the mind. Because there is a word (or symbols) for it, and a corresponding mental picture, we assume it exists as a concrete entity.

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Designing with microprocessors

1 — Basic components of the microprocessor chip

by D. Zissos and Laurelle Valen
Department of Computer Science, University of Western Ontario

This series of articles responds to the need to demonstrate the representability of the microprocessor as a down-to-earth, extremely useful, but entirely non-occult electronic component” (our March editorial) and is intended for electronics engineers who want to learn how this component can be used in the design of systems. The authors therefore use formal, step-by-step procedures in their explanations of how the device operates. This first article deals with the basic components of eight- and sixteen-bit microprocessor chips and the second will continue with their internal operation from the designer’s point of view.

The starting point in the design of microprocessor-based systems, and indeed of all programmable systems, is a working knowledge of hardware, software, and of their interaction. This view, although not generally accepted, is becoming more widespread. The roots of this attitude can be traced back to the early 1960s, when computers were becoming widely used. Because of the lack, at that time, of formal hardware design procedures, much of the research effort was directed towards the development of new independent languages. This resulted in thick layers of software administration, with bureaucrats being erected around the machines. In the 1970s formal methods for the design and implementation of hardware were developed, but largely were, and still are, being ignored by main-frame users. The evolution of m.s.i. and l.s.i. (medium and large scale integration) chips in general, and of microprocessors specifically, has made such an attitude progressively more difficult to sustain and justify, as the software/hardware barriers erected in the 1960s are not easily tolerated today. We shall therefore start the series by finding out how microprocessor chips work.

The newcomer to this area will be relieved to learn that basically there is no difference between various microprocessor chips, in spite of attempts to classify them into various categories, or, for example, into three generations. Their difference (as with cars) is one of refinement rather than substance. The reader should be aware that, in general, superior performance calls for expertise, and that one may experience fewer problems with a less sophisticated microprocessor than with the latest and fastest. As we shall see later, fast system response (if the present-day knowledge, becomes a management rather than a technical problem.

The microprocessor chip

From the user’s point of view, the microprocessor is a device which accepts control data and problem data and produces processed data, as shown in Fig. 1. The control data is commonly referred to as op codes, and the problem data as operands.

Fig. 1. The microprocessor from the user’s point of view.

The basic components of a typical microprocessor chip from the designer’s point of view are:

- The status control signals of the Intel 8080, Motorola 6800 and the Intel 8088 are shown in Figures 3, 4 and 5, respectively.

In Fig. 6 we show the basic configuration of a simple processor system. The functions of the interface blocks are to monitor the status of the signals of the microprocessor chip and of the corresponding peripheral, and to generate the correct sequence of command (control) signals that will allow them to communicate with each other.

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Fig. 3. Status and control signals of the Intel 8080 microprocessor chip.
Designing with microprocessors

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by D. Zissos and Laurelle Valen
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The newcomer to this area will be relieved to learn that basically there is no difference between various microprocessor chips, in spite of attempts to classify them into various categories, or, for example, into three operations. Their difference (as with cars) is one of refinement rather than substance. The reader should be aware that, in general, superior performance calls for expertise, and that one may experience fewer problems with a less sophisticated microprocessor than with the 'latest' and 'fastest.' As we shall see later, fast system response (if desired) with present-day knowledge, becomes a technical problem rather than a technical point.

The microprocessor chip

From the user's point of view, the microprocessor is a device which accepts control data and problem data and produces processed data, as shown in Fig. 1. The control data is commonly referred to as op codes, and the problem data as operands*. From the designer's point of view, the operator is defined as the entity on which operations are performed.

*In microprocessors the word operand is defined as one of the following:

(a) the basic components of the microprocessor chip

(b) any internal register that can be connected to the data bus and is used to hold incoming and outgoing data, as well as the output of specified arithmetic and logic operations. Some microprocessor chips have more than one accumulator; for example, the Motorola 6800 has two accumulators, A and B.

(c) the address bus is the set of wires carrying the data in and out of a microprocessor chip. It is intended for single-processor systems. In multi-processor systems, the address bus is used for automatic memory address generation, and for other control signals.

(d) the control bus is the set of wires carrying the control signals. These signals are commonly determined by the result of the execution of the instruction cycle. The control bus is used to control the operation of the processor and to generate the correct sequence of command (control) signals that allow them to communicate with each other.

The basic components of a typical microprocessor chip from the designer's point of view are:

The accumulator(s) (ace.). This is a register with a dedicated function. Each bit represents one data input or output. The accumulator(s) are used for arithmetic, logic, and control operations. The accumulator(s) is a register that can be connected to the data bus, and it is used to hold incoming and outgoing data, as well as the output of specified arithmetic and logic operations. Some microprocessor chips have more than one accumulator; for example, the Motorola 6800 has two accumulators, A and B.

Addressing registers (r). This register is used to hold incoming and outgoing data, as well as the output of specified arithmetic and logic operations. Some microprocessor chips have more than one addressing register; for example, the Motorola 6800 has two addressing registers, A and B.

Condition flags. This register is used to hold incoming and outgoing data, as well as the output of specified arithmetic and logic operations. The condition flags are used to control the operation of the processor and to generate the correct sequence of command (control) signals that allow them to communicate with each other.

Microprocessor chips generate status signals indicating their internal state. The status signals are used to control the operation of the processor and to generate the correct sequence of command (control) signals that allow them to communicate with each other.

Status information. This is the information that is used to control the operation of the processor and to generate the correct sequence of command (control) signals that allow them to communicate with each other.

*Tristated during software halt

Note: Signal HLDA goes high within specified delay of the loading edge of the clock pulse. The address and data busses are floated high within a brief delay after the rising edge of the next clock pulse.
whether there is a carry after an 'add' operation and so on. They are mainly used to modify the sequence of program execution. Sometimes the condition flags are collectively referred to as condition codes or status word.

Instruction decoder. This is a combinational circuit used to decode the op code, held in the instruction register (I.r.), into a set of signals that can be interpreted directly by the timing and control unit. See Fig. 7.

Instruction register (I.r.). This is a register which receives the op code of each instruction in turn and holds it during execution. In our case the op code is loaded into the instruction register (I.r.) during state M1 T2 in Fig. 8.

Program counter (p.c.). This is an addressing register which holds the address of the next byte in the program memory. The counter is incremented or decreased by an amount equal to the length of the instruction at each state. See Fig. 7.

Timing and control unit. This is a sequential circuit which samples the decoded output of the instruction decoder and the external control signals, and specifies the appropriate machine cycles that are needed for the correct execution of the current instruction. It does so by generating control and timing signals which are routed to the appropriate components of the microprocessor chip. The machine cycles required to execute a three-byte (input/output) instruction are shown in Fig. 8.

Microprocessor chips contain no special circuits that do not exist in conventional digital computers. This raises the question of the necessity for special treatment. The answer is the connection problem imposed by the relatively small number of pins (typically 40) that are attached to a microprocessor chip containing the equivalent of several thousands of discrete logic components. This access problem is solved in practice by time-sharing the address and data pins, as will be described in the next article. To be continued.

The scientific computer club

Following the publication of a two-microprocessor scientific computer design (April to September 1979 and January to February 1980), this series has received some more requests for more information and details of similar systems. We are therefore pleased to note the formation of a computer users' club for the Adams machine, which we hope will stimulate interest in this design and encourage correspondence between readers.

To start the ball rolling a monthly newsletter, starting in May, will be circulated by Phillip Probert to members for an annual subscription of £5.00 including postage. John Adams, the designer, will contribute a series of articles describing the computer in greater detail, and he will also help to answer members' queries. The early issues will contain short editorials and include programming information and examples, while later issues will reflect members' interests by publishing their programs, letters and comments.

Feedback is important, so send subscriptions, suggestions, contributions and queries to Phillip Probert, 36 Cromwell Road, Wimbledon, London SW19, 8LZ, England.

References

A linear channel handles the video signal without stretching or cramping. It normally amplifies the visible spectrum satellite channel, which has a high dynamic range and is fairly constant in mean level throughout the year. It also receives a reasonable range of geographical latitude. The linear channel comprises four parallel linear amplifiers, one selected at a time, and is used as a reference against which the third channel is adjusted. After inversion, the amplified signal is applied to an analogue switch common to both video channels.

A log-channel is used to process the infra-red video signals. However, there are several problems in producing good pictures, such as the small f.m. subcarrier frequency used for a large dynamic content-change. This is due to temperature variations, for example, the coldest cloud tops can be -60°C and the warmest land at about 40°C. If a coastline is to be depicted, which aids location of the weather system and is generally more interesting, only small differences of a few degrees can be expected. Because these changes are in the warm part of the infra-red range, advantage can be taken of the logarithmic amplifying process where the gain is minimum at low (i.e. warm) signal levels and increases with an increase in amplitude. Therefore, the coastline can be enhanced and the cold cloud systems, with their large temperature variations, can be shown quite clearly. Two problems with this technique are the level at which log amplification starts, and the changes in mean temperature with season and latitude. In this design a variable control with a dial is used which rescales for different orbits. The approximate mean picture level for the i.r. channel is roughly matched to that of the sunny portion of the visible channel. The sunny part of the visible channel is used both day and night to see the daytime terminator on a polar orbit, especially in winter. Also, interest is heightened by producing the i.r. and visible pictures side-by-side and observing, from the i.r. scene, the weather in the darkened visible section.

After the input level potentiometer, a switch allows either direct log amplification of the signal, or expansion...
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Program counter (p.c.). This is an addressing register which holds the address of the next byte in the program memory. The program counter will be incremented by the exception of such instructions as jump, branch and so on. It is connected to the address bus, a, during state T1 in a fetch cycle. See Fig. 7.

Timing and control unit. This is a sequential circuit which samples the address of the next byte in the program memory and externally for fax machines, one selected at a time, and is used as a reference against which the third channel is adjusted. After inversion, the amplified signal is applied to an analogue switch common to both video channels.

A log-channel is used to process the infra-red video signals. However, there are several problems in producing good pictures, such as the small f.m. subcarrier, which will be discussed in a later section. Fig. 8 shows the internal operation of a microprocessor chip.

Fig. 7. Components and internal organization of an eight-bit microprocessor chip.

Fig. 8. Internal operation of a microprocessor chip.

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A prototype of the latest American polar orbiting weather satellites, TIROS-N (TIROS X, 1975-1976), was launched on October 13, 1978. One of the main improvements over the TIROS-N series and the ITOS (NOAA) predecessors is the improved picture definition. This is due to improved scanning radiometers and a faster scanning rate, 120 p.m. compared with 48 p.m. for the NOAA.1 to 5 series. Two channels of picture information are sent on the h.t. transmission and in normal use one channel is infra-red while the other is in the visible spectrum. The choice is made at ground control and later satellites will be capable of sending, on h.t., two of five available spectral range pictures from the S-band repertoire. Images received on one of the four frequencies used for the TIROS-N series, 137.50 and 137.62 MHz, have a ground definition of 4km and have image-distortion correction so that the received pictures are flat, and do not suffer from "bottle distortion" as with earlier satellites. The receive antenna needs to be right-hand circularly polarized and the receiver must cope with a peak 2.4kHz deviation of ±17kHz. The TIROS-N series h.t. video format is shown in Fig. 1 and a block diagram of the signal processor is shown in Fig. 2.

The clock channel produces various timing signals, locked to the satellite subcarrier signal, for use within the processor and externally for fax machine or oscilloscope synchronization. A phase-lock loop is used, preceded by a limiter stage to render the clock circuits immune to signal amplitude variations. A 115kHz output is buffered by a Schmitt trigger and divided to produce the timing and synchronizing signals.

This signal processor produces real-time visible and infra-red weather pictures side-by-side and correctly exposed. Up to four satellites may be processed on the unit which has been designed for high quality pictures from orbiting weather satellites.

For a description of a facsimile machine suitable for use with this processor, and for background information on weather satellite reception, readers should refer to previous articles by the author, listed in the references.

This article forms part of a series covering "Microprocessor programming and software development." Prentice Hall, 1979.
The 2.4kHz demodulated subcarrier, which is amplified by the linear channel and analogue switch, is divided by two with an equal mark-to-space ratio. The 4kHz is divided through a potentiometer to set the value for this resistor is 2k2. The linear channel and analogue switch are shown in Fig. 4. The 2.4kHz video signal is taken via S8 to one op-amp in IC5. Each amplifier has a gain control and a level setting potentiometer which can be adjusted for a given satellite without affecting the others. The logarithmic amplifier for amplifying the selected signal is fed to IC6a, which sets the input current. Therefore, the loop current is directly proportional to the input voltage in IC6a. This is a useful feature in winter when the southerly portion of a northern hemisphere pass can be previewed in visible, and the northern portion, which may be in darkness, printed in I.R. without. Switch C1 passes through a flip-flop Q output, and the strobe pulses from the switch are shown in Fig. 4. The 2.4kHz is taken from the flip-flop Q output, and the strobe pulses are amplified and the working point is altered to suit standard values. The linear channel and analogue switch are shown in Fig. 4. The 2.4kHz video signal is taken via S8 to one op-amp in IC5. Each amplifier has a gain control and a level setting potentiometer which can be adjusted for a given satellite without affecting the others. The logarithmic amplifier for amplifying the selected signal is fed to IC6a, which sets the input current. Therefore, the loop current is directly proportional to the input voltage in IC6a. This is a useful feature in winter when the southerly portion of a northern hemisphere pass can be previewed in visible, and the northern portion, which may be in darkness, printed in I.R. without. Switch C1 passes through a flip-flop Q output, and the strobe pulses from the switch are shown in Fig. 4. 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The 2.4kHz output of the p.l.l. is a.c. coupled to Schmitt trigger IC9 which squares the signal at t.l.i. level. This is buffered by Trs 15 and 16 to an external socket for fax and oscilloscope use, and also fed to a series of dividers. IC4 divides by 2 to give 200Hz, part of IC5 divides by 5 to give 400Hz and IC6 divides by 10 to give 4Hz with an equal mark-space ratio. 

The 4Hz is distributed to Schmitt trigger IC12a and IC12b whose gain is selected by R73. A second limiter feeds the p.l.l. whose v.c.o. frequency is set to 2.4kHz by R18. The 4Hz is distributed to external socket, to part of IC5 which selects the Q and Q lines of the analogue switch, and drive l.e.d. circuit has been altered to suit standard values. 

The linear channel and analogue switch are shown in Fig. 4. The 2.4kHz video signal is taken via S3 to one op-amp in IC9. Each amplifier has a gain control and a level setting potentiometer which can be adjusted for a given satellite without affecting the others. The operating points of the linear amplifiers in IC9 are set by the logarithmic video signal leakage. The on resistance varies with the input signal and so the mean 2.4kHz signal is amplified by the linear channel. When using a toggle switch biased to give a good compromise for weak and strong signals. For a strong signal, a duty cycle of 25% is sufficient 2.4kHz to lock the following loop. When using a toggle switch biased to 50%, the loop begins to oscillate. Therefore, the loop current is directly proportional to the input voltage Vinput and the linear channel. 

The logarithmically amplified and inverted signal is switched by S3 to one of the linear amplifiers in IC5 and the selected signal is fed directly to IC8 which switches in the same way as the facsimile switch IC7. 

Construction 

The linear and log. channels should be separated to avoid crosstalk and to enable adjustments to be made without confusion. The gain controls, which are seldom altered after the initial adjustment, can be outer carbon or ferrite potentiometers. 

Table of components 

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<td>Capacitors 20%</td>
<td>20</td>
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<td>1/4W</td>
<td>47, 100, 220, 1000, 1M, 2200, 10k</td>
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<td></td>
<td>IC1, IC2, IC3, IC4, IC5, IC6, IC7, IC8, IC9, IC10, IC11, IC12</td>
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Fig. 3. (top) Clock channel.

Fig. 5. (bottom left) Logarithmic channel.

Fig. 4. (bottom right) Linear channel.
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Fig. 4. (bottom right) Linear channel.
The electromagnetic spectrum and the geostationary orbit for satellites, both of which are natural resources, should be more equitably shared among the common property of mankind. This is one of the conclusions of the final report of the International Commission for the Study of Communication Problems which was recently presented to the director-general of UNESCO. The 16-member commission has welcomed the decision taken at WARC 79 to convene a series of conferences over the next few years on specific aspects of the utilization of these resources (February issue p. 46, March issue p. 58.

The report deals comprehensively with the right to receive, seek and impart information as a fundamental human right, and it's main message is the need for a greater democratisation of communications (as discussed in our December 1979 leader). It takes the view that fundamental communication problems transcend mere media questions and recommends that communication "be no longer regarded merely as an incidental service and its development left to chance". In setting up new systems "participation should be given to non-commercial forms of mass communication" and, while obviously the media need their revenues, "ways and means should be considered to reduce the negative effects that the influence of market and commercial considerations have in the organization and content of national and international communication flows". The report points out that the freedom of the individual may have access to communication, be it as recipient and contributor, is not the same as the freedom of an investor to derive profit from the media while remaining indifferent to quality and content.

On broadcasting, the "development of comprehensive national radio networks, capable of reaching remote areas, take priority over the development of television..." and "national capacity for producing broadcast material is necessary to obtain dependence on external sources...". For communities in developing countries "local radio, low-cost, small-format television and radio systems and other appropriate technologies would facilitate production of programmes relevant to community development efforts, stimulate participation and provide opportunities for diversified expression..."

Traffic for telecommunications, the report says, "are one of the main obstacles to a free and balanced flow of information. This situation must be corrected, especially in the case of developing countries, through a variety of national and international initiatives. Governments should in particular examine the policies and practices of their postal and telegraph authorities. Profits or revenues should not be the primary aim of such agencies. They are instruments for policy-making and planned development in the field of information and culture. International action is also necessary to alter telecommunication tariffs that militate heavily against small and peripheral users... UNESCO might, in co-operation with ITU, also sponsor an overall study of international telecommunication services by means of satellite transmission in collaboration with Intelsat, Interuptruk and user country representatives to make proposals for international and regional co-ordination of geostationary satellite development..."

The new technologies coming into communication have both great potential and great danger, says the report. Countersignals should evaluate their social implications and should promote "participation and discussion..."

**Australian Air Force updates its technology**

William Scholz, a contact in Sydney, reports that the first trials of laser-guided bombs (LGBs) in Australia, using a Mirage fighter of the RAAF, were held recently at the Woomera Rocket range in South Australia. The trials, conducted by Texas Instruments (USA) in collaboration with the Defence Science Research Centre and the Aircraft Research and Development Unit, are a direct result of Prime Minister Fraser’s response to the American call for “increased surveillance of the Indian Ocean area by America’s allies” although why better kill devices are needed to improve surveillance is not necessarily necessary. Those systems are using semi-active homing devices in that they contain passive detectors which collect and process laser energy which has been reflected or scattered from a target, previously illuminated by a separate laser source. The angular displacement between the bomb’s central axis and the direction of the laser is measured by the LGB’s guidance system and correction signals are sent by means of a servo system during flight, causing deflection of the bomb’s strap-on wings. The flight path is corrected accordingly and the bomb steered towards its target.

Despite the general conflict, both the USAF and US Navy employed LGBs as well as electro-optical guided bombs. These bombs use a similar form of visual target identification but were equipped with a different guidance system which offered greater flexibility than the LGB method.
cernet types and have screwdriver access through the instrument case. If the passcure is to be used with a drum fax in a darkroom, it is worth building the instrument either inside the fax machine, or in a shallow case underneath. Also, any LEDs or lamps should be red if bromide type paper is used. It is helpful to use large white lettering for dim-light operation, and to mount the slip-lock switch $S_2$ at a comfortable position away from the other controls. $R_{45}$ can be a screwdriver slot preset, but $R_{46}$ must be noise-free, smooth to operate, well positioned for easy adjustment and fitted with a turn-counting dial if high quality prints are to be obtained. For darkroom use, a digital mechanical dial is better than an engraved analogue type. The output amplifier gain resistor may need to be changed if a different readout device is used, and solder pins on the circuit board make the removal of $R_{45}$ easier.

The power supplies are not critical, but they should be well smoothed. A digital dial if high quality prints are to be obtained, two $2N3704$ devices

To ensure that the circuits, particularly the log. amplifier, are temperature stable, the unit can be permanently on.

After satellite acquisition, slip $S_5$ to establish the picture edge position on the fax or oscilloscope, and select either the side-by-side order of the visible and $S_5$ channels or, by using $S_3$ and $S_5$, select one picture or the pair. At the extreme ends of the pass it may be necessary to reduce the horizontal bandwidth with $S_3$, but normally this can be left in the wide position.

**References**


**Fig. 6. Power supply.**

**Fig. 7. Satellite pictures of the Mediterranean received on the 11th March, 1979. The visible image is on the left.**

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The electromagnatic spectrum and the geostationary orbit for satellites, both of which are natural resources, should be more equitably shared by countries as a common property of mankind. This is one of the conclusions of the final report of the International Commission for the Study of Communication Problems which was recently presented to the Director-General of UNESCO. The 16-member commission has welcomed the decision taken at WARC 79 to convene a series of conferences over the next few years on specific aspects of the utilization of these resources (February issue p. 56, March issue p. 56).

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The new technologies coming into communication have both great potential and great danger, says the report. Community leaders should evaluate their social implications and should promote "participation and discussion..." of social priorities in the acquisition or extension of these new technologies. Decisions on "the orientation given to research and development should come under closer public scrutiny." Concentration of communications technology in a few developed countries and multi-national corporations "has led to virtual monopoly situations in this field. To counteract these tendencies national and international measures are required, among them the control of existing patent laws and conventions, appropriate legislation and international agreements."

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**Spectrum is "common property of mankind"**

William Scholer, a contact in Sydney, reports that the first trials of laser-guided bombs (LGBs) in Australia, using a Mirage fighter of the RAAF, were held recently at the Woomera Rocket range in Australia. The trials, conducted by Texas Instruments (USA) in collaboration with the Defence Science Research Centre and the Aircraft Research and Development Unit, are a direct result of Prime Minister Fraser's response to the American call for "increased surveillance of the Indian Ocean area by America's allies," although why better killing devices are needed to improve surveillance has not been explained. LGBs use semi-active homing devices in that they contain passive detectors which collect and process laser energy which has been reflected or scattered from a target, previously illuminated by a separate laser source. The angular displacement between the bomb's central axis and the direction of the laser is measured by the LGB's guidance system and correction signals are sent by means of a servo system during flight, causing deflection of the bomb's strap-on wings. The flight path is corrected accordingly and the bomb steered towards its target.

During the Vietnam conflict, both the USAF and US Navy employed LGBs as well as electro-optical guided bombs. These bombs used a similar form of visual target identification but were equipped with a different guidance system which offered greater flexibility than the LGB method.

**Microprocessor applications for the disabled**

The Bias '80 exhibition, to be held in conjunction with the Microwave congress in Milano from June 4th to 8th, includes a competition for projects aimed at helping handicapped persons. Total prize money is $7000 in addition to priors in the form of systems, instruments and other items of electronic equipment. Engineers and designers interested in competing should bear in mind that the projects should be useful as aids to disabled persons such as those who are blind, deaf, mute, or persons with difficulties in communication, expression and movement. Consideration will also be given to other unconventional applications of microprocessors not strictly tied to the subject of the competition provided they are of real interest in the bioengineering or medical electronics field.

Special prizes will be presented in this section. Projects should be presented with block diagrams and circuits, hardware complement, software, cost, weight and dimensions. Presentation of a prototype is desirable but not essential. Entries should reach the competition secretary at least 2 weeks before the show. For more information call or write to Studio Barberi, Via Remondini 2, 20129 Milano, Italy, tel. 796 094 421 635.
"Challenge of the Chip" exhibition

There can be many whoana industrialists to whom the "chip" is a total mystery, but few to whom it would do themselves a favour if they were to go along to the Science Museum's "Challenge of the Chip" exhibition, which opened in late February and continues until sometime in December 1980.

In spite of a variety of ailments used to describe it on the sands of jargon reports which did little more than quote the official booklet, it is one of the most effective displays the museum has put on. As a history of the development of modern microelectronics it is highly successful, delving deep into basic materials and fabrication methods to applications in a surprisingly unassuming fashion. Some of the conceptual illustrations are particularly clear-cut, such as, in an early exhibit where the seemingly paradoxical nature of semiconducting materials is illustrated, i.e. that heating causes an improvement in conductivity in semiconductors, as well as an outline, i.e. that heat causes an improvement in conductivity in semiconductors, as well as the apparent incapacity of the technicians to see the grain of the wood, is explained — was totally empty for over 20 minutes while hordes of children gleefully rubbed buttons and pressed things alongside.

In other words, it seems, are one of the major hazards of the exhibition business if the actions of one of the "keepers" were anything to go by. "Too many of the little denizens all at once, that's the worst of the school holidays," one said. Visiting the exhibition during term time might be the best alternative, although this presumes that coach loads will not occasionally press-ganged into the trip by avid science teachers.

Microprocessor competition

To be fair, they couldn't really have known about, for example, the results of the recent British Microprocessor Competition, which was organized by the National Research Development Council (NRDC) in collaboration with the National Computing Centre (NCC). The first prize in category 1 (working model) of £10,000 was won by Siran Agrotec Ltd, of Egham, Surrey, for their design for a potato harvester. This is adaptable for other commodities such as onions, carrots and lettuce, with features similar to that of the selection of a suitable frequency (a frequency other than the 27MHz band on 6 December 1979 that the really strong nearby radio frequency sharing arrangements resulting in the 27MHz band), and only really falling short in the rather common ground between the advocates of c.b. and the government that this frequency would be warn of the plan: or obscene language broadcasts. Furthermore, the point is made that criminal activities would be rendered more difficult by official policing of the system, especially if legislation on c.b. sets included a compulsory identification code signal. Balanced this would be the problems that manifest would be required to regulate the service, which does not fit with current "troubling down" of public service broadcasting, the emergency services, old people's alarm systems and aircraft communications. Signals at this frequency also have a longer range than required.

Estimates have been made that there would be a requirement of between 6 and 8 million sets if c.b. were legalised in the country. A potentially large new market could thus be created for British firms, particularly if the controls imposed on band, modulation and some other criteria, were such that all manufacturers, overseas as well as at home, were starting from a new base in the design of a product. This was brought about by type-approved equipment having to perform to the frequency chosen and the system capable of extension to accommodate more users as funds became available. A decision on the issue was postponed until further information was available to the government, the public and the emergency services.

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In spite of a variety of devices used to describe the exhibition in the sand and dust of daily life, some of which did little more than preach the official booklet, it is one of the most effective displays the museum has yet staged. As part of the development of modern microelectronics it is highly successful, delivering upon its promise to the uninitiated, from sophisticated medical equipment and toys and games based on the chip, explained - was totally empty for over twenty years ago, then maybe the author's "facts" are particularly sharp, such as, in an early batch of two, were suffering from hallucination (possibly low self-esteem) and two from telling the one over the top of the screen.

At £1.50, the official booklet is good value, being crammed with excellent illustrations and only really falling short in the rather wooden style in which it is written and the single hole in its claim, common to the human optical system, to which the microprocessor ("microelectroncs will affect your future.")

However, if one of its more staggering facts is true, any sort of indicator, such as the pocket calculator gives us as much computer power as we would cost £18,000 twenty years ago, then maybe the author's hallucinations of breath at this self-evangelism prevented further literary effort on the subject.

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The relatively "perfect" actions of microcomputers were thrown into sharp relief by the apparent incapacity of the technicians who must surely have set the exhibits up to ensure good results from the video monitors dotted around the showcases. In one batch, two were suffering from hallucination (possibly low esteem) and two from telling the one over the top of the screen.

The Truestock stack control won for Gruney Trellech of Trellech, Mickey, the second prize of £2,000. Once again, however, the displays are dominated by untrained operators enabling, for example, a small ball not to fall onto a line on the floor. A bit explained - was totally empty for over twenty minutes while hordes of children gleefully jiggled buttons and misunderstood things alongside.

In any case, it seems, are one of the major hazards of the exhibition business if the lack of one of the "keepers" is anything to go by. "Too many of the little denizens all at once, that's the worst of the school holidays," was the complaint of one of the "keepers" whoanything to do with a "thief," although this presumption that coach-loads will not occasionally press-gang into the trip by avid science teachers.

"We thought it was very informative, leading right through all the highlights of the first point-contact transistor to the latest on the information retrieval systems.

Some elements were a little silly (but forgivable) such as showing applications of the chip for "testing" processes in rather trivial areas on the floor (e.g. oil petrol level sensing, o.k., but sidestep checking by photocell/irresistors? Men sensors needed to check the checking the i.e.d. which in turn checks on the state of a shocker checking device, always assuming that your i.e.d. are reliable, and you don't come to the conclusion that a length of optical fibre carried from sidestep to the dashboard is all that's needed for instant feedback to the human optical system.

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The Intelligible Plug

Having been involved in power line carrier design for some time I particularly enjoyed reading the article "The Intelligible Plug" in the December 1978 issue. The techniques described for producing the intelligible plug array are both straightforward and practical.

Some time ago I entered a development project involving a power line carrier intercom in conjunction with Semiconductor of Haverhill, Massachusetts. This work culminated in a number of prototype systems, working in pairs so that a person in one room could simultaneously talk and listen to another speaker without having to operate any controls. We even went so far as to install telephone adapters to convert the intercoms more conventional with a normal power line carrier intercom.-operated system with both impulse and touch tone dialing.

From extensive tests on these units by engineers and enthusiastic marketing personnel, we have reached the following conclusions:
- Power line carrier systems provide less than ideal transmission and have a demandable acceptable quality.
- On this side of the Atlantic the lines and 20 kHz do not have the same intercom capability as the one shown in Fig. 2 of your article. However, these characteristics are: circuit can be used to test a house to office to office. The average impedance falls from approximately 30 kΩ to 10 ohms at 20 kHz and then rises, depending on the circuit, to 20 or 50 ohms at 400 kHz. We have stayed clear of high frequencies as we are permitted by the FCC because of the large number of powerful medium wave radio stations near us. As this is under 20 kHz we can use up to 200 MHz. These are resonant as they are tuned to 1 MHz to 40 MHz. This means that our new line will be able to detect almost any transmission that comes within our frequency selection.
- The "Intelligible Plug" produces a local tone in the system by using a frequency close to the carrier frequency. This frequency is then amplified and transmitted over the circuit.
- At high frequencies, where local transmission is most effective, the power line carrier, which is composed of two or three speakers, may work in a simplex system but difficult to use in a duplex system where one doesn't work well, the other one always does.

As an electrical engineer employed by the supplier industry, I read, with interest, the article by Messrs. McKenna, Wingley and Watten on the use of household wiring for data transmission (December 1978). However, the details of electricity distribution given in the article are not entirely correct and this has an effect on some schemes and equipment used in such a data transmitting system.
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Back in 1970 Michael Gerzon, a mathematical researcher at the University of Oxford, was experimenting with tetrahedral recording. Four almost-spherical audition microphones were angled for spherical sound pickup, with playback over four loudspeakers in a tetrahedral array. Microphone angles were determined, matrix-coefficients were calculated, and the discovery made that there was a possibility of horizontal surround sound by reproducing sound and in the enjoyment of music ...

Some time ago I entered a development of the Carr-Bell (1971) tetrahedral recording. Four almost-spherical sound pickup, with playback over four loudspeakers, to give zero phase difference. Now when the height effect is important in reproduction of sound, as it is with a live performance, the periphonic or soundfield illusion of reality should be as close to unity as possible. To oversimplify this, imagine vectors drawn from the centre of a four-speaker array to points in a plane coincident with each speaker and whose length is proportional to the amplitude of sound emitted and add their magnitudes to give a total amplitude. Also add vectorially, which gives a localization according to the Malata theory (which is that direction to which the head turns to give zero phase difference). Now when the head points in another direction the perceived direction generally differs, and while the image position requires that the magnitude of the resultant vector is the same as the total amplitude of sound from the loudspeakers. This ratio is called the vector magnitude, r. (r comes from real; from velocity) and should ideally be unity in reproduced sound, as it is with a live audience.

At high frequencies, where localization depends on inter-aural phase differences, make the length of each vector proportional to the energy of sound emitted and add the magnitudes to give a total energy. Adding vectorially gives a localization according to the Malata theory. At low frequencies, where the head turns to give zero phase difference, then, it is argued, to give good image stability the vector magnitude, r, i.e., the ratio of resultant vector length to total energy, should be as close to unity as possible. (This ratio would be unity for a real sound source, but this cannot be expected in all cases.)

As well as meeting these two criteria good decoder design must get both localization and time-alignment correct, and in all directions. Though it wasn't obvious at the time the trouble with the continued on page 75

First periphonic decoder built by the NRDC sponsored Ambisonic partnership has characteristics that allow a variety of loudspeaker arrays to be used.

THE INTELLIGENT PLUG

Having been involved in power line carrier design for some time I particularly enjoyed the article "The Intelligent Plug" in the December 1979 issue. The techniques described for effective alteration of power line impulses could be used in several ways...

experience with our own full duplex systems forced us to conclude that unless the power lines are fitted with some type of modification to give a suf- fice predictable predictable control knobs, to say nothing of the ex-

We have now been involved with a number of power line carrier intercom systems in conjunction with Industry California and Massachusetts. This work culminated recently in the construction of a number of prototype systems, working in pairs so that a power line is connected between two sets of receiver...
Tune using a variety of different hook-up wires as described in the reference text, and that there is a serious load-sharing problem is shown by the car test results (Table 1). An experienced engineer, I think, would have foreseen these difficulties from the outset, and would have used the usual rig to handle the transformer, and that the transformer is a high-quality unit. The transformer needs to be close to either a thin wire or a thick one, and the minimum height is 3 inches (7cm). The positive output is connected to a thin wire which is used for a few inches of feedback. The feedback path is wound tightly along the transformer and is not necessary away for 7 inches (18cm). The shape of the feedback network is a matter of personal preference, particularly if the thin wire is connected to the output of any part of a half a dozen different sets of output stages. It is difficult to determine something that nothing in electrical engineering is as accurate as the ratio of the Hi-Fi to the mains in the secondary.

It is possible, but not easy, to obtain a considerable output, and one which is not likely to be too low internal resistance (or regulation) to be of use in the output stage. It is difficult to determine the optimum amount of feedback unless one is sure of the amount of feedback used, and one which is not likely to be too low internal resistance (or regulation) to be of use in the output stage. It is difficult to determine the optimum amount of feedback unless one is sure of the amount of feedback used, and one which is not likely to be too low internal resistance (or regulation) to be of use in the output stage. It is difficult to determine the optimum amount of feedback unless one is sure of the amount of feedback used, and one which is not likely to be too low internal resistance (or regulation) to be of use in the output stage. 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assesses the gains made microprocessor-based production is highly relevant and should be used. Alternative technology, of course, exists in the form of traditional local electronic circuits. Some of these may be more suitable for the local conditions and may have a smaller overall system cost. However, the benefits of using microprocessors in this manner are not always obvious, and it is important to consider the potential for scalability and future upgrades. If the design is intended for a specific application, it may be beneficial to build the circuit using commercially available components. This approach is often more cost-effective and can provide better performance. However, if the design is intended to be more flexible, a custom-built circuit may be necessary to meet specific requirements. The use of microprocessors in this context is a promising area for future research and development.
on a narrow block filter as the major part of the IF selectivity, relying on accurate (and usually manual) tuning to provide the necessary h.f. attenuation. The block filters popularly used in the input stage did not have sufficient bandwidth for use in multi-channel applications, and would be limited by the programme source. In this context it is only fair to mention the potential channel rejection within the necessary budget. This means, however, that the recovered audio response falls sharply, and to my mind undesirably, above 3kHz or so, and that receiver tuning has to be very precise.

Prove this ludicrous proposition with an independent listening panel under a scientifically controlled set of conditions. If the panel are able to detect with statistical confidence a 0.05dB difference in performance, I will donate £100 to any charity of whichever type you might name by whatever take-up my challenge. I have my money ready if the tests fail, to receive the same amount from the proposition's supporter.

Meanwhile, may I conclude by expressing my disappointment that a magazine of Wireless World's stature should continue to provide a platform for cranky views. These are more proper to the hi-fi comics, to my mind undesirably, above 3kHz or so, and that receiver tuning has to be very precise.

MILLIBEL IS RUBBISH

I have a little sympathy for Mr Duncan's cri de coeur (January letters) over your super hi-fi amplifier project (October 1979). Too often designers are carried away by maternal enthusiasm for their brainchild and the accuracy of a modern calculation, and completely overlook the realities of the situation – that the amplifier is but one part of an audio chain. The mass transmission hall and office block will shortly be supplanted by the BBC's requirements – what an ideal opportunity to provide a show-case for the Corporation's achievement, and we BA already have a broadcasting gallery in London, yet while the centre is 3kHz output, it would be relatively easy to make displays at major BBC centres in London and elsewhere. Public interest is likely to be centred in a variety of 'open days' over the early days of broadcasting. For the present, however, the transmitter itself remains intact. Since the prime movers and rotating machinery have gone, it can never be used again, but it would provide a unique centrepiece for any museum. The main transmitter hall and office block will shortly be supplanted by the BBC's requirements – what an ideal opportunity to provide a show-case for the Corporation's achievement, and we BA already have a broadcasting gallery in London, that the big musical noise from the transmitter can be 'muted' and made audible, as at WO, I feel the Centre Box and the Worm should be subdivided into major sections, displaying the various types of programme used, and the displays obtained with the instrument.

1kHz square wave, while that in Fig. 2 is obtained with a 1kHz sine wave, showing 3rd and 5th harmonics. These experiments, however, were performed at a lower frequency than the fundicature signal, in each photograph are spurious products resulting from the method of analysis chosen: they do not normally cause trouble, since they are generally lower in frequency than the fundamental. As Mixer once observed, 'all jokes are equally offensive to everyone. 

If I look like becoming political myself, it just shows what happens when such matters are brought into W.W! - M.G. Scroggie

Mixer replies: Having been at the receiving end of many shafts of 'humour' concerning my own name, I hope that Mixer considers the 'slight wofce' that Mr Scroggie feels is implied in my attacks at the mention of haggis, cabers and political discussion in so many places, and my use of an extremely narrow-band filter also has the advantage of eliminating high-frequency distortion products arising from the detection process.

Finally, I should like to point out that there are at least two transmitters with a groundwave capable of causing interference to parts of the country, which radiate a much wider audio bandwidth than the 5kHz now standard within the UK and much of Europe. They are, of course, the time of writing, RTE Radio 2 on 613kHz, which can be received quite well in Wales, West and North-West England, Southern Scotland and Northern Ireland, and the pirate stations Radio Caroline on 1004kHz, which can be heard in South East England. It is, strictly speaking, illegal to listen to these transmitters, are the time of writing, RTE Radio 2 on 613kHz, which can be received quite well in Wales, West and North-West England, Southern Scotland and Northern Ireland, and the pirate stations Radio Caroline on 1004kHz, which can be heard in South East England. It is, strictly speaking, illegal to listen to these transmitters, and 'accustomed to read about the demise of the Brooktopers, I was willing to yield in order to improve the recovered audio response falls sharply, and to my mind undesirably, above 3kHz or so, and that receiver tuning has to be very precise.
on a narrow block filter as the major part of the IF selectivity, relying on accurate (and usually manual) tuning to provide the necessary h.f. attenuation. The block filters popularly used have very short lengths and little more than 6 kHz, presumably a sacrifice willingly yielded in order to eliminate adjacent-channel rejection within the necessary budget. This means, however, that the recovered signal is less than the minimum 100 Hz and to my mind undesirable, above 3 kHz or so, and that receiver tuning has to be very precise.

Given that the brief of consumer audio equipment is generally to provide the best possible reception of local transmissions, where even at night the wanted signal may be presumed to be at least as strong if not stronger than anything on the adjacent channels, I would suggest that a better approach would be to employ a much wider block filter, with a 3 dB bandwidth of around 16 kHz, and then to eliminate adjacent-channel whistles and 'monkey chatter' by means of a Skp, and preferably switchable, low-pass filter with a cut-off frequency between 4.5 and 3 kHz. The use of such a filter also has the advantage of eliminating high-frequency distortion products arising from the detection process. Finally, I should like to point out that there are at least two transmitters with a ground-wave signal of usable strength in some parts of the country, which radiate a much wider audio bandwidth than the 3 kHz noted above. The BBC is at the cutting edge. Here is the opportunity to provide a platform for cranky views. These are more proper to the hi-fi comics.

Reg Williamson
Norwich

NATIONAL MUSEUM OF BROADCASTING

As a BBC Engineer at Washford, I was interested to read the demise of the English Parks Park Transmitters. The Washford transmitter was in fact taken out of service at the end of October, after 46 years of service. Both on grounds of efficiency and maintenance costs, it was felt for the best. However, it is just that the main points will go, but its destruction breaks another link with the early days of broadcasting.

For the present, however, the transmitter itself remains intact. Since the prime moves and rotating machinery have gone, it can never be used again, but it would provide a unique centrepiece for any museum. The main transmitter hall and office block will shortly be sold to developers. The BBC is under the impression that a potential buyer for the Corporation's television studio has already been found. As the后来 (January 1885) Verlookup of the World's fair exhibition, so that the old site remains intact.

MILBELL IS RUBBISH

I have a little sympathy for Mr Duncan's cri de corer (January letters) over your so-called super hi-fi amplifier project (October 1979). Too often designers are carried away by the maternal enthusiasm for their brainchild and the certainty of a modern calculation. Consistently overlooked are the realities of the situation - that the amplifier is but one element in a long chain of planning, performance and, in a domestic system particularly, the ultimate fidelity overall will be limited by the programme source.

However, I am fed up with seeing a letter in the March issue with a suggestion of such aloofness that I had to check the cover to make sure that it wasn't an issue a few weeks early. But no, the writer was clearly and dangerously literal in his conception. It can really be suggested that again, for one small element in the recording/reproducing chain, it is imperative that any amplitude/frequency deviations be maintained within an accuracy of 0.05 dB (as I assume that this is the total spread). Frankly, I do not see and regard the notion as absurd. It is time, perhaps, to say that an auditor of 30 years' experience and accustomed to working to tolerances far tighter than those that we believe practicable in the hi-fi industry. For a start, how in heaven's name can we guarantee a consistency considerably better than this outside the pre-amplifier - in the programme source, for example, which is not likely to be used for the subjective issue! Even before, when these were singing a myth being propagated by hi-fi commentators of questionable ability, offered a sum of money to any charity if the spurious arguments being got forward could be proved. My bait was never taken and it remained for others to quantitatively demolish the false gods. I will make the same offer yet again, and for the same time.

Prove this ludicrous proposition with an independent listening panel under a scientifically controlled set of conditions. If the panel are able to detect with statistical significance a frequency/amplitude deviation at any agreed point in the output of the amplification stage, of 0.025 dB on a variety of programme material, I will donate £200 to any charity named by whoever takes up my challenge. I haveemy officially that the test fails, to receive the same amount from the proposer's supporter.

Meanwhile, may I conclude by expressing my disappointment that a magazine of Wireless World's stature should continue to provide a platform for cranky views. These are more proper to the hi-fi comics.

J. E. Butterworth
Bolar

The block diagram of a conventional spectrum analyser is shown in Fig. 3. The local oscillators are tuned to the frequency of interest. One commercial design uses five crystal resonators to achieve the required performance.

A P O O R J O K E

In your issue in January, Greenwood lodged an objection to a marked tendency in Wireless World to regard the propagation phenomena, and in matters of opinion. Though I suspect I may have a little more sympathy with some of the views expressed (though not in Pet's case) I equally consider that W.W. is the wrong place to transform them. Given the political discussion in so many places, and lack of W.W. as a unique source of technical information within certain ill-defined but well-understood limits.

Having stood up to be counted at this end of W.W. I now turn to the other to express my views. No, not to be a formal reply from the author. Some years ago I was able to pass over the inevitable linkage of Scotland with northern media dragging with no more than a slight wince, but I did seriously de- pose his gratuitous addition 'of BL cars disintegrating' as one of the noises over which I have certain Kxaxen heard be could be heard. For one thing, it is in this context meaningless jbl of the same order as the potential nuclear-in-law jokes - hardly up to W.W. standard. But the serious aspect is that it is one more example of the British disease of self-deification, which ultimately deter runs people from buying cars that have been made to look a joke. Does Mixer know that BL vehicles are more proper to the hi-fi comics. Even though myself of their superior quality, I was not Counted at this end of W.W. standard. The serious aspect is that it is one more example of the British disease of self-deification, which ultimately dete- runs people from buying cars that have been made to look a joke. Does Mixer know that BL vehicles are more proper to the hi-fi comics.

The conventional mode of operation of commercial spectrum analysers entails the use of an extremely narrow-band filter, a circuit which is too complex and expensive to be attractive to the home constructor or schools.

Consequently, the design described in this article uses an unusual technique of frequency switching which cheaply avoids the difficulty. This type of analyser is intended to investigate un- varying signals, which means that this analyser is not suitable for analysing music or speech waveforms.

Figures 1 and 2 show examples of displays obtained with the instrument. The trace in Fig. 1 is the spectrum of a 1 kHz sine wave, while in Fig. 2 is the analysis of a sine wave at the same frequency, with small 3rd and 5th harmonics. Bandwidth was 200Hz.

Mixer replies: They have arrived at the end of many shafts of humour concerning my own work, mixed in with the "slight noise" which Mr Scroggie feels implies inferiority at the mention of haggis, cabers and national origins, I am familiar with the "slight noise" which Mr Scroggie feels implies inferiority at the mention of haggis, cabers and national origins, I am familiar with the

Housed in an historic and polytechnical institute in Toronto.

Fig. 4. Method used in this design, in which the filter takes the form of a low-pass circuit in the audio range.

Maxwell's equations revisited

We have received a large number of letters concerning this topic, several of which were visited by Iver Cott in the March issue. There are too many to be published individually, and so all the points will be selected and presented collectively, accompanied by a point reply from the author.
tively a band-pass filter, with its centre frequency at the setting of the local oscillator and a bandwidth equal to twice the cut-off frequency of the low-pass filter. The design of the analysis filter thus becomes an exercise in low-pass filter design. In the prototype, a four-pole Sallen and Key filter was used with cutoff frequencies between 5 and 250 Hz.

For those familiar with the techniques of correlation analysis, the analyser may be regarded as a type of cross-correlator. The local oscillator sine wave is cross-correlated against the input signal, the low-pass filter is an averaging device which produces a signal whenever a match is found between the input sine wave and that of the local oscillator.

The local oscillator must tune over a much wider range in proportion to its centre frequency than in a conventional spectrum analyser. In this design, a sweep range of 100 Hz and 16kHz was achieved without undue difficulty. The range may be moved by switching a local oscillator capacitor.

A particular advantage of this system is its ease in identifying the frequency of any particular harmonic: the analysis frequency is equal to the local oscillator frequency. In this design, a simple digital readout of analysis frequency is provided.

Changes in analysis bandwidth in the low-pass filter have the effect of changing the quiescent output voltage of the filter. The simplest solution to this problem is to capacitively couple the filter to the output of the mixer, even though this results in the narrow response in the centre of the analyser's filter pass band shown in Fig. 5(b). This is a slight inconvenience in use, since the local oscillator must be slightly detuned from the harmonic frequency when reading. However, the notch does help in determining the exact frequency of a signal.

The major problem with the synchrodyne analyser is that harmonics of the local oscillator fall within the pass band of the analysis filter and show up on the display as false readings below the fundamental frequency of the input.

There are two approaches to this problem. One, obviously, is to keep the distortion of the local oscillator as low as possible. The easiest approach to the design of a swept oscillator is to use a function generator, and the output of a function generator must be shaped in a diode network to produce a sine wave. It is difficult to reduce the distortion of such a sine wave network to a low level, particularly when this waveform is to be varied in frequency over a wide range.

The other approach is to learn to recognize and identify the spurious harmonics. An example of this is shown in Fig. 6, the analysis of a 2.98kHz sine wave from a commercial function generator. The vertical axis has been shaped to a logarithmic scale by the Hewlett-Packard Log Converter, thereby emphasizing low level distortion products.

The spurious distortion products due to the analyser are labelled A, B, C and D on this graph. Notice that these fall below the fundamental of the input signal and that they are not harmonically related to the input signal. Spurious product A is created when the fifth harmonic of the spectrum analyser local oscillator beats with the fundamental of the input signal. Products B, C and D are similarly caused by the fourth, third and second harmonics of the local oscillator.

Fortunately, M. G. Scruggs has suggested an alternative technique based on the synchrodyne radio receiver. Figure 4 shows a block diagram of this analyser. The tunable local oscillator sweeps over the range to be analysed, and the low-pass filter passes signals that are close to a zero beat between the input signal and the analysis signal. This process may be regarded as a translation of the low-pass filter to the frequency of the local oscillator, together with a mirroring of the low-pass filter characteristics around the local oscillator frequency as shown in Fig. 5(a). The result is effectively a translation of the high pass characteristic to the frequency of the local oscillator, thus ensuring that all signals over the range of interest are visible.

In this design, a swept oscillator is used in frequency-response tests of the spectrum analyser. In this design, a simple digital readout of analysis frequency is provided. Changes in analysis bandwidth in the low-pass filter have the effect of changing the quiescent output voltage of the filter. The simplest solution to this problem is to capacitively couple the filter to the output of the mixer, even though this results in the narrow response in the centre of the analyser's filter pass band shown in Fig. 5(b). This is a slight inconvenience in use, since the local oscillator must be slightly detuned from the harmonic frequency when reading. However, the notch does help in determining the exact frequency of a signal.

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The 5.95kHz harmonic is the second harmonic of the input signal. Spurious products do not appear below this harmonic because both it and the spurious products of the local oscillator are small in magnitude.

The spectrum analyser is shown in Fig. 7 and its detailed block diagram in Fig. 8.

**Detailed circuit description**

**Multiplier.** A Motorola MC1495 is used as the signal multiplier shown in Fig. 9. Its maximum input signal should be limited to 8V peak to peak to limit distortion in the multiplier. The RC networks on the inputs (9102 in series with 10pF) lower Q of the input leads and damp any tendency to high frequency oscillation since the MC1495 is capable of operation up to 10MHz.

The 10kΩ potentiometers are adjusted to minimize feedthrough of the v.c.o. signal when the other signal is absent.

**Low-pass filters.** The low-pass filter in Fig. 10 consists of a differential amplifier, followed by a four-pole, Salen and Key, low-pass filter to achieve a slope of 24dB/octave above the cutoff frequency.

**Local oscillator.** The Interstellar 8038 uses an undertone, square and triangle waveforms. Unfortunately, the sine wave is very distorted since, although the 8038 requires a full +5V to −5V, in this case it is being operated from −15V only. The distortion is reduced to an acceptable level by the germanium diode/2kΩ resistor network connected to pin 8 of the IC. The 2kΩ resistor should be adjusted while observing the spurious harmonics on a display as in Fig. 6. The square wave output from the 8038 is used in the frequency counter display circuit.

Voltage control of frequency is accomplished by the op. amp. network connected to pin 8. Since this is a linear v.c.o. circuit, the voltage range must be equal to the frequency range. Although the 8038 contains a 1000Ω resistor, improved stability and lower distortion are obtained by selecting the v.c.o. capacitor by the h.f./l.f. range switch. An exponential v.c.o. is described later.

A transistor network connected to pin 10 of the 8038 generates a compensation current of about 1mA to improve the symmetry of the waveforms at very low frequencies. If operation at very low frequencies is not a requirement, it may be omitted.

The square wave is buffered by a 741 op. amp. and passed to the local oscillator output connector. This signal may be used in frequency response tests of
equipment. A second op. amp. increases the sine-wave amplitude by a factor of 6.7 to provide sufficient signal for the multiplier circuit.

SwEEP CONTROL. Maximum and minimum frequency are set by the two ten-turn potentiometers, F_max and F_min shown in Fig. 12. Unity-gain amplifiers A_1 and A_2 buffer these voltages, and set them up at opposite ends of the ten-turn tuning control. In 'manual' mode, the tuning control will vary the v.c.o. control voltage between the F_max and F_min voltages set up on the F_max and F_min pots. (Some care must be taken in operation that the F_max voltage is always greater than the F_min voltage.) Amplifier A_3 reverses the sense of the sweep电压 so that an increase in the v.c.o. control voltage will produce a decrease in the negative-going sweep voltage. The discrete-component amplifier driven by the 7400 flip-flop amplifies the t.l.t. signal to +12V to drive the sweep direction indicator i.e.d. and the integrator.

Frequency counter. The heart of the frequency counter in Fig. 13 is the National 74C925, which contains four decade counters, latches, a display multiplexer, and a seven-segment decoder. Transistors Tr_1 to Tr_5 are the digit drivers for the common-cathode display which, in the author's instrument, was a surplus nine-digit integrated type, only four digits being used.

The gate for the frequency counter is provided by a 555 timer, which, although possessing a time accuracy of only about 1%, is satisfactory for this circuit as a replacement for a dial indicator.

Signetics 8162 monostables provide the proper timing signals to latch and clear the counter in the manner shown in the timing diagram of Fig. 14. The 'gate time' switch sets the period of counting to 1.0 or 6.1 seconds. A second contact on this switch causes Tr_2 to select the proper decimal point for the display.

Power supply. The power supply is conventional. Integrated circuit regulators — National LM30 and Fairchild 7805 — generate the required voltages. To avoid noise and oscillation problems the sections of the spectrum analyser should be wired separately, as in Fig. 10.

Logarithmic sweep
The frequency scale in the instrument was chosen to be linear to show more clearly the relationship between harmonics of a periodic waveform. In practice, a logarithmic scale of frequency may be more useful. Fig. 17 shows how the local oscillator may be modified for a logarithmic frequency scale. Transistors Tr_1 and Tr_2 are the 8083 current sources which charge and discharge the timing capacitor.

Fig. 10. Low-pass filter. The resistors shown as R are switched, and for bandwidths of 10, 20, 50, 100, 200, 500 Hz should be 72k, 36k, 15k, 7k, 3.6k and 1.3k.

Fig. 11. Local oscillator circuit diagram.
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**Fig. 11.** Local oscillator circuit diagram.

**Fig. 12.** Sweep control section. Components marked with asterisk are mounted on connector.

**Fig. 13.** Frequency counter and display. Author used a surplus National Semiconductor display module in his prototype. A multiplexed, common-cathode type is needed. An error: pins 6, 7, 9, 10 are transposed; pin 10 should be "units".

WIRELESS WORLD, MAY 1980

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exponential relationship between base voltage and collector current in these transistors will provide the desired relationship between control voltage and oscillator frequency. The 741 operational amplifier reduces the control voltage swing at pin 8 to the desired amount.

In practice, the base-emitter diodes of Tr1 and Tr2 are not perfectly matched and the output waveform becomes asymmetrical at low frequencies. Thus 10kΩ/2Ω network at pin 4 provides suitable compensation voltage. Depending on the mismatch of the transistors, it may be necessary to ground pin 4 and connect the compensation network to pin 5.

References

Printed circuit boards
A set of single sided p.c.b.s for the radio spectrum analyser is available for £10.50 including v.a.t. and UK postage. The circuit is designed by W. L. Hale & J. W. Sagn in 22 Kayes Road, London N.W.2.

Sixty years ago
There are several reasons for printing a monthly piece entitled ‘Sixty Years Ago’. One can pick out the first mention of a well-known method or piece of equipment; sometimes the writing itself can be funny, as in none of the replies to queries (“We advise you to take up some other pastime”); occasionally a historical event is remembered; the outlook of war perhaps. But the most interesting are the personal experiences which are widely maccarrel. For example, though, one would think there would be an increase in the demand for a ‘blinding flash’, and just such a one appeared in the issue for May 11, 1918, in the article on research for the amateur, by W. T. Ditcham. “I propose to look at every one to see if a simple rectifying tube can be made to detect oscillations of suitable characteristics, and there are good grounds for thinking that such a one is probably the case. Dr. W. H. Eccles some years ago demonstrated the production of oscillations by a galena crystal, though at what frequency and amplitude, or what constancy, I am not aware.”

With conventional modulation methods the spectrum available for land mobile radio is insufficient to meet the demand. In this article the author first outlines the propagation properties of wireless links in conjunction with moving vehicles then considers the number of users possible in a given area and finally goes on to consider the possibility of using wideband modulation such as in the various spread spectrum techniques.

The conventional method of providing radio communication to vehicles on land is to use either a.m. or f.m. radio operating at v.h.f. or u.h.f. In general the number of channels available is insufficient to meet the demand from users or potential users of these systems.

Most signals for communicating to vehicles use a base station with antennas at a high point to cover the area to be served. High antennas on the vehicles are, however, close to the ground and it is usual for there to be a clear line of sight between the base station and the vehicle antennas. The signal suffers from reflection at the ground, reflection from buildings, diffraction over hills and diffraction around buildings. As a vehicle drives along the road, the variation in signal strength can be divided into three parts. Firstly, the constant component between transmitter and receiver increases there is an increase in the signal level and an increase in the standard deviation.

For this type of path the received power falls approximately as the fourth power of the distance between transmitter and receiver. This variation in median power level can be compared with the square law variation expected in free space.

The median power level falls much more rapidly on a mobile radio path than, for example, in a line-of-sight radio relay system. The variation in power with distance is illustrated in Fig. 1. This is drawn for a transmitter power of 30W, a half wave dipole antenna at the transmitter, a transmitter height of 100 metres, a receiver height of 2 metres and a quarter wave monopole at the receiver. It is assumed that the antennas are omnidirectional and the ambient noise is that due to the ground. The charts indicate that there is no circuit loss in the system, the fourth power law is independent of frequency, but the free space variation depends on frequency when the antenna gains are constant. To provide reference level the ideal noise power in a bandwidth of 10kHz is shown.

These curves show that, as the distance increases from 100km, there will be a 40dB decrease in received power. It also appears that using a 10W transmitter there is a good margin between the received power and the noise level which may be expected in the receiver. If we assume a receiver if bandwidth of 10kHz and a noise figure of 6dB, then at a range of 20km the margin is 45dB. However, we have not yet taken into account the fluctuations in received power due to diffraction and reflection.

Because vehicles have to follow the roads the path between transmitter and receiver will be obscured by hills and buildings. The vehicle is in the shadow areas, a signal may be received by diffraction over the hills or around the buildings. Such diffraction effects are relatively insensitive to frequency and over any one of the bands of interest for mobile radio the attenuation of the signal due to shadowing is relatively constant for any one path. For a particular path the effect of shadowing may be calculated. However, when designing a mobile radio system we want to know the fluctuations which may occur due to shadowing as a vehicle moves from one point to another and these fluctuations are best described by a probability distribution which shows the probability of a certain shadow attenuation occurring. Measurements taken over a large number of sites show that the distribution of shadow fading follows a log-normal distribution. This is shown in Fig. 2. The log-normal distribution is characterised by the standard deviation σ in dB and for different areas and frequencies the value of σ may change. However, typical values for σ seem to lie between 6 and 12 dB. Taking the curve for σ = 6dB, we can see that an attenuation of more than 14dB can be expected at 1% of sites, or for a vehicle travelling along a road for 1% of the time.

Besides the attenuation due to shadowing, there is also fading caused by the phase interference of signals arriving by different paths. This occurs because signals can be reflected from buildings giving a signal at the receiver which is the sum of the signals arriving by different paths, with only to move a short distance in

Fig. 1. Variation in mean received power in a mobile radio system with fourth power law dependence on distance compared with square law variation in free space. Transmitter power is 10W; antenna gains 2-15dB; antenna heights, transmitter 100m, receiver 2m.

Land mobile radio and spectrum utilisation
Introduction to the possible use of wideband modulation techniques
by P. A. Matthews Sc.(Eng.), Ph.D., F.I.E.E., M.I.E.E.
Department of Electrical and Electronic Engineering, University of Leeds

Some years ago demonstrated the production of oscillations by a galena crystal, though at what frequency and amplitude, or what constancy, I am not aware. The signal suffers from reflection at the ground, reflection from buildings, diffraction over hills and diffraction around buildings. As a vehicle drives along the road, the variation in signal strength can be divided into three parts. Firstly, the constant component between transmitter and receiver increases there is an increase in the signal level and an increase in the standard deviation.
exponential relationship between base voltage and collector current in these transistors will provide the desired relationship between control voltage and oscillator frequency. The 741 operational amplifier reduces the control voltage swing at pin 8 to the desired amount.

In practice, the base-emitter diodes of \( T_1 \) and \( T_2 \) are not perfectly matched and the output waveform becomes asymmetrical at low frequencies. This 10kHz/20 network at pin 4 provides suitable compensation voltage. Depending on the mismatch of the transistors, it may be necessary to ground pin 4 and connect the compensation network to pin 5.

References

Printed circuit boards
A set of single sided p.c.b.s for the radio specimen are available for £10.50 including v.a.t. and UK postage. Ask for 'The Amateurs' Series' from Sagin at 23 Kayes Road, London N.W.2.

Sixty years ago
There are several reasons for printing a monthly piece entitled 'Sixty Years Ago'. One can pick out the first mention of a well-known effect or piece of equipment; sometimes the writing itself can be funny, as in none of the replies to queries ('We advise you to take up some other pastime'); occasionally a historical event is mentioned - the outbreak of war perhaps. But the most interesting are those on everyday experiences which are widely inaccurate. Every so often, though, one comes across an amusing blinding flash, and just such a one appeared in the issue for May 15, 1920, in an article on research for the amateur, by W. T. Ditcham...

As far as I can see, whether a simple rectifying circuit can be made to produce oscillations of suitable characteristics, and there are good grounds for thinking that such is probably the case. Dr. W. H. Eccles some years ago demonstrated the production of oscillations by a galvanic cell, though at what frequency - and amplitude, or what constancy, I am not aware, of the wave. Now, W. Pickard, the American experimenter, has recently published a paper in which he discusses the signals in the United States from European continuous wave stations on an oscillating crystal heterodyne. There seems to be a difficulty, in the way of a practical application, of the use of such oscillations, due to lack of continuity of the oscillations...
Because of the combined effects of shadowing and the rapid fading due to reflection, the probability distribution for the received signal depends on the combination of the two individual distributions. The derivation of the expression for the probability distribution has been given by French. The result is shown in Fig. 3 for two different values of the standard deviation \( \sigma \) of the shadow fading. These curves show that at 1% of sites and with a \( \sigma \) of 6dB an attenuation of 24dB or more may be expected. Thus the median margin above noise of 4dB is reduced to only 21dB for 1% of sites. The actual margin required depends on the type of modulation used and the output signal/noise ratio required. For example, for a s.a.m. system the input s.n.r. is the same as the input s.n.r. for a s.s.b. system with an output s.n.r. of 10dB and a 99% probability of reception. Fig. 3 shows a range of 36km. For f.m. with a 1kHz bandwidth and assuming no noise improvement the corresponding range is 25km.

**Wideband modulation**

For so far this discussion has considered f.m. for a s.s.b. transmission, and it has shown that when interference between transmissions on the same frequency is taken into account the number of users/mHz in a given area is limited to a small number. We need to consider whether other modulation techniques can accommodate more users. A class of modulation techniques that should be considered are the various spread spectrum techniques.

The use of wideband spread spectrum techniques has generally been ruled out for mobile radio systems because of its apparently extravagant use of the radio bandwidth. In a spread spectrum system the available bandwidth is divided over a bandwidth of possibly tens of megahertz, either by modulating a conventional frequency carrier for a wideband signal or by hopping the carrier frequency over a band. At the receiver, the original transmission is recovered by taking advantage of known properties of the wideband noise-like signal or of the hopping pattern. In both cases the s.n.r. for the wanted signal is relative to that of unwanted signals by the ratio: 

\[
\text{S.N.R.} = \frac{G_b}{G_w} = \frac{G}{1 + \sigma^2/G}
\]

where \( G_b \) and \( G_w \) are the signal powers due to the narrow band and the spread band signals respectively. This so-called processing gain \( G \) improves the s.n.r. for the wanted signal, and at the same time gives the interfering signals a noise-like property. The processing gain alone is relative to the correlated correlation between the wanted and unwanted signals. Ideally, there should be no cross-correlation.

If a given band is to be shared by a number of users, interference fading from each user must be spread in a manner which is unique to that user, and a wide number of users in inverse proportion to the carrier frequency component at any one time may be reduced due to phase interference fading. The problem of recovery of the signal at any one time is a narrow band signal on a particular frequency. The effect of shadow fading is removed by controlling the mean power level of the particular frequency component at any one time. Calculating the fading can be done by measuring the path loss in some way.

The use of wideband spread spectrum may provide at least as much system capacity as narrow band schemes. This problem of recovery of the signal will differ depending on whether a noise-like wideband signal or a frequency hopping scheme is used. In a frequency hopping scheme the signal at any one time is a narrow band signal on a particular frequency. Even if the effect of shadow fading is removed by controlling the mean power level of the particular frequency component at any one time may be reduced due to phase interference fading. The effect of shadow fading can in general be controlled by measuring the path loss in some way. This may be possible by using the signal received at the mobile from the base station to control the level of transmission back to the base station.

Because of the combined effects of shadowing and the rapid fading due to reflection, the probability distribution for the received signal depends on the combination of the two individual distributions. The derivation of the expression for the probability distribution has been given by French. The result is shown in Fig. 3 for two different values of the standard deviation $\sigma$ of the shadow fading. These curves show that at 1% of sites and with a $\Delta f_B$ of 24dB or more may be expected. Thus the median margin above noise of 45dB is reduced to only 21dB for 1% of sites. The actual margin required depends on the type of modulation used and the output signal/noise ratio required. For example for a s.s.b. transmission the output $s.n.r.$ is the same as the input $s.n.r.$ Assuming a 5kHz spaced channel, the required output $s.n.r.$ of 10dB and a 99% probability of reception Fig. 3 shows a range of 30km.

For f.m. with a 1kHz bandwidth, assuming no noise improvement the corresponding range is 25km.

Area cover and number of users

If an isolated area is served by one base station the problem of fading can in principle be overcome by increasing the transmitter powers. However, there are practical limits to the power of mobile transmitters and problems caused by intermodulation of signals. In the isolated area the number of users is limited by the number of channels available. In practice the radio transmissions are not confined to an area and interference is likely between users of the same channel in adjacent areas. To limit the effect of interference there must be sufficient distance between transmitters using the same frequency for the probability of interference to be below some low limit. If the radius served by a given transmitter is $R$ and the distance between transmitters using the same frequency is $r = \frac{R}{2}$ for a large area that frequency can only be used for a fraction of the total area. The total area that is mutually shadowed and the total number of channels divided into groups shared between the cells. If the ratio of the area served $A_s$ to the total area is designated $C = \frac{A_s}{r^2}$. To find the re-use distance the probability of interference occurring must take account of the probability of fading of the wanted transmission, while the interfering signal may not have faded. The result is that the re-use distances may be large and hence the number of frequencies is increased. The re-use distance is a ratio of distances, the number of groups is independent of the particular frequency component used and is the same for all the radio horizon distance. The re-use distance presented in (2) show the equilibrium account both shadow fading and phase interference fading. The actual number of channels may have to be divided into large numbers of groups. For example, for a peak to peak value of $10 \mu V$ with 25kHz spacing may require 67 groups, if the output power is 1W. Considering a 100MHz bandwidth, the f.m. system with a channel spacing of 5kHz allows 20 channels per group. Thus, in any one particular area the number of channels which can be used is large and so the problem of mutual interference is taken into account.

Because the number of groups and cells is independent of their area the number of users in a given physical area can be increased if the area covered by each cell is limited. This implies using a large number of cells with low power transmitters in each cell. However, such a large number of transmitters in one cell has to be made over a distance spanning several cells. Direct communication is not allowed and a cell hierarchy must be set up to transfer calls from one cell to another.

Wideband modulation

So far this discussion has considered f.m. or s.s.b. transmission, and it has shown that when interference between transmissions on the same frequency is taken into account the number of users/MHz in a given area is limited to a small number. We need to consider whether other modulation techniques can accommodate more users. A class of modulation techniques which should be considered are the various spread spectrum techniques.

The use of wideband spread spectrum techniques has generally been ruled out for mobile radio systems because of its apparently extravagant use of the f.m. bandwidth. In a spread spectrum system the bandwidth of a transmission is much wider than the bandwidth of the wideband signal or by hopping the carrier frequency over a wide band. At the receiver the original transmission is recorded by taking advantage of known properties of the wideband noise-like signal or of the hopping pattern. In both cases the s.n.r. for wideband signals is relative to that of unwanted signals by the ratio; the bandwidth of the wanted signal to that of the narrow band signal. This so-called spreading gain $G_3$ improves the s.n.r. for the wanted signal and at the same time gives the interferring signals a noise-like property. The processing gain also depends on the correlation between the wanted and unwanted signals. Ideally, there should be no cross-correlation.
Digital capacitance meter

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Programmable audio attenuator

Gain controlled line amplifier offers a 60 dB range in 1 dB steps

by J. M. Didden

After experimenting with various linear gain control systems, the author chose a combination of linear and logic circuits to provide a high quality audio attenuator. The final design uses a 6-bit word to program the gain, and can be used for remote control applications or, with the aid of a microprocessor, for automatic level control.

This circuit was originally designed to remotely control the volume and balance in a stereo system. Several methods were tried, such as the two-quadrant multiplier in Fig.1. However, this circuit suffered from high distortion for input levels of more than 100mV, and tracking between units was poor. Attempts to improve the performance with current-source loading did not significantly improve the performance. A f.e.t. used as a voltage controlled attenuator produced similar problems, so a l.d.r. design was tried as shown in Fig.2.

The basic circuit is shown in Fig.3. When f.e.t. S1 is closed, the signal across it equals the input voltage times the ratio of R5 to R1. In practice, ratios of 1/1000 are easily obtained, so a signal level of several volts, which is not uncommon in a line amplifier, produces only a few millivolts across the switch. At these levels the f.e.t. is almost perfectly linear. Two independent gain settings can be achieved by switching R3 and keeping I3 constant. With S2 closed and S3 open in Fig.4, R5 is connected to the virtual earth of the op-amp. With S2 open and S3 closed, R5 is connected to the real earth. Therefore, by using a s.p.d.t. switch for S4, gain settings are possible.

An extension of this circuit is shown in Fig.5. With S4 open and S5 closed, gain is determined by the ratio of R7 to R5. With S5 open and S4 closed, the gain is determined by the ratio of R9 to R7 and R5 to R4. Combining the circuits in Fig.4 and Fig.5 gives eight gain settings. For all of these configurations the switches have only a small signal across their on resistance and carry very little current when opened. The values of the series resistors are high compared with the on resistance.

Selection of a suitable f.e.t. presented some problems. Switch arrays for analogue applications are available, but are generally expensive. Analogue multiplexers, such as the 4051, contain eight c.m.o.s. switches with a common input and integral one-of-eight decoder for control by a 3-bit word. However, the switching produces spikes on the audio output due to an internal capacitive coupling of the control signal to the switch terminals. This can be minimised by loading the switch, but smaller resistors must then be used which consequently produces higher distortion levels. Although "soft" switching with a RC network is one solution, see Fig.6.
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Fig. 1 Basic two-quadrant multiplier.

Fig. 2 Closed-loop light dependent resistor attenuator.

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This problem can be overcome by grounding the left switch terminal of $S_1$ when it is open, and this is easily achieved with the 4007 s.p.d.t. switches. Because there is an on resistance, $R_s$, a small signal voltage remains across the open switch. The low-pass filter $R_c$, $C_2$ compensator for this with $S_1$ closed when $S_{3a}$ is closed and $S_{3b}$ is open. The frequency response is flat within 0.3 dB up to 25 kHz and at high attenuation, Fig. 8 shows the final circuit for one channel and Table 1 shows the range of attenuation levels.

Ten mixed s.p.s. and s.p.d.t. switches are required and these can be produced with five 4007 ICs. It is important that the signal amplitudes across $S_1$, $S_2$, $S_3$, and $S_4$ do not exceed the positive or negative supply voltages because an internal protection diode will conduct and cause distortion. As audio signals are bipolar, the supply voltage should be centered around ground because one side of the open switches is always connected to either a signal ground or virtual earth. To balance the on resistances of the p and n-channel m.o.s.f.e.ts, a positive supply of 7.6V and a negative supply of 4.2V is used. In Fig. 8, $S_1$ and $S_{3ab}$ can be controlled by a single bit. Switches $S_2$, to $S_3$, and $S_5$, to $S_7$, require the four decoded values of a 2-bit control word. This is carried out by a 4556, which contains two one-of-four decoders, see Fig. 9.

Selection of the switch-network resistors is a compromise as already explained. The typical on resistance of a switch is about 3000 and the maximum variation is about 2000. With a series resistor of 22kΩ, this is comparable with the switch tolerance. Calculations for the resistor values are given in the appendix. Fig. 8 also shows that some switches are capacitor-coupled to the circuit by $C_7$ and $C_8$. These remove a small output offset voltage change with gain which can be heard as clicks at low input signal levels.

The capacitor values have been chosen to give a low-frequency response below 10kHz. A f.e.t. input op-amp, LF 356, is used to provide a high input impedance, wide bandwidth, high slew-rate and low distortion. A NE 5534 is used at the output because it can deliver a high output level into a 600Ω load with little distortion. With $R_x$, and $C_{20}$ to stabilize the op-amp, a 10Ω load will not produce ringing or overshoot of a square-wave signal. The 5534 is also a low noise device, which is important, because most of the attenuation takes place at its input and this reduces the signal-to-noise ratio of the last stage. Performance parameters of the complete amplifier are shown in Table 2, a f.e.t. input selector switch is required, the LF 356 can be used in the inverting mode as shown in Fig. 10. The compensation capacitors, which may be necessary with other op-amps, are shown in Fig. 11.

If a visual indication of the attenuation is required, the control word can be converted to a two-digit b.c.d. output for driving a seven segment display.

Appendix

Calculation of resistor values.

For these calculations a d.t. table or calculator with log. and inverse log. functions is required.

For the 1, 2 and 3 dB attenuators in Fig. 12, with S open,

$$R = R_0 \left( \frac{1}{G} \right)$$

(1)

for an output of $U_0$ volts. With $S$ closed and an output of $U_0$ volts, the equivalent voltage source $U_1$ is

$$U_1 = \frac{R_0}{R} U_0 + R \Delta U$$

(2)

and the equivalent source resistor is

$$R_{eq} = R_0 \left( \frac{1}{G} \right)$$

(3)

therefore,

$$R = R_0 \left( \frac{1}{G} \right)$$

(4)

Because it always equals $U_0$, equations (1) and (4) are equal. Substituting $G$ for $U_0$ in 1 gives

$$R = R_0 \left( \frac{1}{G} \right)$$

(5)

The minimum resistor values for $R_0$ and $R_1$ for a given $G$ and $R_0$ are obtained if $R_1 = R_0$.

The minimum $R_0$ is found for $G = 1$ and, taking $R_0 = 2.2k\Omega$ as a design value, $R_1$ and $R_2$ are about 18kΩ. However, $R_2$ is also part of the 4dB network, so this is calculated first using a $R_0$ of 18kΩ.
The gate of the f.e.t. must be accessible. I finally decided to use the low cost 4067 which contains two s.p.d.t. switches and an inverter.

In practice, 1dB steps in gain produce a gradual change and a range of about 60dB is sufficient for most applications. Because high value series resistors are required, high attenuation can only be achieved with the circuit in Fig. 5. However, as shown in Fig. 7, if $S_a$ is closed and $S_b$ is open, a small current flows through the internal switch capacitance. At high attenuation and high signal frequencies, this current may not be insignificant and can cause an output that rises with frequency.

The switches are grouped in five i.e.s as

$$S_2$$

Fig. 66 $ab + S_7 - S_8 • Y$

Internal capacitance effect and compensation low-pass filter.

In Fig. 6, $S_5$, $S_5$, $S_4$, $S_5$, $S_5$, and $S_5$ do not exceed the positive or negative supply voltages because an internal protection diode will conduct and cause distortion. As audio signals are bipolar, the supply voltage should be centered around ground because one side of the open switches is always connected to either a signal ground or virtual earth. To balance the on resistances of the p and n-channel m.o.s.f.e.ts, a positive supply of 7.6V and a negative supply of 4.2V is used. In Fig. 8, $S_2$ and $S_3$ can be controlled by a single bit. Switches $S_4$ to $S_6$ and $S_7$, $S_8$ require the four decoded values of a 2-bit control word. This is carried out by a 4556, which contains two one-of-four decoders, see Fig. 9.

Selection of the switch-network resistors is a compromise as already explained. The typical on resistance of a switch is about 3000 and the maximum variation is about 2000. With a series resistor of 22kΩ, this is comparable with the switch tolerance. Calculations for the resistor values are given in the appendix. Fig. 8 also shows that some switches are capacitor coul to the circuit by $C_1$ and $C_2$. These remove a small output offset voltage change with gain which can be heard as clicks at low input signal levels.

The capacitor values have been chosen to give a low-frequency response to below 100Hz. A f.e.t. input op-amp, LF 356, is used to provide a high input impedance, wide bandwidth, high slew-rate and low distortion. A NE 5534 is used at the output because it can deliver a high output level into a 600Ω load with little distortion. With $R_x$ and $C_2$ to stabilize the op-amp, a 10MΩ load will not produce ringing or overshoot of a square-wave signal. The 5534 also has a low noise device, which is important, because most of the attenuation takes place at its input and this reduces the signal-to-noise ratio of the last stage. Performance parameters of the complete amplifier are shown in table 2. A f.e.t. input selector switch is required, the LF 3530 can be used in the inverting mode as shown in Fig. 10. The compensation capacitors, which may be necessary with other op-amps, are shown in Fig. 11. If a visual indication of the attenuation is required, the control word can be converted to a two-digit b.c.d. output for driving a seven segment display.

Appendix

Calculation of resistor values.

For these calculations a d.f.t. table or calculator for log and inverse log functions is required.

For the 1, 2 and 3 dB attenuators in Fig. 12, with $S_a$ open,

$$i = \frac{U_{in}}{R_x + R_2}$$

(1)

for an output of $U_{out}$ volts. With $S_b$ closed and an output of $U_{out}$ volts, the equivalent voltage source $U_i$ is

$$i = \frac{U_i}{R_x + R_2}$$

(2)

and the equivalent source resistor is

$$R_x = R_2$$

(3)

therefore,

$$i = \frac{U_i}{R_x + R_2}$$

(4)

Because it always equals $i$, equations (1) and (4) are equal. Substituting $G$ for $U_{out}/U_{in}$ gives

$$\frac{R_x}{G} - \frac{R_2}{R_x} = \frac{R_2}{R_x}$$

(5)

The minimum resistor values for $R_1$ and $R_2$ for a given $G$ and $R_x$ are obtained if $R_1 = R_2$.

The minimum $R_x$ is found for $G = 1$ and taking $R_2 = 28kΩ$ as a design value, $R_1$ and $R_2$ are about 16kΩ. However, $R_1$ is also part of the 4dB network, so this is calculated first using $R_x$ of 16kΩ.

<table>
<thead>
<tr>
<th>Table 1. Gain and switch settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attenuation steps dB</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>2</td>
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<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
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</tbody>
</table>

Table 2. Performance details of the attenuator

<table>
<thead>
<tr>
<th>Max. r.m.s. output level</th>
<th>Max. input level</th>
<th>Max. capacitive load</th>
<th>Frequency response</th>
<th>Output noise level</th>
<th>Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.5V across 600Ω.</td>
<td>3.8V or 9V</td>
<td>10 nF</td>
<td>better than 10 Hz</td>
<td>10 dB below 10 kHz</td>
<td></td>
</tr>
<tr>
<td>0 dB up to 25 kHz</td>
<td>0 dB up to 25 kHz</td>
<td>10 nF</td>
<td>0.3% and 0.2%</td>
<td>20 dB below 10 kHz</td>
<td></td>
</tr>
<tr>
<td>0 dB up to 10 kHz</td>
<td>0 dB up to 10 kHz</td>
<td>10 nF</td>
<td>less than 0.03 nF</td>
<td>30 dB below 10 kHz</td>
<td></td>
</tr>
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<td>0 dB up to 1 kHz</td>
<td>0 dB up to 1 kHz</td>
<td>10 nF</td>
<td>less than 0.01 nF</td>
<td>40 dB below 10 kHz</td>
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<td>less than 0.001 nF</td>
<td>50 dB below 10 kHz</td>
<td></td>
</tr>
</tbody>
</table>

Performance parameters of the complete amplifier are shown in table 2. A f.e.t. input selector switch is required, the LF 3530 can be used in the inverting mode as shown in Fig. 10. The compensation capacitors, which may be necessary with other op-amps, are shown in Fig. 11.
The circuit in Fig. 13. If $S_2$ is closed and $S_3$ is open,

$$U_3/S_1 = R_1/R_2$$

With $S_2$ open and $S_3$ closed,

$$U_3/S_1 = R_1/R_2$$

Choosing 33 kΩ for $R_1$ gives 21.83 kΩ for $R_2$. Subtracting the 3 MΩ on resistance gives a standard value for $R_1$ in Fig. 8 of 21.8 kΩ and 33 kΩ for $R_2$. Calculations for the remaining switch network are more difficult because the series resistors are either connected to ground or to virtual earth, so the equivalent circuit in Fig. 15. To save a switch, $R_{12}$ in Fig. 8 always delivers current to the summing node. Therefore, for the various gain settings, the following input currents flow.

No input:

$$i_1 = 0$$

$$i_2 = 0$$

With $S_1$ and $S_3$ closed,

$$i_2 = i_1$$

and

$$i_1 = i_2$$

For a gain step $A$, the current ratios are

$$i_1/A$$

and

$$i_2/A$$

If all series resistors are equal, gain changes only depend on voltages $G_{u1}$ and $G_{u2}$. Therefore,

$$G_{u1} = A$$

$$G_{u2} = A$$

The value of $R_1$ in (5) now becomes 17.46 kΩ, i.e., $R_1/R_2$. The $R_1$ value in (6) is 6.2 kΩ, which is the on resistance in Fig. 9. For $G = 2$, $R_1$ is 34.32 kΩ which is $R_1 + R_2$ on resistance. For $G = 3$-db, $R_1$ is 34.32 kΩ, i.e., $R_1 + R_2$ on resistance. With the nearest preferred value, $R_1$ is 34.32 kΩ and $R_2$ is 34.32 kΩ. For the 9-db switch refer to Fig. 14. With $S$ open the gain is 0-6 db, and with $S$ closed the gain is $R_1 + R_2$, which gives

$$G_{u1} = 3$$

$$G_{u2} = 3$$

Note that $A$ is the input-current gain step and $G_{u1}$ is the gain step of the voltage across the series resistor relative to $G_{u1} + A$.**, continued on page 74**

---

**Fig. 15**

As already mentioned, $i_1$ and $i_2$ are equal in both cases. In the first case, gain is the ratio of $i_1$ to $i_2$, and in the second case, the ratio of $i_1$ to $i_2$. The change in gain is therefore

$$G_{u1} = 1/A$$

and

$$G_{u2} = 1/A$$


displaced from the input to the output. Also, because

$$G_{u1} = G_{u2}$$

and

$$G_{u1} = G_{u2}$$

Again, using a design value of 25 kΩ for the series resistors, and adding 3 MΩ on resistance gives 23.2 kΩ for each resistor. As $R_1$ in Fig. 8 has no series switch, $R_1$ formula in (24) and on will be 23 kΩ. After a little trial-and-error to find a standard value for $R_1$, the value of $Z_2$ was set at 15.04 kΩ, which is the constant load present to the buffer amplifier. From (22), (23) and (24), $Z_1$ is 41.3 kΩ and $R_2$ is 39.4 kΩ. From (25), $R_2$ is 10.35 kΩ. By repeating this procedure, the simplified circuit in Fig. 16 is achieved where

$$R_1 = Z_1(1-G_{u1})$$

and

$$R_2 = R_{12}$$

If $A$ is 16-dB, 

$$G_{u1} = 1/A$$

Note that $A$ is the input-current gain step and $G_{u1}$ is the gain step of the voltage across the series resistor relative to $G_{u1} + A$. **continued on page 74**
The circuit is given in Fig. 13. If S1 is closed and S2 is open, 

Fig. 13

\[ R_s = \frac{R_1}{G} \]  

Choosing 33 kΩ for \( R_s \) gives 21.83 kΩ for \( R_p \). 

Subtracting the 33 kΩ on resistance gives a standard value for \( R_p \), in Fig. 8, of 21.8 kΩ and 33 kΩ for \( R_p \). 

Calculations for the remaining switch network are more difficult because the series resistors are either connected to ground or to virtual earth, see the equivalent circuit in Fig. 15. To save a switch, \( R_s \) in Fig. 8 always

![Diagram](image1)

And (6), (7) and (9) give

\[ R_s = R_{(G-1)} \]  

Substituting \( R_s / R_1 = 196Ω \) in (10) gives

\[ R_p = G.18kΩ \]  

For \( G=6dB \), \( R_p \) is about 48kΩ. Using the standard value of 47kΩ and adding the nominal on resistance of the switch gives 47.3kΩ and \( R_p \) becomes 27.3kΩ. With the nearest preferred values, \( R_s = 47kΩ \) and \( R_p \) is 27kΩ in Fig. 8.

The value of \( R_s \) in (5) now becomes 17.46 kΩ, i.e. \( R_s / R_p \). The \( R_p \) values are calculated next.

For \( G=1 \) dB, \( R_p = 72.64 kΩ \), which is the on resistance in Fig. 8. For \( G=2 \) dB, \( R_p = 34.32 kΩ \) which is \( R_s + R_p \) on resistance. For \( G=3 \) dB, \( R_p = 21.46 kΩ \), i.e. \( R_s + R_p \) on resistance. With the nearest preferred values, \( R_p = 21.2 kΩ \), \( R_s = 14.2 kΩ \) and \( R_p = 11.2 kΩ \). For 8 dB switch refer to Fig. 14. With open the gain is 0 dB, and with \( S \) closed the gain is \( R_s + R_p \), whichever

![Diagram](image2)

Then.

\[ G_s = \frac{1}{A} \]  

\[ R_s = \frac{R_p}{G} \]  

Note that \( A \) is the input current gain step and \( G_s \) is the gain step of the voltage across the series resistor relative to \( G_s \).

![Diagram](image3)

In the simplified circuit of Fig. 16, because

\[ Z_1 = Z_2 / R_1 \]  

and

\[ R_1 = Z_2 / R_1 \]  

then

\[ G_s = \frac{1}{A} \]  

\[ R_s = \frac{R_p}{G} \]  

Note that \( A \) is the input current gain step and \( G_s \) is the gain step of the voltage across the series resistor relative to \( G_s \).

continued on page 74
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<tr>
<th>Code</th>
<th>Description</th>
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<tr>
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<td>465S</td>
<td>(240V A.C.+Battery)</td>
<td>£169</td>
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<tr>
<td>470G</td>
<td>As model 469 but without autoranging, but includes an analogue meter for peaks and scanning trends</td>
<td>£89</td>
</tr>
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</table>

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WIRELESS WORLD, MAY 1980

Binary codes for error protection

So far as is possible without recourse to far more mathematics than would be appropriate in Wireless World, Prof. Bell expounds the theory underlying the use of protection bits, which enable error-detecting and correcting transmission to be detected and corrected. An example of the technique is the Hamming code used to protect the header line in teletext and Videotel transmissions.

The term "error-protection" covers both "error-detection" and "error-correction". The latter is prima facie more desirable but is always more complex (much more complex for multiple errors) so that it is sometimes better in practice to use only detection and to re-process erroneous items either by repetition or by taking them out of the system. Communication systems have to rely on repetition, but in bank clearing operations an occasional cheque on which the account number cannot be correctly read by machine can be diverted from the machine for human attention. (This is particularly relevant because error-correcting codes are less well developed in decimal than in binary notation.)

Check digits

Most of the codes in common use are binary codes, and most readers must be familiar with the use of a single-basis (binary) check digit to detect a single error, or more exactly any odd number of errors. For example, in the ASCII code for input to a computer or for the text of telegrams, each character (number, letter, punctuation mark, etc.) is represented by a particular pattern of 7 binary digits. One then adds an eighth digit which is made 1 or 0 according as the number of ones in the original 7 digits is odd or even; the total count of ones over the 8 digits is then always even, i.e. it is equal to the zero modulo 2. In order to correct an error in a binary group, one need only find which digit is in error and interchange it so as to make it a zero. This is a straightforward scheme, and one check digit is enough to detect the presence of one error in the group of 8 digits, but it can only correct a single error in the group of 8.

The addition of one overall check digit to any error-correcting code will allow it to detect and correct any one error. See below for explanation in terms of "distance". Thus the (7,4,1) code can be extended to length 8 digits, 4 information and 4 check digits, which will correct all single errors and detect all double errors. There are then 10 possibilities to consider (no error, 8 distinct single errors, or any double error) so that 4 check digits are ample: the modified code is not perfectly packed. This is the code which is used for the address elements in teletext.

It was remarked above that a single-error-detecting code using a simple parity check will actually detect any odd number of errors; but this is usually not found to be the case because the occurrence of three errors is of negligible probability compared with the occurrence of one error. If errors occur at random, affecting only one digit at a time, with probability p per digit, then the probability of a one error in a block is 1 - p 3. One commonly takes the approximation that if the chance of one error in a block is so low that the probability of three or more errors is P 3. So if a single parity check is used for error detection when the probability of one error in a block is 10 -6, one can ignore the detection of a triple error which is less than one in probability about 10 -4. One is more concerned about the undetected double error which in this case would have probability about 10 -4.

Codes for multiple-error-correction

For codes with the capability of correcting multiple (random) errors, the method of allocating a particular task to each check digit is impracticable and one has to turn to the idea of distance between code members. The idea in principle is that one allocates to each message a cluster of signals surrounding the corresponding code-member

* The terminology is that a message is a unit of information to be communicated, e.g. a number or a letter or a group of them, while a signal is that which is transmitted, e.g. a group of binary digits.

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</table>

Other codes

One has to turn to the idea of a single information digit with one check digit to detect a single error, or more exactly any odd number of errors. For example, in the ASCII code for input to a computer or for the text of telegrams, each character (number, letter, punctuation mark, etc.) is represented by a particular pattern of 7 binary digits. One such digit can detect an error in digit number 3.

Check no. 2

Check no. 3

Digit no. 1

Digit no. 2

Digit no. 3

1 0 1 2 3 4 5 6 7

Check no. 1

0 1 0 0 0 1 1 1

Check no. 2

0 2 0 1 0 0 1 1

Check no. 3

3 1 0 1 0 1 0 1


digit place is covered by at least one check digit, so any single error will be detected. For example, in the two check digits is then a (3,1) code which fits into the standard range of single-error-correcting codes with r = 2, n = 2, m = 3, k = n - r - 1.

Let us now try to construct the (7,4) code which has r = 3. In order to show which digit places are checked by each check digit, an array is constructed with a line for each check digit containing a weight (either 0 or 1 in binary) for each of the n digits of the code. (Remember that the check digits are included in the n places.) In the following example every digit place is covered by at least one check digit, so any single error will be detected; put another way, the no-error condition is indicated by the success of all three parity checks.

Codes for multiple-error-correction

For codes with the capability of correcting multiple (random) errors, the method of allocating a particular task to each check digit is impracticable and one has to turn to the idea of distance between code members. The idea in principle is that one allocates to each message a cluster of significance representing the corresponding code-member

The terminology is that a single-error-detecting code using a simple parity check will actually detect any odd number of errors; but this is usually unnecessary because the occurrence of three errors of negligible probability compared with the occurrence of one error. If errors occur at random, affecting only one digit at a time, with probability p, then the probability of a one error in a block is 1 - 3 . One commonly takes the approximation that if the chance of one error in a block is 1 , then the probability of t errors is 1 . So if a single parity check is used for error detection when the probability of one error in a block is 1 , one can ignore the detection of a triple error which will be very improbable.

Then proceeding by successive binary divisions, the first check digit indicates whether there is an error in the second half; the second check digit covers the second and fourth quarters; and the last covers the odd numbered places (odd eights, approximately) .Hamming (1950) offered a special feature: if the check digit places are in places 1, 2 and 4 (and successive powers of two for longer codes), the combined result of the check sums (known as the "syndrome") will be the number of the erroneous digit. For example, if check number 1 produced an even sum but numbers 2 and 3 produced odd sums.
signal. Then as long as errors shift the signal from the code member only to another point in its cluster, the receiver can still identify the signal as originating from that code member (provided the clusters do not overlap to such an extent that it is impossible to distinguish it from geometrical distance) is defined as simply the number of digits in which they differ and the entire cluster of code members are known as guard points. A code to correct t errors must encode at least 2t+1 + 1 between any pair of code points, since each such interval is bounded by a cluster of extent t, and to avoid overlapping the clusters must be separated by a further unit distance. If the distance is increased by one by the addition of an overall check digit, the extra set of points allocated would be equivalent between two signal points, and this means that a maximum of 8 erroneous but not corrected. The code will still be capable of correcting t errors and can now also detect t+1 errors. In the single-error-correcting code with n = 3, no new erroneous so that each cluster will contain n + 1 points, including the code point, and the binary code has n(n - 1)/2 irreducible polynomials; and since each irreducible factor may in principle be degree of m when n = 2m - 1, there may be at most mt check digits. But it may be possible to use a factor of less degree, like one in this factor. It is not necessary to use the number of check digits is less than n. It depends on n - t - 1 factors. It can be shown that BCH codes of length n = 2m-1, distance d = n - t+1 and t = [n/4], where the square bracket is the least integer greater than or equal to n, are the BCH (Bose-Chaudhuri-Hocquenghem) and has the special feature that a code of length n that can correct t errors can be constructed with more than mt check digits. For t = 1 the relation means always holds exactly and these codes are exactly equivalent to the minimum Hamming distance of n. For n = 15 and greater and t = 3 for n = 15 and roughly proportionately larger for check digits, fewer check digits are required. Figure 1 for n = 15 (a fairly small value of m makes the calculation of binomial coefficients) is a table of BCH codes. The codes are therefore said to be perfectly packed, meaning that every point in the available space is allocated to the clusters of guard points.

Each code word for correcting t errors will need guard points corresponding to 1, 2, ... t-1 errors, the number of which is given by
\[
N = \binom{n-t}{t-1}
\]
where the binomial coefficient is the number of ways of choosing t erroneous digits out of n and is equal to n(n-1)...(n-t+1)/t!.

When n is a power of 2 and the code word is in the form of the (23,12,3) code due to Golay (see Appendix), multiple-error-correcting binary codes are not perfectly packed and the packing gets worse as n increases. (One can visualise packing of shapes in three dimensions with the packing of polyhedra in n dimensions, where n may vary.) The number of points of the code word can therefore be packed into the code word.

Implementation of BCH codes

BCH codes are cyclic, i.e. if one has a key pattern of digits to represent 2°, then the second pattern shifted x places. One can represent the whole code by an array (matrix) of codewords corresponding to the code word. As a simple example, the (7,4) code can be represented by a generator matrix G.

If the degree of the composite factor, k(n - r) is the number of information digits. But in this case k = 5, n = 15, r = 10 and therefore k = n - 5. This is a (15,5,3) code. For a code of this length there would be 5 irreducible polynomials and since each irreducible factor may in principle be degree of m when n = 2m - 1, there may be at most mt check digits. But it may be possible to use a factor of less degree, like one in this factor. It is possible to use a factor of less degree, like one in this factor. It is not necessary to use the number of check digits is less than n. It depends on n - t - 1 factors. It can be shown that BCH codes of length n = 2m-1, distance d = n - t+1 and t = [n/4], where the square bracket is the least integer greater than or equal to n, are the BCH (Bose-Chaudhuri-Hocquenghem) codes.

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Each code word for correcting t errors will need guard points corresponding to 1, 2, ... t-1 errors, the number of which is given by
\[
N = \binom{n-t}{t-1}
\]

The codes for being "suitable" factors go beyond the mathematical depth of this article.

Fig. 1. Numbers of check digits for error-correcting codes of length 15. (a) Single-error correcting (best out of three voting) 35 planes. (b) Double-error-correcting (best out of four voting) 27 planes. (c) Triple-error-correcting (best out of seven voting) 5 planes.

Then if the 4-digit binary number 1101 (decimal 13) is encoded into the first, third, fourth and rows G, corresponding to 2°, 2° and 2° and add them together to get a final digit of Hadamard (this is the code word is the code word. As a simple example, the (7,4) code can be represented by a generator matrix G.

The fact that the (7,4) code and H(7,4) are not perfectly packed and the packing gets worse as n increases. (One can visualise packing of shapes in three dimensions with the packing of polyhedra in n dimensions, where n may vary.) The number of points of the code word can therefore be packed into the code word.

1. The order of the digits in a code word is not alterable; the order of the digits in the check matrix is immaterial to the same matrix. The code word is encoded from one such order is equivalent to the original order.
2. The message for being "suitable" factors go beyond the mathematical depth of this article.
3. Binary codes are not perfectly packed; 3
4. sands, is to most of us just a form of art. It is recognized as erroneous but not corrected. The code will still be capable of correcting t errors and can now also detect t+1 errors. In the single-error-correcting code with n = 3, no new erroneous so that each cluster will contain n + 1 points, including the code point, and the binary code has n(n - 1)/2 irreducible polynomials; and since each irreducible factor may in principle be degree of m when n = 2m - 1, there may be at most mt check digits. But it may be possible to use a factor of less degree, like one in this factor. It is not necessary to use the number of check digits is less than n. It depends on n - t - 1 factors. It can be shown that BCH codes of length n = 2m-1, distance d = n - t+1 and t = [n/4], where the square bracket is the least integer greater than or equal to n, are the BCH (Bose-Chaudhuri-Hocquenghem) codes.

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Fig. 1. Numbers of check digits for error-correcting codes of length 15. (a) Single-error correcting (best out of three voting) 35 planes. (b) Double-error-correcting (best out of four voting) 27 planes. (c) Triple-error-correcting (best out of seven voting) 5 planes.

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and where provision must be made as many as possible may be packed into the n-dimensional space that as clusters of guard points. Therefore the greatest number of code points which can be packed into the corresponding to 1, 2, ..., divided by the number of possible errors so that each stage is passed to the next in line; in this way a digital operation can be inverted and on each clock beat the content of any two similar inputs (or all three inputs) can be used to form a generator matrix G, a tapped shift register and adders, and in parallel to another circuit corresponding to the multiplying circuit of Fig. 2(b). The output is zero for any number of stages is preferable for a large number of stages. Implementation of BCH codes BCH codes are cyclic, i.e. if one has a key pattern shifted x places. One can represent the whole code by an array (matrix) of length n and the number of rows is equal to the number of code points for the given word. As a simple example, the (7,4) code can be represented by a generator matrix G:

\[
G = \begin{bmatrix}
1 & 0 & 1 & 1 & 0 & 0 & 1 \\
1 & 0 & 1 & 0 & 1 & 1 & 0 \\
1 & 0 & 1 & 1 & 1 & 0 & 0 \\
1 & 0 & 0 & 1 & 0 & 1 & 1 \\
1 & 0 & 0 & 1 & 1 & 0 & 1 \\
1 & 0 & 0 & 0 & 1 & 1 & 1 \\
1 & 0 & 0 & 0 & 0 & 1 & 1
\end{bmatrix}
\]

If r is the degree of the composite factor, \( n = r \) is the number of information digits. In this case \( n = 15, r = 10 \) and therefore \( k = 5 \) is a (15,5,3) code. For a (15,5,3) code the errors will be irreducible polynomial and since each irreducible factor in principle be of degree m when \( n = 2^m - 1 \), there may be at most \( m \) check digits. But it may be possible to use a factor of less degree, since the code is in this case that the number of check digits is less than \( m \). It depends how \( n \) factors are employed are above the level which results in the World Wide Web.) It therefore is expected to be able to decode those. Who are not deterred by the use of combinatorial algebra can find the details in a specialist book. A general-purpose set of codes, which can be constructed to any length \( n = 2^m - 1 \) and certain other lengths and with various error-correcting capacities is generally known, BCH (Bose-Chaudhuri-Hocquenghem) in full; and it has the special feature that a code of length \( n \) can be used to correct \( t \) errors can be constructed with not more than \( n - t \) check digits. For the relation \( r \) is always holds proportionally for larger lengths, fewer check digits are required. Figure 1 for \( n = 15 \) (a fairly small value of \( n \) makes the calculation of binomial coefficients manageable). The use of tabulated values shows (a) the minimum number of check digits ideally required in order to correct 1, 2, 3 or 4 errors the straight-line relationship between each row of this code is known BCH codes. BCH codes result from factoring suitably \( x \), where \( n \) multiple of the length \( x \). The BCH code polynomials (the algebraic equivalent of prime numbers) is given in reference (4). The composite factors \( g_1(x) \), \( g_3(x) \), the code polynomial: an \( x \) for which \( x \) is a node of the code. Decoding by majority vote of a group of digits read out from certain memory planes and the digits of these majority groups, consisting partially of data points and partly of check digits are interleaved and shared in such a way that the total number of memory planes need not be increased. The form, which for 25-bit error-free output are:

(a) Single-error-correcting (best out of three voting) 35 planes.
(b) Double-error-correcting (best out of five voting) 25 planes.
(c) Triple-error-correcting (best out of seven voting) 5 planes.

In general the code works for the first output bit \( h \) in the case of a single error-correcting code which has a total of 35 planes and \( h = 0 \) to 16, plus 10 check digits \( C \) to \( C_{16} \). The correct output is instantaneous on the detection of any error, since two successive error groups, the output of which will agree with any two similar inputs (or all three inputs) can be used to form a generator matrix G, a tapped shift register and adders, and in parallel to another circuit corresponding to the multiplying circuit of Fig. 2(b). The output is zero for any number of stages is preferable for a large number of stages. Implementation of BCH codes BCH codes are cyclic, i.e. if one has a key pattern shifted x places. One can represent the whole code by an array (matrix) of length n and the number of rows is equal to the number of code points for the given word. As a simple example, the (7,4) code can be represented by a generator matrix G:

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therefore, \( R_2 \) is \( \frac{\text{Wid a Iew}}{\text{Wid a Iew}} \) where \( \text{are typical of land-line circuits} \), as often said that random errors are result shifts which are taken to be the powers the pattern decimal number the construction of these cyclic lengths 7, 15, 27, 34 and capable of being burst errors as well as random errors is to scramble the order of digits before transmission and use it as an error pattern at the receiver. The re-ordering of digits at the receiver will bring up any bursts into scattered errors which can be dealt with by a code for random errors. However, the whole point of burst-error-correcting codes is that for a given number of check digits they can deal with bursts errors in a burst than scattered at random; so the scrambling should extend over many than one block so that, for example, a burst of 6 errors in one block length during transmission becomes 3 random errors in each of two blocks after "uncrambling" in the receiver.

Error-correcting and error-detecting codes constitute a vast subject: it is merely to explain the ideas behind two important classes of coding in this book. It is not possible to give ideal image by the GEC-Marconi Group and a teachers' demonstration which produced a very satisfying result, the loudspeakers being as acoustically unobtrusive as one would hope. The images were not so sharp as perhaps one is accustomed to with two speakers, but were more than the G.E. group. There is a further qualification to stress, because it also provides conventional stereo and GaAs will be used only where its directional components, whereas for a periphonic decoder the gains are 1.0 and 0.9, perhaps what is needed is a statistical prediction periphonic decoders is \( 0.5 \) dB. The new company is an information service, ways of making BBC miniature trading company called BBC Data established by Dr Cyril Hiltum, a leading UK and acoustic engineers respectively, where 1.0 meant "slightly better" than two-speaker stereo. Little wonder it didn't catch on.

### Programmable audio attenuator

**From the equations:**

\[
\begin{align*}
R_{\text{in}} &= R_{\text{in}}(1 - G_{\text{L}}) \\
&= R_{\text{in}}G_{\text{L}} \\
R_n &= R_{\text{in}}G_{\text{L}}(1 - G_{\text{L}}) \\
&= R_{\text{in}}G_{\text{L}}^2 \\
&= \cdots \\
R_n &= R_{\text{in}}G_{\text{L}}^n \\
R_n &= \frac{R_{\text{in}}}{1 - G_{\text{L}}}
\end{align*}
\]

There appears to be a requirement to correct both random and burst errors. It is often said that random errors are typical of radio communications, the result of thermal and shot noise in the receiver and atmospheric disturbances which are of local interest, in circuits such as amplifiers and mixers. The nearest standard value for \( R_1 \) is 1.24 dB and for \( R_2 \) is 1.54 dB. The last step gives Fig. 18

**Printed circuit board**

A printed circuit board which accommodates the electronics for the complete system is shown in Fig. 19. This board is made up of a four-layered circuit board with each layer being a square layer, with the ground plane being the outermost layer.

**Exhibitions and conferences**

**Broadway '80** will be held at the Royal Horticultural Halls, Ewell St, Westminster, London SW1, from November 26 to 30, 1980. Operation times have been changed to read Wednesday 26, 10 a.m. to 6 p.m., Thursday 27, 8 a.m. to 6 p.m., Friday 28, 10 a.m. to 6 p.m. and Saturday 29, 10 a.m. to 4 p.m.

**Electronic Test and Measuring Instrumentation '80** will be held at Wembley, London, from September 26 to 28, 1980. The conference will cover topics ranging from electronic test equipment to the design of electronic systems. The conference will also include a special session on microprocessors.

**Exhibition '80** will be held at the World Trade Centre, Singapore, Singapore, in June 2000. The exhibition will cover a wide range of topics, including microprocessors and related technologies.

**World Trade Centre**

**The S.E. Asia 3rd Biennial International Exhibition and Conference on Electronics and Electrical Engineering** is being held at the World Trade Centre, Singapore, in June 2000. The exhibition will cover a wide range of topics, including microprocessors and related technologies.

**Massive report on GaAs is dubious**

A article written by Gene Hnatek, quoted as a general user's guide to practical use of GaAs technology, was dismissed by Dr Cyril Hiltum, a leading UK and acoustic engineers respectively, where 1.0 meant "slightly better" than two-speaker stereo. Little wonder it didn't catch on.
WIRELESS WORLD, MAY 1980

**Programmable audio attenuator**

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>R2</td>
<td>(R2 + R3)</td>
</tr>
<tr>
<td>R3</td>
<td>R4</td>
<td>10000000</td>
</tr>
<tr>
<td>R5</td>
<td>R6</td>
<td>10000000</td>
</tr>
</tbody>
</table>

Therefore, R1 = 9.09 kΩ (3.3 kΩ standard value) and R2 = 1.54 kΩ.
The last step gives Fig. 18 where

\[
\begin{align*}
R1 &= R2 + R3 + R4 + R5 + R6 \\
&= 10000000 \\
&= 10 \text{ MΩ}
\end{align*}
\]

**Early tetrahedral array (besides its awkwardness) was that these two localizations coincided; if fast energy vector localizations show that will be still a big problem because these are in high frequencies and possible to correct by loudspeakers. More hints for coincidence of localizations according to the two main theories are nearly summed up in Gerton's new book.**

**References**


**The author**

J. M. Didden started his career in 1964 with the design of bx receiver detection circuits. After spending three years at the National Royal Air Force to work in air defence operations and specialise in software.

The author is currently involved with software and micro-processors in defence systems. Apart from audio, his hobbies include reading science fiction.

**Exhibitions and conferences**

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**Massive report on GaAs is dubious**

A report written by Gene Hootis, quoted as "a noted US expert on integrated circuit technology" by Innotech, and which is said to consist of 300 pages, priced at $500, has been dismissed by Dr Cyril Hiltum, a leading UK authority on the same applications, as "melodramatic."

The report maintains that GaAs devices, due to the smallness of the chip, "rapidly replace the silicon chip," but Dr Cyril Hiltum argues that production processes cannot compete with silicon on an economic and technical basis. They need properties which make it a sensible choice.
15V ½A regulator

Although cheap and general purpose components are used throughout, this circuit offers good load regulation and temperature stability. Output resistance is typically 30 µΩ at low frequencies and, unlike conventional regulators where the power transistor is connected to the op-amp output, only a few hundred milliVolts are required across the series-pass transistor to maintain regulation. The circuit can be built for negative regulation by using n-p-n transistors in the negative supply lead of the 741. Fold-back current limiting is included to limit the maximum dissipation to 4W. The 3k3 resistor allows the output stage of the 741 to turn off when no current is being drawn, and the 220Ω resistor prevents the 741 quiescent current from turning the power transistor on. The diode and 470kΩ resistor allow start-up and the 0.1µF capacitor improves the response to sudden changes in output current.

J. W. Rowe
Birnley
Notts.

High-frequency doubling with c.m.o.s.

High-frequency doubling can be achieved by using the propagation delay of c.m.o.s. together with exclusive OR gating. The circuit shows an oscillator operating at 1.6 MHz, and an exclusive OR gate fed with the oscillator output and an inverted and delayed output. Propagation delay of the buffers depends on $V_{00}$ and the load capacitance, but for a 7.5V supply and a load capacitance of 50pF, the delay for each buffer is about 3ns. Therefore, the total delay $t_o$ for six buffers is 18ns and the difference between the two signals is 170ns, which produces a 3.2 MHz output with an almost equal mark-to-space ratio.

D. J. Greenland
Bear Hill
Cambridge

Simple manual-reset latch

One 4001 can provide a latch that will turn off but will not turn on again until manually reset. Gates a and b together with two resistors form a Schmitt trigger which provides noise immunity. A low at the input causes the output of gate a to go high and the output of gate d to go high which then inhibits the output of gate b after it has gone low. Reset is achieved by removing the power supply to discharge $C_1$, or replacing $C_1$ with a push-to-make switch for manual reset. If the capacitor is used it must be large enough to ensure that the input goes high before point A goes low. If a switch is inserted at point B and 1MΩ resistor connected to 0V, the circuit will follow the input. Resistors $R_1$ and $R_2$ can be omitted if the latch is driven by logic and noise is not a problem.

I. J. Nicolle
Guernsey
Channel Isles

Variable phase all-pass filter

This all-pass filter offered constant amplitude, a distortion content of less than 0.1% for a 1V r.m.s. output, and a frequency range up to 100 kHz. Transistors $T_1$, $T_2$ and $T_3$ form a low-output-impedance phase-splitter which drives a CR network. Transistors $T_4$ and $T_5$ form a buffer stage, and the 1kΩ gate resistor prevents spurious oscillations. With a 10kΩ potentiometer and a suitable value for $C$, the phase of a waveform can be varied from 0 to nearly 180°, or, by reversing $C$ and $R$, from 180° to near 0°. The graph shows the normalized all-pass phase response with four values of $R$.

T. G. Izatt
Preston Polytechnic
and
E. Ball
Salford University
CIRCUIT IDEAS

15V ½A regulator

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High-frequency doubling can be achieved by using the propagation delay of c.m.o.s. together with exclusive OR gating. The circuit shows an oscillator operating at 1.6 MHz, and an exclusive OR gate fed with the oscillator output and an inverted and delayed output. Propagation delay of the buffers depends on Vcc and the load capacitance, but for a 5V supply and a load capacitance of 50pF, the delay for each buffer is about 3ns. Therefore, the total delay for six buffers is 18ns and the difference between the two signals is 170ns, which produces a 3.2 MHz output with an almost equal mark-to-space ratio.

D. J. Greenland
Bear Hill
Cambridge

Simple manual-reset latch

One 4001 can provide a latch that will turn off but will not turn on again until manually reset. Gates a and b together with two resistors form a Schmitt trigger which provides noise immunity. A low at the input causes the output of gate a to go high and the output of gate d to go high which then inhibits the output of gate b after it has gone low. Reset is achieved by removing the power supply to discharge C2, or replacing C2 with a push-to-make switch for manual reset. If the capacitor is used it must be large enough to ensure that the input goes high before point A goes low. If a switch is inserted at point B and 1MΩ resistor connected to OV, the circuit will follow the input. Resistors R1 and R2 can be omitted if the latch is driven by logic and noise is not a problem.

I. J. Nicolle
Guernsey
Channel Isles

Variable phase all-pass filter

This all-pass filter offered constant amplitude, a distortion content of less than 0.1% for a 1V r.m.s. output, and a frequency range up to 100 kHz. Transistors Tr1, Tr2, and Tr3 form a low output-impedance phase-splitter which drives a CR network. Transistors Tr4 and Tr5 form a buffer stage, and the 1kΩ gate resistor prevents spurious oscillations. With a 1kΩ potentiometer and a suitable value for C, the phase of a waveform can be varied from 0° nearly 180°, or, by reversing C and R, from 180° to near 0°. The graph shows the normalized all-pass phase response with four values of R.

T. G. Izatt
Preston Polytechnic
and
E. Ball
Salford University

www.americanradiohistory.com
Multi-channel voltmeter with tv display

This voltmeter provides up to 25 channels and displays them as horizontal bars on a television screen. A scale is provided by an 8 x line-frequency square wave, gated as a video signal between adjacent bars. The circuit comprises an integrator which ramps from 0 to 1V in 40µs and is reset to slightly below 0V at each line sync. pulse. The input signal is gated by one or more 4051 analogue multiplexers, depending on the number of channels required, and fed to a 74S comparator whose remaining input is connected to the integrator. When the integrator output equals the input signal, the video output is switched from white to black. The sync timing chain consists of a 1MHz crystal oscillator, a 4024 and 4518 which provide a divide-by-64 for line sync. and a second 4024 provides a divide-by-320 for frame sync.

An AF139 modulator is shown, but the circuit can be modified to drive one of the commercial modulators now available. The transistor is housed in a small tin box and the 10kΩ preset is adjusted to zero the display on a convenient scale point close to the left of the screen. The 10kΩ preset is adjusted with a 1V input to set the display on the tenth scale point. These adjustments should be rechecked because there is some interaction between the controls. The display can also be adjusted for centre zero.

A similar circuit, but without the scale and input multiplexing, can be used as a wobbulator display or a simple oscilloscope. One channel is used as a divide-by-32 and 64 on the gate 3 partially discharge gate 4 and is reset to 0V at each line sync., except frame sync., are increased in the nth scale point. These adjustments should be rechecked because of some interaction between the controls. The display can also be adjusted for centre zero.

C.m.o.s. 60 kHz receiver

One c.m.o.s. NAND gate i.e. can be used as a low frequency receiver as shown. All of the gates are connected as inverters and the first three operate in the linear mode with 100% feed-back. Gate 4 and 5 provide amplification and a l.i.f. interface. The input to gate 4 is biased so that, with no carrier, Tr4 is turned off and the output is high. With the carrier on, negative half-cycles at the output of gate 3 partially discharge C1 via D1 and turn Tr5 on via gate 4. Although the a.c. gain and d.c. input-output voltage varies with different packages, three 4011A E i.c. can function satisfactorily with R6 adjusted to give a carrier-off voltage of 0.7V at the base of Tr5. With a correctly tuned aerial, the only critical components are C1, C2 and C3. The value of C2, assumes L, to give the input winding of a yellow-coded i.f. transformer.

J. D. Owen
Caste Lloyd
Dyfed

Micro-soldering !

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TCSU1 & CTC

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Model TCSU1

Accurate pin point temperature control between 65° and 450°C. Heating element and sensor built in tip of the iron for fast response. Interchangeable circuits. bits from 0.6 mm (1/32") down to 0.5mm. Zero voltage switching, no spikes. No magnetic field, no leakage. Supplied with miniature CTC-12 volt welding iron or TX21/6watt TCSU1 soldering station with TXC or CTC iron £36.64. Next to industry.

Model SK3 Kit

Contains both the model CX200 soldering iron and the ST3 stand. ST3. Priced at £21.70 (4.6). The iron is the present production version of the non-mercury, safe and simple amateur or hobbyist.

Model SK4 Kit

With the model CX220 general purpose iron and the ST3 stand this kit is a must for every looked for in the home. CTC-24 volts. Priced at £39.75 (8.7). Also available for 240V.

Model SK1

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Model MLX

12 volts

ST3 Stand.

A miniature iron with the element enclosed first in a ceramic shaft, then in stainless steel. Virtually leak-free. Only 7½" long. Weight 3½ oz. £14.80.

Model ST3 kit only available from 0½" down to 3/64". Also available for 240V.

Model CX 11watts - 230 volts

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Model X25 25watts 230 volts

A strong chromium plated, stainless steel iron for the home and office. Packed with 15 feet cable and battery clips. Priced to a serving station and can be a bonus or a gift ready for the do-it-yourselfer in the family. Price £14.55 (3.4).

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J. D. Owen
Caste Lloyd
Dyfed

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12 volts

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The sync timing chain consists of a 1MHz crystal oscillator, a 4024 and 4518 which provide a divide-by-64 for line sync. (15.625kHz) and a second 4024 provides a divide-by-320 for frame sync. (60kHz).

The drive for the v.c.o.s can be generated from a second 4051.

If Tr4 is turned on via gate 4. Although the a.c. output is switched from white to black., the input is biased so that with no carrier, Tr4 is switched on. All of the 4024 outputs, except frame sync, are increased in frequency four times.

J. D. Owen
Cafle Lloyd
Dyfed

C.m.o.s. 60 kHz receiver

One c.m.o.s NAND gate is often used as a low frequency receiver as shown. All of the gates are connected as inverters and the first three operate in the linear mode with 100% feed-back. Gate 4 and Tr5 provide amplification and a t.l.c. interface. The input to gate 4 is biased so that with no carrier, Tr4 is turned off and the output is high. With the carrier on, negative half-cycles at the output of gate 3 partially discharge C1 via D3 and turn Tr5 on via gate 4. Although the a.c. gain and d.c. input-output voltage varies with different packages, three 4011A.I. ICs functioned satisfactorily with R9 adjusted to give a carrier-off voltage of 0.3V at the base of Tr5. With a correctly tuned aerial, the only critical components are C1, C2, and C3. The value of C1 assumes I, to be the input winding of a yellow-coded i.f. transformer.

G. Jackson
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A miniature iron with the element enclosed first in a ceramic shaft, then in stainless steel. Virtually leakless. Only 71/2" long, 1.5 oz. 3.25" bit. £4.80

Model CX5 25watts 230 volts

A general purpose iron also with a ceramic and steel shaft to give the toughness combined with near-perfect isolation. Save time, save money. £6.00. Also available by post at £4.25. Also available for 240 volts. Also available in kit form.

Model SK3 Kit

Model SK4 Kit

Contains both the model CX230 soldering iron and the stand ST3. Priced at £8.75 (187)

Contains both the model CX230 general purpose iron and the ST3 stand this kit is a must for every soldered in the home. £8.75 (187)

Model SK1

Model MLX 12 volts

The soldering iron in this kit can be cleaned from any circuit with a single movement of the iron. Also available by post at £4.80. Also available in kit form.

Model X25 25watts 230 volts

A strong aluminium plated lever action iron. Suitable for use on circuit boards, battery packs, transformers and also for ANTEX models soldering iron. Priced at £4.80.

Spare element Model CX50E

Spare element Model X25/240E

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A weak chromicacid based levers in lever action types. Also available by post at £4.80.

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Facts from Fluke on low-cost DMMs

Is this any way to treat an £89 multimeter?

In the rough world of industrial electronics, even a precision test instrument can get treated like dirt. You stain it, you squeeze it, you shunt it, you drop it, you drive over it. And you've survived because we never cut corners on quality, even on our lowest-priced, six-function Model 80G2A Troubleshooter at £89.

One of the cost constraints has been a low-cost DMM from Fluke and you'll notice tough, lightweight construction that stands up to the hard knocks of life. Sturdy internal design and high-impact, flame retardant shells make these units practically unbreakable. Right off the shelf, they meet or exceed severe military shock/vibration tests. Even our LCDs are protected by cost-tempered plastic shields. We use rugged CMOS LCDs for integrity and endurance, and devote a large number of components to protection against overloading, accidental inputs and operator errors.

We go to these lengths with all our low-cost DMM's to make sure they are genuine price/performance values. You can count on that. Because, that's what leadership is all about.

For more facts on DMM reliability and where to find it, call (0923) 401411; see the coupon below or contact your Fluke sales office or representative.

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Why does an electron have inertia?

Give me an electron and I can move the world


Professor Jennison's article in June 1979, in dealing with the mass and inertia of the electron, mentioned Mach's suggestion that the inertia of a body originating from the interaction of the distant masses of the Universe. Although the Mach Principle has empirical support, the author here sketches an elementary scheme for the interaction it visualizes and claims that this "appears capable of explaining, in a manner, some of the known facts concerning, inertial mass."

When you switch on an oscilloscope to monitor a signal, you are in essence deflecting a scanning beam of electrons by an electric field proportional to the signal. The inertial mass of an electron has been established as a constant whose value is known to 6 parts in 10^10, so that the angle through which the beam will be deflected can, if you wish, be predicted for any given strength of the transverse electric field.

Many people, however, are not satisfied by merely knowing how things behave: they want to find out why as well. Why does an electron have inertia and furthermore why is its inertial mass that particular value and not some other magnitude? Indeed, why may it be generally exhibited inertia? Inertia is, of course, defined in Newton's Second Law. Therefore the question is reduced to why F = ma, where the symbols have the same significance. Our modelling of the objective world will be more complete if this law, of which the First Law is a special case, is as derived and no longer remains an axiomatic postulate.

Mach Principle

As pointed out in a recent Wireless World article, so far the only suggestion to explain inertia is that attributed to Ernst Mach. The idea is an elaboration of the Mach (his) hypothesis - that of a luminous sphere whose radius is determined by the speed of light, and which is experienced whenever traveling through empty space. What we assume that the light of this sphere would be deflected if it were to pass through the luminous sphere. This is similar to the question of how far the light source is from the object. In this case, the luminous sphere is related to the speed of light and the distance of the object.

In his book "The Speed of Light," Meinheimer, in the 1970s, that Newtonian cosmology leads to results which are consistent with the predictions of general relativity. The author concludes that this conclusion is true, and that the speed of light is a fundamental constant of nature. This constant is related to the speed of light in empty space, and is given by the equation:

\[ c = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \]

where \( c \) is the speed of light in empty space, \( v \) is the velocity of the object, and \( f \) is the frequency of the radiation. The equation is derived from the principle of special relativity, which states that the speed of light is constant in all inertial frames of reference. This constant is used in general relativity to define the metric of space-time, and is also used in the definition of the speed of light in empty space.

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Facts from Fluke on low-cost DMM's

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People, however, are not satisfied by merely knowing how things behave: they want to find out why as well. Why does an electron have inertia, and furthermore why is its inertial mass that particular value and not some other magnitude? Indeed, why matter in general exhibits inertia? Inertia is, of course, defined in Newton's Second Law. Therefore the question is reduced to why F = m a, where the symbols have their usual significance. Our modelling of the objective world will be more complete if this law, of which the First Law is a special case, is as shown derived and no longer remains an axiomatic postulate.

Mach principle

As discussed in a recent Wireless World article¹, so far the only suggestion to explain inertia is that attributed to Ernst Mach. The idea is essentially the same as Einstein's later, more far-reaching, ideas and the young, Leibniz, it is usually referred to as the Mach Principle, a terminology used by Einstein who attributed to Mach's work. Although he was not quite correct, it is contrary to the opinion expressed in that article, not entirely a qualitative hypothesis that is incapable of accountancy for the precise observations of inertial mass and inertial force. In fact, it has been realised in a number of alternative theories². True, none of these is commonly accepted. Nevertheless, many interesting deductions can be made in even a simple realisation of the Mach Principle; some we are going to describe in this article. First, however, let us discuss the content and the plausibility of Mach's (or Leibniz's) proposal.

The Mach Principle embodies the conception that the inertia of an object arises wholly from its interaction with background matter. A force has to be applied to an electron to change its state of motion, because, in its own frame of reference, the applied force is needed to balance the pull by you, the Earth, the sun and planets, and the 'fixed stars'. This pulls which is generated whenever it accelerates relative to the surrounding matter. Were all background matter removed then for the electron, alone, no distinction could be made between uniform and accelerated motions. This vacuum in a number of virtual particles is, however, completely irrelevant because there are no other particles to absorb or emit them.

In other words, accelerating an electron is not equivalent to a change in its state of motion. It is equivalent to an applied force, in this case, the pull of you, the Earth, the sun and planets, and the 'fixed stars'.

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even pathological) relativistic models can be avoided, and at the same time difficulties in deriving the infinite gravitational potential in an unbounded universe disappear. In this way, the effective gravitational force will be completely unified, and also the problem of infinite self-gravitational energy for the Universe (i.e., in the Universe \(N = \sqrt{Gm^3/c^2}\), factors such as \(r/\Delta m^3\) again being neglected. By a statistical rule of thumb,

\[\Delta m^3 = 1/\text{Newton}^2.\]  

Hence (2) probably reduces to

\[F = \text{Newton}^2 \cdot \Delta m^3.\]

The results may then be expressed in seconds of arc, the units for which are used in the works of the author.


can be derived via the Machian theory, we point out that in Newtonian mechanics. The case of trifugal and Coriolis forces of the right background matter, is summed in the following sentence of this paragraph.

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the Machian theory, we point out that
form come out when F
in Newtonian mechanics. The case of
trifugal and Coriolis forces of the right
surprising, since these forces are
models, in a series of papers in Pro-
wegung' of electrons _ etc.) and are
elementary particles in two bodies
coincidences, Dirac has proposed
is in fact but a manifestation ofF
satisfied, however, in either classical i
principle. They are of imposing importance
There are in cosmology a number of
accelerated with respect to other matter
infinite gravitational potential in an

F=-Fm, Newton's Second Law is at


\[ \frac{\Delta m}{\Delta N} = 1/N \]
Substituting for N and eliminating \( \Delta m \) between

\[ m/c^2 = \sqrt{c^4 E^2 - m^2 c^4} \]

which, on plugging in the numerical

\( \Delta m = m^2 c^2 / 2 \)

relativistic energy difference in the Breit

\[ \Delta m = \sqrt{c^4 E^2 - m^2 c^4} \]

and gravitation

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within the

The mass of an electron beam in the oscilloscope, and
why one should use a seat belt?

References


Communication receiver

design

Even at the end of the 1930s, the h.f.
communications receiver could provide a
high standard of performance with
smaller dimensions than could be
achieved by the vacuum-tube receiver.
Unfortunately, though, the sensitivity
is even further from being perfect.
Winter Sporadic E

Recently it was suggested (W0AR
March) that while American amateurs
recognise the existence of a winter
Sporadic E season, this did not appear to
be the case in Europe. John Branegan,
GM41HJ of Saline, Pře, however,
reports that he has obtained Sporadic E
during the season year since 1977. He uses
sensitive receivers and a high-performance
EDdyson 7780 r.f. receiver, various
pre-amplifiers and converters feeding a
Yaesu FT 207 A 82 multi-notch r.f.
tuner and rotary s.e. yagi array.

He finds the winter Sporadic E season
usually starts about Christmas and lasts
until about the first week in February
(three of these days of such events
followed by several days without any).
During winter, Sporadic E signals are heard
up to about 53MHz and on about one-in-
to-three occasions to 76MHz, very rarely
to about 90MHz. An example of an
arrangement has been observed. From
contacts with VK41J during F2-layer
opening, he believes that winter Sporadic E
occurs on the same days at around 1440MHz.
As an example of a typical winter Sporadic E
event he provides a clear picture of
radio reception at 1440MHz on
January 21 this year. Curiously, he does
not find that the range of Sporadic E
changes in the manner that has been
suggested as likely due to the gradual
correlation of metallic particles in
cirrus sheets, but remains in the range of
650 to 1250 miles throughout the

Sporadic E seasonal

Winter Sporadic E

Combination of the excellent
mechanical quality of the
Klystron and the...
Outlook for short-wave broadcasting

Meagre increase of frequency allocations gained from WARC 79

by Jim Vastenhoud Radio Nederland

Most readers will have seen reports about the 1979 World Administrative Radio Conference (WARC 79) in this journal, and will know that the world radio stations all over the world attach great importance to the result of this conference. The main objective of the conference was the allocation of the radio spectrum and is the standard reference for radio users all over the world. Article V was revised previously in 1968. Since then, however, there have been significant shifts in the usage of the spectrum, partly due to technical developments, such as the opening up of satellite communications, but also results from world developments like the new frequency requirements of nations which have gained their independence since 1968. These frequency requirements of the emerging nations affect all fields of communications and especially those bands which were already heavily loaded, or even congested, in 1958.

Increased demand

The most marked increase in the demand for radio spectrum space in the past twenty years is the growth of the fields of maritime mobile communications and short-wave radio broadcasting. In Band V, a frequency agreement was reached at WARC 79 on an expansion in Regions 1 and 2 to 108 MHz. A planning conference, to be held in a few years' time, will decide about the channel allocation for each area. Before this can take place, however, non-broadcasting services which still require space have to be relocated in other frequency ranges. Short-wave broadcasting has also grown considerably, but a frequency plan for the medium- and long-wave bands was not yet reached. The measure work is on engineering projects and the co-ordination of frequencies in the short-wave band was successful. The more crowded the spectrum, the more it is necessary to think long-term and to be prepared for future growth. Jim Vastenhoud, author of the current article, is the deputy director of engineering services at Radio Nederland, the Dutch world broadcasting organization, and was responsible for the re-allocation of the (W ARC 78) in February 1976. He has also been vice-chairman of the Plenary Conference.

Excessive h.f. bands

Most countries, however, short-wave broadcasting stations have not been allowed to operate "out-of-band", as they are in the broadcast bands. A new frequency agreement was reached by the WARC 79 which set in motion the long-sought expansion of the frequency band for the medium- and long-wave broadcasting. It was decided to allocate additional space to broadcasting and non-broadcasting services which were not sufficient in the fixed bands. The decision was also motivated by the need to provide enough channels to the expected rapid growth of broadcasting services. The frequency plan adopted at WARC 79 in February 1976 is based on technical data rather than on political motives. It is a disapproving result, which may also be accredited to the failure of some delegates from less technical countries. The results are now being implemented by the authorities of the various countries.

The case for community radio

Many people are dissatisfied with the centralised nature of national broadcasting, even when it includes regional and local stations. Community feeling, discussion and culture could be encouraged by alternative radio. Jim McLeod assesses what could be done in the UK.

"Off-resonance" metal detector

This newcomer to metal detecting is basically similar to the b.f.o. type but senses the search coil's inductance change, and uses the properties of a parallel-tuned circuit to obtain more information about the physical nature of the object.

What happened to analogue computers?

Apart from the i.c. op-amp, analogue computing techniques seem to have been swamped by the tide of digital computers and microprocessors. This article reminds us of the basic electronic analogue techniques and of how flexible they are for modelling proposed systems.
Outlook for short-wave broadcasting

Meagre increase of frequency allocations gained from WARC 79

by Jim Vastenhoud Radio Nederland

Most readers will have seen reports about the 1979 World Administrative Radio Conference (WARC 79) in this journal, and will know that short-wave radio stations all over the world attach great importance to the results. One of the main objectives of the conference was the reallocation of the short-wave spectrum. The outcome of the conference, all international agreements on the use of the spectrum and the standard reference for radio users all over the world. Article V was revised previously in 1959. Since then, however, there have been significant shifts in the usage of the spectrum, partly due to technical developments such as the opening up of satellite communications, but also results from the grouping together of the fields of maritime mobile communications and short-wave radio broadcasting. In Band 2, the v.h.f./f.m. bands, the use of short-wave broadcasting without the use of repeaters or satellites. This fact makes this h.f. part of the spectrum important to various users — mobile communications on land, at sea or in the air, fixed communications between points on earth, radio amateurs, and broadcasting to mention a few. In the past twenty years the occupation of various bands in this range has changed. Extensive monitoring, taking place all over the world, in recent years, has shown that the number of stations in the fixed bands (which occupy about 48% of the available short-wave spectrum) has considerably decreased. It has also shown that the number of stations inside the allocated short-wave broadcasting bands has grown to intolerable levels.

The decrease of band loading in the fixed bands was due partly to the development of satellite communications, which proved to be more reliable to the fixed user and is able to handle all traffic without interference. Apart from this measured effect, however, many young nations still feel the need for frequencies in the fixed bands, to establish and maintain domestic or international radio communications (teletype, commercial traffic, data transmission).

Many short-wave broadcasting organizations, after studying the results of monitoring the fixed bands and looking at the gloomy situation inside the short-wave broadcasting bands, had the feeling that it would be reasonable to reallocate portions of the fixed bands for broadcasting purposes. This feeling was strengthened by the knowledge that some administrations (the official postal and telecommunication authorities of the various countries) have permitted their short-wave broadcasters to move into the fixed bands. This situation, not endorsed by many countries who live by the intentions and rules of the Radio Regulations, was made worse by a clause in these regulations which renders such a move possible if no interference is caused to other services which are allotted in the fixed bands. Since the broadcasting service usually replaced a fixed service of the same country (though at an increased bandwidth), generally no complaints from other fixed users were filed and the broadcasting service in the fixed band could thus be established.

Excessive h.f. bands

In most countries, however, short-wave broadcasting stations have not been allowed to operate "out-of-band". Because the administration is wary of causing congestion in the fixed bands with transmissions of another kind. Most administrations felt bound by the 1959 agreement, which established certain frequency bands for the exclusive use of high frequency (short-wave) broadcasting only and provides a similar arrangement for the fixed bands. Mixing the two would cause precedents which would harm international interests.

At the start of WARC 79 a number of administrations had hoped to correct this situation. The proposal was strengthened by the knowledge that some administrations (the official postal and telecommunication authorities of the various countries) have been dissatisfied with the frequency plan for the medium- and long-wave bands, which have been replaced a fixed service of the same kind and used for broadcasting. The administration is wary of causing congestion in the fixed bands with transmissions of another kind.

The outcome must be considered meagre. The short-wave broadcasters in the western world have to work with present regulations, which means measuring and evaluating data and calculating what they consider to be a very reasonable proposal for all concerned, based on technical data rather than on political motives. It is a disappointing result, which might also be ascribed to the failure of some delegates from less technically developed areas to fully appreciate the real value of the proposals put forward and their unjustified reserve as to the good intentions behind them.

An observer at WARC 79 must have felt the line of the voting was indeed not free from political motivation. Some countries who wanted to be seen jumping together, and the influence of certain leaders was sometimes very evident. But this is all part of the modern set-up where each country establishes a good service while doing away with the privileged situation of those broadcasters who are already operating in the fixed bands. It was not expected that all the administrations would consult with each other to agree on a frequency plan in these bands. However, things turned out differently. The non-aligned countries, which now occupy the majority in most international bodies, could only be partly convinced of the reasonableness of the International broadcasters' requirements. Moreover, they were concerned about the possibility of a change in fixed frequencies, which are very vital to them.

Meetings held in the important world Broadcasting Conferences, to be held every five years or so, are for the benefit of all administrations. In WARC 79, the frequency range between 3.9 and 27.5 MHz, were difficult and progress was slow. The group, in the majority group, did account for about 40% of the traffic for all broadcasting bands between 9 and 22 MHz, or less than half the extension needed to operate short-wave broadcasting stations, on frequency redefinitions, on solar indices, and so on.

The second session, which will be the planning conference proper, will be held in 1981. During this period all concerned will be in possession of the same data. This means that there will be no technical arguments based on data of different origins or liable to different interpretations. It also means that everyone concerned has at least the opportunity to prepare for the difficult task of participating in a world conference on fixed broadcasting, which will determine its will and woe for the next twenty years or so.

News notes

The Australian government has authorized a number of radio stations to go ahead with data broadcasting services. The announcement was made by Mr T. Staley, the minister for Post and Telecommunications, who welcomed this development as a useful addition to community services.

A multi-track digital recording of an opera, using the 3M Minicom 32-track digital mastering system, was made by Polygram during December. The recording of Wagner's four-and-a-half-hour opera "Parsifal" was performed by the Berlin Philharmonic Orchestra and the Chorus of the Berlin Opera. Analogue tapes were also made of "Parsifal". The Tape was opened on 1 March.

The first deep water optical-fibre telephone cable, a trial 9.5km long, was laid by the STC division of ITT, using the Post Office cable-laying ship "Trinity". In Loch Fyne, on the West coast of Scotland, July 1979, the Chorus of the Berlin Opera, Analogue tapes were also made of "Parsifal". The Tape was opened on 1 March.

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Transistor and valve oscillators can be closely related: not in the obvious way by a direct replacement, but with inputs and outputs interchanged. If a particular network requires a transistor of short-circuit current-gain $h_{fe}$ for oscillation, and used with a valve with terminations reversed requires an open-circuit voltage gain $v_{bc}$, then $v_{bc} = h_{fe}$. Neither the input resistance of the transistor nor the output resistance of the valve appear in the frequency- and gain-determining relationships. This is a surprising result and though exactly true only for a circuit composed of pure reactances it remains useful under a wide range of practical conditions. The minimum number of pure reactances for oscillation with a single device is three, of two one type and the third of the opposite type. By extension, circuits may use mutual inductance and other more complex arrangements but in the frequency of oscillation the reactances are always equivalent to two inductive and one capacitive or vice versa.

Taking the device resistance $R_0$ for the transistor and $R$ for the valve into the external circuit the passive circuit becomes the general form shown, i.e. activated by an ideal voltage amplifier from left to right or by a current amplifier from right to left. The particular LC form corresponds to the previous valve-transistor oscillators. The configuration is identical with the RC lag-lead network, the basis with the related Wien and lead-lag networks of so many RC oscillators. In the LC form the overall phase shift is found to be $180^\circ$ at the frequency for which the reactances go into series resonance and an inverting amplifier is used. The RC circuit has zero phase-shift at the frequency of maximum response and needs a two-stage amplifier for the non-inverting gain.

The standpoint of frequency stability is the rate-of-change of phase of the passive network at the frequency of oscillation that is important. The higher the frequency the smaller the frequency shifts in compensating for internal amplifier phase errors or those resulting from the intermodulation via feedback distortion components.

These are quite different for the two circuits: that the LC circuit has a higher $Q$, and $X_L(X_C+X_L)$ is less than that of the RC circuit. For the former, the $Q$ is limited by the reactance of the capacitor, while for the latter the $Q$ is limited by the reactance of the resistor. The result is that the LC oscillator has a higher $Q$ than the RC circuit but with equal time-constants. There is then a simple relationship for the frequency allows $R$ to vanish from the frequency and gain-determining equations. The fraction of the output current flowing in $h_{fe}$ is $\frac{X_L}{X_L+X_C}$ and the behaviour of $X_L$ can then be determined.

Further inspection of the phase relationships shows that the voltages across $C$ and $L$ as anti-phase with $v_{bc}$, greater in magnitude than $v_{bc}$. Because, at resonance, $v_{bc}$ is antiphase to the drive voltage $v_L$, the inductive voltage in this configuration is normally adjusted to drive the oscillatory loop. This form is shown in the second of the two circuits with an inverting amplifier. If the locations of $L$ and $C$ are interchanged then at the same frequency the output of the network is now in phase with the drive voltage but of greater magnitude. Hence a non-inverting voltage amplifier with voltage gain below unity is required. The new oscillator might be described as a grounded-collector (or drain or anode) oscillator but not a common-collector. This last terminology must be avoided as there is no external signal source and hence there cannot be a common point between input and output. The term that is grounded is merely a matter of convenience, possibly of biasing of minimizing stray capacitance or of extracting the signal; the nature of the oscillator remains unchanged.

The three circuits shown simply represents shifts in ground points for the same basic oscillator. $L_1$ still appears between base and emitter, $L_2$ between collector and base. The supply times are assumed to have zero impedance to ground and bias networks are omitted. This latter point is of practical importance because one factor influencing the choice of configuration will be the case of biasing. Considering the common base circuit first it can be seen that a direct current path is needed for the collector current, but one whose impedance is very high at the frequency of oscillation. This suggests a large-value inductance (or a parallel resonant circuit) which is not an attractive solution. This problem is avoided with the other two, though each requires a bias path for base currents. If the bipolar transistors are replaced by junction fets capable of operating with $V_{gs} = 0$ then a self-biasing oscillator results in each case.

The theory of with $h_{fe}$ of 50 is used with $C = 500\text{pF}$ and is required to oscillate at $200\text{kHz}$. Determine suitable values for $L_1$, $L_2$.

A bipolar transistor with $h_{fe}$ of 50 is used with $C = 500\text{pF}$ and is required to oscillate at $200\text{kHz}$. Determine suitable values for $L_1$, $L_2$.
LC oscillators: general theory

by Peter Williams, Ph.D. Paisley College of Technology

Transistor and valve oscillators can be closely related: not in the obvious way by a direct replacement, but with inputs and outputs interchanged. If a particular network requires a transistor of short-circuit current gain $h_{\text{fe}}$ for oscillation, and used with a valve with terminations reversed requires an open-circuit voltage gain $v_{\text{eb}}$, then $v_{\text{eb}} = h_{\text{fe}}$. Neither the input resistance of the transistor nor the output resistance of the valve appear in the frequency and gain-determining relationships. This is a surprising result and though exactly true only for a circuit composed of pure reactances it remains useful under a wide range of practical conditions. The minimum number of pure reactances for oscillation with a single device is three, two of one type and the third of the opposite type. By extension, circuits may use mutual inductance and other more complex arrangements but in the frequency of oscillation the reactances are always equivalent to two inductive or one capacitive or vice versa.

Taking the device resistance $r_{\text{th}}$ for the transistor and $r_{\text{L}}$ for the valve into the external circuit the passive circuit becomes the general form shown, i.e. activated by an ideal voltage amplifier from left to right or by a current amplifier from right to left. The particular LC form corresponds to the previous valve-transistor oscillators. The configuration is identical with the RC lag-lead network, the basis with the related Wien and lead-lag networks of so many RC oscillators. In the LC form the overall phase shift is found to be 180° at the frequency for which the reactances go into series resonance and an inverting amplifier is used. The RC circuit has zero phase shift at the frequency of maximum response and needs a two-stage amplifier for the non-inverting amplifier. From the standpoint of frequency stability, it is the rate-of-change of phase of the passive network at the frequency of oscillation that is important. The higher the phase the smaller the frequency shifts in compensating for internal amplifier phase errors or those resulting from the intermodulation via feedback distortion components.

These are quite different for the two circuits: that the LC circuit has a higher dp/dv at the frequency of oscillation. Considering the RC circuit first, the two sections result in successive phase lags and leads. It is simplest to visualise if the second stage impedance is much higher than the first but with equal time-constants. There is then a simple relationship for the frequency can therefore become zero resulting in there being no voltage dropped across $R$. There is then a simple relationship for the frequency when the reactances go into series resonance and an inverting amplifier is used. The RC circuit has zero phase shift at the frequency of maximum response and needs a two-stage amplifier for the non-inverting amplifier.

Further inspection of the phase relationships shows that the voltages across $C_1$ and $L_2$ are anti-phase with $v_{\text{eb}}$ greater in magnitude than $v_{\text{eb}}$. Because, at resonance, $v_{\text{eb}}$ is anti-phase to the drive voltage $v_{\text{eb}}$, the inductive voltage in this configuration is normally used to drive the oscillatory loop. This form is shown in the second of the two circuits with an inverting amplifier. If the locations of $L_1$ and $C_1$ are interchanged then at the same frequency the output of the network is now in phase with the drive voltage but of greater magnitude. Hence a non-inverting voltage amplifier with voltage gain below unity is required. The new oscillator might be described as a grounded-collector (or drain or anode) oscillator but not a common-collector. This last terminology must be avoided as there is no external signal source and hence there cannot be a common point between input and output. The terminal that is grounded is merely a matter of convenience, perhaps of biasing of minimizing stray capacitance or of extracting the signal; the nature of the oscillator remains unchanged.

The three circuits shown simply represents shifts in ground points for the same basic oscillator. $L_1$ still appears between base and emitter, $L_2$ between collector and base. The supply times are assumed to have zero impedance to ground and bias networks are omitted. This latter point is of practical importance because one factor influencing the choice of configuration will be the case of biasing. Considering the common base circuit first it can be seen that a direct current path is needed for the collector current, but one whose impedance is very high at the frequency of oscillation. This suggests a large-value inductance (or a parallel resonant circuit) which is not an attractive solution. This problem is exacerbated with the other two, though requires a bias path for base currents. If the bipolar transistors are replaced by junction fets capable of operating with $v_{\text{in}} = 0$ then self-biasing oscillator results in each case.

**EXAMPLE**

A bipolar transistor with $h_{\text{fe}} = 50$ is used with $C = 500\mu\text{F}$ and is required to oscillate at $200\text{kHz}$. Determine suitable values for $L_1$, $L_2$.

For this second form, $V_{\text{os}}$ is anti-phase to the output and $A < 0$.

- **THEORY**

  - The two forms have the passive networks similarly terminated on the assumption that only the input resistance of the transistor and the output resistance of the valve are of importance. In both cases there is a conducting path across $L_1$ but not across $L_2$.
  - Let $L_1$ be used for the general passive network shown. Applying Thevenin’s theorem to $R$, $Z_2$.

  

  \[
  Z_1 = \frac{1}{\omega L_2} \quad \frac{1}{Z_3} = \frac{1}{\omega C_3} + \frac{1}{\omega C_2}
  \]

  \[
  Z_2 = \frac{Z_3}{Z_3 + Z_2} + \frac{g_1 + g_2 + g_3}{Z_2}
  \]

  Equating real and imaginary parts

  \[
  A_1 = 1 - \frac{X_3}{1 - \frac{X_1}{X_2}}
  \]

  \[
  X_1 + X_2 + X_3 = 0
  \]

  (i) This last condition corresponds to the series resonant condition of $X_1, X_2, X_3$.

  - The constraint cannot be satisfied using three reactances of the same type as there must be at least one capacitive and one inductive condition.

  - If used with a grounded-emitter (grounded-source) stage with inverting gain then $h_{\text{fe}} > X_1$ and thus must be of opposite type.

  - To simultaneously satisfy the second condition, $X_1$ must be of the same type as $X_2$.

  The above are the conditions resulting from $A_1 < 0$. Other conditions obtain for $1 > A_1 > 0$ and $A_1 = 1$.

  - A comparison of the related LC and RC forms shows the lead/lag cancellation of the former, and the availability of more than one feedback connection for the latter, since the input voltages are all either in phase or in antiphase.

  - Because $V_1 + V_2 = V_3$, and $V_2$ is antiphase to $V_3$, then $V_1$ is in phase with $V_2$ and exceeds it (i.e. $V_1 > 0$).

  For the second form, $V_{\text{os}}$ is anti-phase to the output and $A < 0$.

  \[
  X_1, X_2, X_3, A = -1, 1
  \]
**NEWPRODUCTS**

**Image sensor**

Drive circuits are included in the IFL 64P image sensor i.c., which forms the first item in a new family of devices from Integrated Photometrics. It can be operated in conjunction with a t.l.f. oscillator and other features include a programmable shift register, inter, making operation as a 1 to 36 element array possible. The unit is e.m.o.s. compatible and a quarter window extends the spectral response to 250nm, making it suitable for spectrographic applications. The one-off price is £65 Integrated Photometrics Ltd, The Grove Trading Estate, Deckchester, Dorset.

WW381

**Flexible contact transducer**

Designed as a self-adhesive acoustic transducer and intended for applications such as the direct amplification or recording of acoustic musical instruments, "Ducer" is a flexible sheet first transistor in flat tape form available in several lengths to suit various instruments. According to the manufacturers, C-Tape Developers, the device offers a very low noise level, a flat frequency response over the range 10Hz to 5MHz, and is supplied complete with a f.e.t. amplifier, which has a variable output level, permitting control of an external amplifier. Because the device detects vibrations through a solid it is relatively insensitive to airborne signals, partially relieving the problem of "howling" which is induced acoustic feedback. The makers quote many other devices such as that of strain detection, barometric alarms (where "invasive" sounds can be picked off for attention), or situations where a high sensitivity to electromagnetic or radio frequency interference is a problem. The amplifier/polarizing supply required consists of two FP3 batteries and the amplifier unit is portable. The "professional" range has provision for mains phantom powering and the price scale begins at £99.50 V.E.T. Developments, 128 Grange Rd, Guildford, Surrey.

WW392

**Versatile microcomputer**

The System 80 computer, which is fundamentally a packaged Nascom-2 has been designed for flexibility, several new boards having been introduced. The main housing contains a framing which holds a mother-board and a power supply; the p.c.p. board and up to four expansion boards. Provision is made for external connection to the boards and the computer has a g.p.p. cover with a keyboard outlet. A future extension housing will accommodate a further five boards, mounted on top of the main housing. A programmable character generator board uses 32 bytes of static r.a.m. and can accept the Nascom block graphics. High resolution graphics operate on a cell structure consisting of 128 x 128 dots and a complete twin disc set, the cost is about £17.50. All parts can be supplied in kit form. Nascom Microcomputers Ltd, 92 Broad, The Common, Hitchin, Herts.

WW368

**Sound level exposure time meter**

The Department of Employment "Code of Practice for Reducing the Exposure of Employed Persons to Noise" defines the maximum sound pressure level for which an employee may be safely exposed to high sound levels in a working day. At 90dBA an employee may work for eight hours but if the level increases to 95dBA (a barely audible increase), the energy content is doubled and the permissible working time reduced to four hours. At a digital-photocell level of 110dBA the exposure limit is less than five minutes per day. In addition to displaying the d.c. level, the Wesel 880 has a linked scale showing the level and the maximum permissible exposure time. The microphone is mounted on a "pull-out" boom to limit case reflections and the final price of the complete unit is £130. It also is available as a full test kit complete with multimeter, calibrator in an attractive case, priced at £12.50. C.W. Willis and Co, Ltd, 6 Methil St, Scotstoun, Glasgow G51 40DF.

WW396

**Wrap-around braided connectors**

Although a specialised tool recommended for installation by the makers, Thomas and Betts, the "Shield-Ion" range of connectors can be used to make secure outer braided or foil connections to conventional shielded or coaxial cables. A matter of concern is the permissible interference the signal, by means of the SINAD or quieting method. Price of the test set is quoted as "well under £50.00, excluding v.a.t." Farrell Instruments Ltd, Ranelagh Way, Wetherby, Yorkshire LS22 4DH.

WW385

**Contour TTS 520 digital fader**

A new conductive plastic fader offers a direct grey scale 4-bit output from zero to decimal 255 within a stroke length of 10mm. The makers are Penny and Giles and the fader is intended for use in the company's 1100 and 1900 series faders, making use of identical top-plates and fascias. Applications quoted for the fader include driving digital attenuators or direct input devices such as synths, microcomputers, or tape recorders. The fader fully sealed touch key advancement of the LEA type fader. Penny and Giles (Group, Moseley, Christchurch, Dorset. BB132 6AT.

WW311

**Wireless world, May 1980**

**Sealed touch keyboard**

Optional X/Y or individual lead-out keys, a choice of 12 or 16 key formats are features of the In- vader fully sealed touch keyboard. The unit, manufactured by Jack Evans Electronic Distributors Ltd, has a normal operating temperature range of -29°C to 60°C and each contact will carry up to 600mA at 50V d.c. at a typical contact resistance of 1 difference. The makers quote the advantages of a wipe-clean flat surface and key layout, and the keyboards are fully l.t. and e.m.o.s. compatible. Jack Evans Electronic Distributors Ltd, 246 High St, Hayes, Middlesex.

WW316

**Conductive plastic digital fader**

A new conductive plastic fader offers a direct grey scale 4-bit output from zero to decimal 255 within a stroke length of 10mm. The makers are Penny and Giles and the fader is intended for use in the company's 1100 and 1900 series faders, making use of identical top-plates and fascias. Applications quoted for the fader include driving digital attenuators or direct input devices such as synths, microcomputers, or tape recorders. The fader fully sealed touch key advancement of the LEA type fader. Penny and Giles (Group, Moseley, Christchurch, Dorset. BB132 6AT.

WW311

**Power line filters**

Protection against surges and transients in the main function of the Kimpower" line filters, made by Lightning Elimination Associates. The MB series is an extension of the LSA type MB filters and offers the additional features of protection from noise spikes, t.l. and other disturbances which could cause damage or logical error. Typical applications mentioned by the makers include computers, multiplexers, medical monitoring systems, electronic computers, word processors, telecommunications systems on 200/ 240V a.c. supplies and has a maximum current rating of 35 amps. Lightning Elimination Associates' Ltd, Vine Cottage, Moreton, Thame, Oxon.

WW397

**Neon displays**

Described as "bright neon orange seven segment displays" by the St. Chustco, Incorporated, the NE- 9000 range of indicators measure 0.5mm diameter, operating at a "peak sound output of 19W and pedestal current of about 5mA. Normal operating temperature range is -10°C to +60°C and the displays are designed for either p.c.b. or socket mounting and the makers expect them to be used in public information displays, vending equipment and industrial control equipment. Incusimple Ltd, Factory Lane, Horsham, Sussex.

WW312
**NEWPRODUCTS**

**Image sensor**

Drive circuits are included in the IPL 64P image sensor i.e., which forms the first item in a new family of devices from Integrated Photometrics. It can be operated in conjunction with a TTL oscilloscope and other features include a programmable shift register, which can be configured to act as a line detector, a binary counter, a delay line, or a delay and pulse stretcher.

**Flexible contact transducer**

Designed as a self-adhesive acoustic transducer and intended for applications such as the direct amplification or recording of acoustic musical instruments, the`Ducer` is a flexible sheet of material that can be attached to a variety of surfaces.

**Sound level exposure time meter**

The Department of Employment's Practice for Reducing the Exposure of Employed Persons to Noise` defines the maximum permissible noise level for an employee which may be exposed to high sound levels in a working day. A 90dB an employee may work for eight hours, but if the level increases to 93dB (a barely audible increase), the energy content is doubled and the permissible working time reduced to four hours. A digital display of 110dB the exposure limit is less than five minutes per day. In addition to displaying the sound level, the Willie 85E has a pull-out beep limit to case level responses and the beep time of the complete unit is £39. It is also available as a full transmission kit complete with a calibrated microphone to an attached case, priced at the 90,000 offer, which considers the type of stress detector and the importance of accurate feedback to limit cases.

**Mobile radio test set**

Full system testing of mobile communication receivers and transmitters in the function of the Fernell TTS 1100. The test set is designed to allow the type of frequency response over the frequency range to 5MHz, and is supplied with a choice of either a.c. or d.c. at.

**Power line filters**

Protection against surges and transients in the main function of the Lea 1100 and 1000 series sets, making use of identical top plates and fascias. Applications quoted for the Lea 1100 include driving digital attenuators or direct interfacing to an electrician's tester.

**Neon displays**

Described as "bright neon orange" seven segment displays by the St. Charles, Illinois, L.E.D. 5000 range of indicators measure 4"x5", operating from a 120V a.c. or 110V a.c. power supply of 180V and 200V. The displays are designed for either p.c.b. or socket mounting and the makers expect them to be used in public information displays, vending equipment and industrial control equipment.

**Conductive plastic digital fader**

A new conductive plastic digital fader offers a direct grey scale f.t.u. output to zero from -30Hz within 255 within a stroke length of 10mm. The makers are Penny and Giles and the fader is intended for use on the company's 1100 and 1000 series faders, making use of identical top plates and fascias. Applications quoted for the fader include driving digital attenuators or direct interfacing to an electrician's tester.
Extended view

We get a lot of press handouts from the BBC and IBA. Fairly often, they are about new transmitters and relay stations and, to be perfectly honest about it, we don't often spare them much more than a passing glance as they slither across our desks on their way to the news person. We think we know all about it, you see, having read so many.

So I thought, too, until I read a recent example and took note of some of the figures. Four new relay stations were to be opened, each serving as few as 500 people. One of them was to transmit to an audience of 2500, but three of the four were for 500-600. It struck me as totally admirable that small communities like this weren't being ignored, so I rang the BBC to ask for more information. (I spoke to the BBC because it was their press release, but the IBA are just as much involved.)

It turns out that a four-channel relay station can cost about £40,000, so that the smallest groups are having about £8 per person spent on them, split between BBC and IBA. In Orkney, where the groups are so sparse, the cost has been much higher – around £400 per person. In a year the two broadcasting organizations get through about £8million between them on this sort of work, which is quite a lot of money. The information was gathered by telephone, and the figures were compiled and checked. Coverage of the UK population is now 98.6% and it would need about another 100 relays like these to achieve complete coverage.

A bewilderment of terms

I think it's time we tidied up the verbage a bit, because it's beginning to confuse a lot of people who aren't engineers, but who have to know something about electronics so that they can make decisions which can affect everyone. It isn't just beginning either – it's got some of them talking a whole lot of utter cobblers because they've misunderstood definitions.

A recent report for the Department of Industry set out to discover what use industry was making of, to pluck a word out of the air, microprocessors. The information was gathered by telephone, the questions being put to managing directors of companies by interviewers whose main concern in life is not electronics. But I do agree, start with this, not a very promising approach; not many company directors could, with any confidence, distinguish an integrated circuit from a momentarily-inactive condensate. It was, in fact, a proceeding not unlike a Xingo game native of Vladivostok discussing Test cricket. The reason for the difficulty seems to lie in the quantity of different descriptions given to ICs, some of which mean the same while others don't. Take just a few: 'integrated circuit', 'microelectronics', 'microchip', 'microprocessor', 'solid-state', 'new technology', 'silicon chip', 'silicon microcircuit', 'microcomputer' – how on earth can we expect a non-specialist to ask or answer intelligent questions when faced with a collection of gobbledygook like this?

For example, if a non-engineer is asked how long his company has been using microchips, microelectronics, silicon microcircuits or solid-state devices, he might say they've used them for ten years, say, meaning they've had small-scale logic, linear circuits, counters and the like. The trouble is that these words are taken to be synonymous with 'microprocessor', 'new technology' and 'microcomputer' to the lay mind, which does rather tend to mean that any survey conducted on these lines will be, at the very least, suspect.

Vorbose video

All that exhausting trekking across the sitting room carpet every two or three hours to push the television channel button is now, of course, very much a thing of the past. Sixty ways to do anything out of the air, microprocessors.

I exaggerate, of course. Garage mechanics are quite possibly totally admirable to a man, but I usually come upon them in circumstances of such dire discomfort and after such long periods of lonely vigil by the roadside that Sir Galahad himself would appear ill-natured and surly.

Having, at length, arrived on the scene, diagnosis of the trouble is usually rapid, and the fault can be put right there if it's at the garage, because spares are fairly often on the shelf and reasonably quick, though expensive, to fit. (I speak as one who has some experience of the above scenario.)

In short, on their own ground these shops are pretty proper, on the whole, even though the prices they charge often do seem to have been calculated by squaring the chassis number. What bothers me is what will happen when microprocessors begin to take over.

It is also a matter for concern to Olaf Lambert, of the Automobile Association. While conceding that chips will make for faster and more economical cars, he is worried that not many garages are going to be able to afford the test gear to diagnose faults, particularly as the connectors may well be different in different makes of car, in keeping with the VITSOL policy (Variety is the spice of life).

I do agree, it is fairly easy to imagine the minor prophet at the local garage explaining the sleeping sickness affecting one's wheels in terms of microprocessors. "It's yer chips, innit?" he will say. "What yer want is new r.o.m. - soon wear out, these foreign ones will be as bad as old ones. He will remark, casually, mentioning also that he's not involved in microcomputer technology bonus' and that it will therefore cost even more than usual.

It almost makes me hope the old cars carry on quietly so that we can all go back to push-bikes.
We get a lot of press handouts from the BBC and IBA. Fairly often, they are about new transmitters and relay stations and, to be perfectly honest about it, we don’t often spare them much more than a passing glance as they slither across our desks on their way to the news person. We think we know all about it, you see, having read so many.

So I thought, too, until I read a recent example and took note of some of the figures. Four new relay stations were to be opened, each serving as few as 50 people. One of them was to transmit to an audience of 2500, but three of the four were for 500-600. It struck me as totally admirable that small communities like this weren’t being ignored, so I rang the Beeb to ask for more information. I spoke to the BBC because it was their press release, but the IBA are just as much involved.

It turns out that a four-channel relay station can cost about £40,000, so that the smallest groups are having about £80 per person spent on them, split between BBC and IBA. In Orkney, where the groups are smaller, the cost has been much higher — around £480 per person. In a year the two broadcasting organizations get through about £8million between them on this sort of filling-in exercise and the communities served are getting smaller as the bigger blank spots are eliminated. Coverage of the UK population is now 90.6% and it would need about another 100 relays like this to get it up to 98.7.

I have to agree. For example, if a non-engineer is asked how long his company has been using microchips, microelectronics, silicon microcircuits or solid-state devices, he might say they’ve used them for ten years, say, meaning they’ve had small-scale logic, linear circuits, counters and the like. The trouble is that these words are taken to be synonymous with ‘microprocessor’, ‘new technology’ and ‘microcomputer’ to the lay mind, which does rather tend to mean that any survey conducted on these lines will be at the very least, suspect.

A bewilderment of terms

I think it’s time we tidied up the verbiage a bit, because it’s beginning to confuse a lot of people who aren’t engineers, but who have to know something about electronics so that they can make decisions which affect everyone. It isn’t just beginning either — it’s got some of them talking a whole lot of utter cobblers because they’ve misunderstood definitions.

A recent report for the Department of Industry set out to discover what use industry was making of, to pluck a word out of the air, microprocessors. The information was gathered by telephone, the questions being put to managing directors of companies by interviewers whose main concern in life is not electronics. I am sure, start with this, not a very promising approach; not many company directors could, with any confidence, distinguish an integrated circuit from a momentarily-inactive condensate. It was, in fact, a proceeding not unlike a Xingu Indian and a native of Vladivostok discussing Test cricket. The reason for the difficulty seems to lie in the quantity of different descriptions given to i.c.s, some of which mean the same while others don’t. Take just a few: integrated circuit, microelectronics, microchip, microprocessor, solid-state, ‘new technology’, silicon chip, silicon microcircuit, microcomputer — how on earth can we expect a non-specialist to ask or answer intelligent questions when faced with a collection of gobbledygook like that?

For example, if a non-engineer is asked how long his company has been using microchips, microelectronics, silicon microcircuits or solid-state devices, he might say they’ve used them for ten years, say, meaning they’ve had small-scale logic, linear circuits, counters and the like. The trouble is that these words are taken to be synonymous with ‘microprocessor’, ‘new technology’ and ‘microcomputer’ to the lay mind, which does rather tend to mean that any survey conducted on these lines will be at the very least, suspect.

Vorbose video

All that exhausting trekking across the sitting room carpet every two or three hours to push the television channel button is now, of course, very much a thing of the past. Staying with the sixties news, no one with any claim to the smallest degree of savoir vivre will countenance any more effort than a touch of the button of a remote-control unit. A quick tap on the key-pad and off goes one piece of imported American life-style propaganda to be replaced by something more mind-stretching like “Blanketly Blank.” You can even wind down the sound during the commercials without turning yourself out. What more could one ask?

A good deal, it appears, because there are people producing a toy-box called the “Match” which can do almost anything. It is only as it is told but tells you it’s done it — it talks back. Now, personally, I have a feeling that you will see in pets, small children, wires and domestic appliances is blind, unquestioning obedience. I do not wish to become involved in tedious discussion with a garrulous electrical device. I can see myself becoming visibly annoyed if, when told to switch to “Match of the Day” the creature says “Oh! do you think that’s wise?” There is a Western on BBC 2 which is really rather super. I am sure he would not be a better off with that.” Mind you, if you could install some semblance of your own mind into a box in the machine, you would be able to rely on the thing protecting you from nasty shocks. An inadvertent instruction to start the old one out quickly so that we can all go back to push-buttons.

Garage gurus

“I’ll cost yer, squiv,” is a remark that garage mechanics learn before they progress to more advanced expressions such as “Mama”. The pursed lip, some rowful shake of the head and low whistle of disbelief are acquired much later in life, or in the threshold of the garage and around the time when they learn how not to bat an eyelid when uttering a statement such as “That’ll be a fiver, guv,” after a cursory glance at the points and a quick polish of the radiator cap.

I exaggerate, of course. Garage mechanics are quite possibly totally admirable to a man, but I usually come upon them in circumstances of such dire discomfort and after such long periods of lonely vigili by the roadside that Sir Galahad himself would appear ill-natured and surly.

Having, at length, arrived on the scene, diagnosis of the trouble is usually rapid, and the fault can be put right there in the garage, because spaces are fairly large and the hold of and reasonably quick, though expensive, to fit. (Typical as one with some experience of the above scenario.)

In short, on their own ground these chaps are pretty competent, even to the point of making changes to the chassis to suit the car owner’s requirements, at a cost often do seem to have been calculated by squaring the chassis cap.

It’s a remarkable thing to think that these words are taken to be synonymous with ‘microprocessor’, ‘new technology’ and ‘microcomputer’ to the lay mind, which does rather tend to mean that any survey conducted on these lines will be at the very least, suspect.

And a suggestion that you read a good book for the next two hours because there isn’t anything worth watching. Maybe there’s something in the idea after all.
Simply ahead...
I.L.P's PROVEN RANGE OF HIGH

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I.L.P. constructional modules are different. Whereas most others come with components neatly arranged on open P.C.B.s with little else, I.L.P. modules are encapsulated within totally adequate heatsinks and have circuitry which makes further components unnecessary. As a result, I.L.P. power amplifiers, pre-amp and matching power supply units are infinitely more rugged, in keeping with extremes of temperature in use and they are positioned to requirements. Nor is any work needed to take away heat connections. I.L.P. modules are made for endless years of optimum service. Circuitry, workmanship and performance are of the highest standards, equal to the demands of the finest loudspeakers, pick-ups, factory digital sound sources, etc.

I now only need to be even more exciting than today's so that any amplifier system less than the best will be completely inadequate. Now study the tested and guaranteed specs. For I.L.P. That is why more people in more countries prefer these British designed and made modules.

Why toroidal?
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IN ELECTRONIC MODULAR DESIGN
AVAILABLE ALSO FROM WATFORD ELECTRONICS, MARSHALLS AND CERTAIN OTHER SELECTED DEALERS

and staying there

PERFORMANCE MODULAR UNITS

HY5 PRE-AMPLIFIER

VALUES OF COMPONENTS FOR CONNECTING TO HY5

Volume - 10K'2' log.

THE POWER AMPLIFIERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Output Power R.M.S.</th>
<th>Distortion at 1KHz</th>
<th>Minimum Signal/Noise Ratio</th>
<th>Power Supply Voltage</th>
<th>Size in mm</th>
<th>Weight in gms</th>
<th>Price + VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY30</td>
<td>15 W into 8</td>
<td>0.02%</td>
<td>0.0%</td>
<td>80V/800MHz</td>
<td>115x50x25</td>
<td>155</td>
<td>£6.34 + 95p</td>
</tr>
<tr>
<td>HY50</td>
<td>30 W into 8</td>
<td>0.02%</td>
<td>0.0%</td>
<td>90V/800MHz</td>
<td>105x50x25</td>
<td>135</td>
<td>£7.24 + 110p</td>
</tr>
<tr>
<td>HY120</td>
<td>60 W into 8</td>
<td>0.01%</td>
<td>0.0%</td>
<td>114x50x85</td>
<td>114x100x85</td>
<td>155</td>
<td>£18.20 + 220p</td>
</tr>
<tr>
<td>HY200</td>
<td>120 W into 8</td>
<td>0.01%</td>
<td>0.0%</td>
<td>114x50x85</td>
<td>114x100x85</td>
<td>155</td>
<td>£18.64 + 227</td>
</tr>
<tr>
<td>HY400</td>
<td>240 W into 4</td>
<td>0.01%</td>
<td>0.0%</td>
<td>114x50x85</td>
<td>114x100x85</td>
<td>155</td>
<td>£27.68 + 315</td>
</tr>
</tbody>
</table>

Load impedance — all models 4 - 16.£)
Input sensitivity — all models 500 mV
Input impedance — all models 10K £
Frequency response — all models 10Hz - 45kHz - 3dB

THE POWER SUPPLY UNITS

HY5 Power Supply Units are designed specifically for use with our power amplifiers and are in two basic forms — one with circuit panel mounted on conventionally styled transformers, the other with toroidal transformers, having half the weight and height of conventional laminated types.

<table>
<thead>
<tr>
<th>Model</th>
<th>Input/Output Voltage</th>
<th>Minimum Input/Output Voltage</th>
<th>Price + VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSU 30</td>
<td>15V ± 100mA to drive up to 5W</td>
<td>10W at 15V</td>
<td>£4.64 + 74p VAT</td>
</tr>
<tr>
<td>PSU 36</td>
<td>15V ± 100mA to drive up to 10W</td>
<td>15W at 15V</td>
<td>£8.10 + 115p VAT</td>
</tr>
<tr>
<td>PSU 50</td>
<td>24V ± 100mA to drive up to 50W</td>
<td>50W at 24V</td>
<td>£42.00 + 743p VAT</td>
</tr>
<tr>
<td>PSU 60</td>
<td>36V ± 100mA to drive up to 60W</td>
<td>60W at 36V</td>
<td>£44.80 + 745p VAT</td>
</tr>
</tbody>
</table>

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I.L.P. constructional modules are different. Whereas most others come with components neatly arranged on open P.C. boards with little else, I.L.P. modules are encapsulated within totally adequate heatsinks and have circuitry which makes further components unnecessary. As a result, I.L.P. power amplifiers, pre-amp and matching power supply units are infinitely more rugged, insensitive to extremes of temperature in use and they are also positioned to requirements. Nor is metal work needed to take away heat connections. I.L.P. modules are made for endless years of optimum service. Circuitry, workmanship and performance are of the highest standards, equal to the demands of the finest loudspeakers, pickups, hi-fi digital sound sources, etc.

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VALUES OF COMPONENTS FOR CONNECTING TO HY5

Volume - 10K ±2 log, Treble - 100K ±2 log, Balance - 5K ±2 log.

THE POWER AMPLIFIERS

The HY5 pre-amplifier 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-functional equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits: 500 mV ±15%, Distortion: ±0.04%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

FURTHER DETAILS

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Brief specification

Rectangular 30 cm over line numerical display

Dimensions less than 3%

Closed-loop band sweep

Sensitivity

50 mV/cm (30 MHz)

Input Impedance

50 MΩ, 1 nF

Resting 11.7 V

Sweep delay, 0-100 ms

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Brief specification

Rectangular 30 cm over line numerical display

Dimensions less than 3%

Closed-loop band sweep

Sensitivity

50 mV/cm (30 MHz)

Input Impedance

50 MΩ, 1 nF

Resting 11.7 V

Sweep delay, 0-100 ms

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LED indicator lights - Fuse holder

Switches - toggle, slide, rocker, push-button - Cable connectors

Binding posts - Mono plugs and sockets
Terminals - Miniature jack plugs

Valve sockets - Apparatus plug connectors
Mains connectors - Coaxial components

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- 10 free print buffer
- Optional tractor feed
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- External sync for optional synchronisation of baud

Expansion Nascom-1

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
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<tr>
<td>NASCOM 1</td>
<td>£32.50</td>
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<tr>
<td>Memory kit board</td>
<td>£5.00</td>
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<td>1K RAM</td>
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<td>32K RAM</td>
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<td>EPROM programmer</td>
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<tr>
<th>Model</th>
<th>Description</th>
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<th>AC Current</th>
<th>DC Voltage</th>
<th>AC Voltage</th>
<th>Resistance</th>
<th>Conductance</th>
<th>Volts/Ohms</th>
<th>Resolution</th>
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<td>8806A</td>
<td>New 8-digit</td>
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<td>0-1, 10, 100, 500, 1k, 10k, 50k, 100k, 500k, 1M, 5M</td>
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<tr>
<td>8010A AND 8012A BENCH MODELS</td>
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- Resistance
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<th>Model</th>
<th>Features</th>
<th>Price</th>
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<tr>
<td>IBM GOLFBALL Typewriter</td>
<td>Full upper/lower case character set</td>
<td>£275.00 (£250.00)</td>
</tr>
<tr>
<td>RS 232/V24 Interface</td>
<td>Paper tape reader/punch</td>
<td>£35.00 (£32.50)</td>
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<tr>
<td>RS 232 interface</td>
<td>Works as stand-alone word processor</td>
<td>£95.00 (£90.00)</td>
</tr>
<tr>
<td>Full technical information available</td>
<td></td>
<td>£375.00 (£350.00)</td>
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</table>

**DATABYTES KSR 390**

- Printing terminal
- Full 232 interface
- Optional stand available at no extra cost
- In first-rate condition
- £175.00 (ASR teletypes available from £275.00)

**OLIVETTI Model 318/328**

- ASCII coded
- Paper tape reader and punch
- TTY compatible interface
- RS 232 line unit
- Free optional stand
- £150.00 (correspondence quality u/l case version available at £250.00)

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- Paper tape reader and punch
- TTY compatible interface
- RS 232 line unit
- Free optional stand
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All assemblies use ribbon cable. Standard lengths are 6, 12, 18, 24 and 36 inches.

**SINGLE-ENDED DIP JUMPERS**

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<tr>
<th>Pins</th>
<th>36&quot;</th>
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**ADDITIONAL OPTIONS**

- Available with 14, 16, 24 and 40 contacts.
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JVC CAMERAS, JVC RECORDERS, JVC STUDIO EQUIPMENT, JVC MONITORS, ELECTRONIC MONITORS, FILM VIDEO, TAPE

WW 5

WW — 100 FOR FURTHER DETAILS
Exorciser Compatible Products

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
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<tbody>
<tr>
<td>9600 MPU Module</td>
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<tr>
<td>9601 Motherboard (16 kbit)</td>
<td>£128.65</td>
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<td>9603 Motherboard (28 kbit)</td>
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</tr>
<tr>
<td>9602 Card cage (Kit)</td>
<td>£65.00</td>
</tr>
<tr>
<td>9610 Prototyping Board</td>
<td>N/A</td>
</tr>
<tr>
<td>9612 EPROM/RAM Module</td>
<td>£191.00</td>
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<tr>
<td>9620 port parallel I/O (with 2 IFA 3)</td>
<td>£225.00</td>
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<td>9622 Combination Serial/Parallel I/O Module</td>
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<td>9612 Buffered Utility Prototyping Board</td>
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<td>9627 8L6K RAM Module (48k 16k bytes)</td>
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<td>9630 Card Extender</td>
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<tr>
<td>9650 8 port Duplex serial I/O (with 8 x 685-ns)</td>
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<td>9650-2 port Duplex serial interval (with 2 x 685-ns)</td>
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<td>9670 Relay Contact Module</td>
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<tr>
<td>9680 Card Puller</td>
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<tr>
<td>9610 32/32 I/O Module</td>
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SPECIAL OFFER: 2716 (+ SV Version) £18.50

Hi-Fi DRIVE UNITS

<table>
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</table>

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The latest additions to the Boccon range of instrument cases are a masterpiece of modern tooling.

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The Boccon Commander is a large keyboard and display enclosure made in black foam plastic. The housing is designed to accept most proprietry keyboards. The front and rear panels are satin anodised aluminium. There is a second smaller Commander constructed as two clip-together halves in black a.b.s. again with anodised panels.

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- 9601 Motherboard (8 slot) £73.60
- 9602 Card cage (Kit) £55.00
- 9610 Prototyping Board N/A
- 9616 32K EPROM/ROM Module £191.00
- 9620 16 port parallel 1/O (with 8 PIA's) £225.00
- 9620 16 port parallel 1/O (with 2 PIA's) £185.00
- 9622 Combination Serial/Parallel 1/O Module £200.00
- 9624 Buffered Utility Prototyping Board 1.5k N/A
- 9627 8 16K RAM Module (400s 16k bytes) £235.00
- 9627 8 16K RAM Module (400s 16k bytes) £506.00
- 9627 A 16K RAM Module (800s 16k bytes) £418.00
- 9620 Card Extender £44.00
- 9640 Multiple Programmable Timer £269.40
- 9640 Multiple Programmable Timer (Part populated) £285.00
- 9650 8 port Duplex serial 1/O (with 8 x 650 x 16) £240.50
- 9650 2 port Duplex serial 1/O (with 2 x 650 x 16) £207.00
- 9670 Relay Contact Module £275.00
- 9680 Card Puller £9.95
- 9610 32/32 I/O Module £7.50

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LINSLEY HOOD CASSETTE RECORDER 2

LINSLEY HOOD CASSETTE RECORDER 1

SUPER BARGAIN OFFER LENCO FFR CASSETTE DECK

CASSETTE HEADS

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BAILEY 30 WATT AMPLIFIER

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Miles per gallon instant Miles per gallon Average "Miles per gallon" column "Miles per gallon" Average "Miles per hour" column "Miles per hour" Average "Gallons used since Fillup" Times "Gallons used since Fillup" Times "Miles to empty" "Mile to empty" "Miles to empty" "Mile to empty" Times "Miles on trip to empty" "Miles on trip to empty" "Miles on trip to empty" "Miles on trip to empty" "Miles on trip to empty" "Miles on trip to empty" "Miles on trip to empty" "Miles on trip to empty" "Miles on trip to empty" Fuel Used 1-3%

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FUEL COST EFFICIENT FUEL MANAGEMENT

"Miles per gallon" instant "Miles per gallon" Average "Miles per gallon" column "Miles per gallon" Average "Miles per hour" column "Miles per hour" Average "Gallons used since Fillup" Times "Gallons used since Fillup" Times "Miles to empty" "Mile to empty" "Miles to empty" "Mile to empty" Times "Miles on trip to empty" "Miles on trip to empty" "Miles on trip to empty" "Miles on trip to empty" "Miles on trip to empty" "Miles on trip to empty" "Miles on trip to empty" "Miles on trip to empty" "Miles on trip to empty" Fuel Used 1-3%
Careers in the electronics industry

Types of work available and what you need for them

by Ronald G. Slater, F.I.E.R.E. TJB Electrotechnical Personnel Services

This review sets out some of the careers which the electronics industry has to offer, the academic qualifications which are needed and the possible rewards. It is intended to help those who are already employed in the industry, although electronics is very certainly possible to succeed without formal qualifications if it is increasingly difficult to do so and almost certainly the entry point on the career ladder will be determined by the educational course which has been followed and by the qualifications which have been attained.

Although in terms of employment there will be considerable overlap, technical personnel in the electronics industry can, in general, be divided into the three grades recognised by the European Council of Ordinaries of B.S., Technicians, 'Technicians Engineers' and 'Chartered Engineers'. To become registered in any of these grades needs specified academic attainments plus a laid down period of training experience and responsibility. Registration will normally be made through an appropriate society or institution. For Technicians and Technician Engineers these are the Society of Electronic and Technical Engineers (SERT) and the Institution of Electrical and Electronic Engineers (IEEET); for Chartered Engineers there are also two institutions, these being the Institution of Electrical Engineers (IIE) and the Institution of Electronic and Radio Engineers. Any one who is seriously attempting to carve a career in electronics should strive for corporate membership of an appropriate professional society or institution; not only for the qualification and the letters it allows one to append after one's name but for the facilities it provides for mixing with persons with similar professional interests and for keeping up-to-date with advances in technology.

Full details of the requirements for registration as a Technician, Technician Engineer or Chartered Engineer are available from the organisations mentioned above, all of which are in the London telephone directory. Very briefly, the choice of 'academic' requirements at present is as follows: Professional journals and the technical press; if it is not, then it can only lead to frustration and discontent. It really comes down to the not easy task of knowing oneself and one's capabilities. We do not all have the ability to become a first-rate researcher or the managing director of a large company. It is better, far better, to become a first-rate technician, a moderately able production engineer or an accountant.

There is just one further thing to be said about education and that is quite simply that it is not a 'once and for all' experience. It is, or should be, a continuing process that will go on for the whole of a person's career. This is particularly necessary in an industry such as electronics where technical advances are so rapid. Continuing education may take the form of 'in-house' courses, short courses at educational establishments, attendance at conferences or diligent reading of professional journals and the technical press.

Types of jobs

In electronics there is a very wide range of jobs and careers available, and within the confines of this article it is not possible to give an exhaustive list. In addition the names used to describe various tasks may vary from company to company and, particularly in the smaller companies, there may be considerable overlap in the tasks one is called upon to perform. The following will, however, represent the main activities of a typical company:

Research

Design and development

Production engineering

Quality and reliability engineering

Test

Sales and marketing

Installation and commissioning

Service

Within these you go into may be divided into educational attainments and personal inclinations, plus, of course, the availability of jobs within the desired location. The following paragraphs outline the educational and personal attributes which are generally necessary in the various sectors of the industry:

Research. The primary reason for research is to extend the frontiers of knowledge. A great deal of fundamental research is being carried out by the larger manufacturers. Many research projects will require the services of multidisciplinary teams which may consist of materials scientists, physicists, mathematicians, electronic physicists, etc. To take an active part in research will generally require the acquisition of highly specialized qualifications and an ability for at least a good first degree and possibly a second degree (e.g., M.Sc., Ph.D.). It also calls for a questioning mind, an ability for innovation and the willingness to continue to seek for a solution where none seems possible. In terms of self-esteem and inner satisfaction the rewards of successful research can be very great, but not all research is successful and it is all too easy to accept one's defeat, preferably after months or, even years, and then be called 'a failure' by the manager or director of research it is also essential to have that fine judgement which can distinguish the successful and which should be abandoned.

Development and design. The purpose of design and development is to produce some product or service and to manufacture it and sell it. The 'something' may range from a single component such as a relay or valve to a complex computer-controlled data communication system. It may by one or more persons, or by need the expertise of a number of multidisciplinary teams. The range of engineers working outside specialist companies in, for instance, the design and supply of large scale integrated circuits.

In most cases the precise objective will be known and the design and development work may have to be carried out within the constraints of a tight performance specification and against a rigid time scale while at the same time taking account of national, international or military standards.

The most usual qualification for a design and development engineer is a degree in electrical and/or electronic engineering or a related subject such as physics or computer science, but sometimes qualifications such as HND and HNC are often acceptable, especially if backed up by relevant experience.

Apart from technical knowledge the design and development engineer is a strong human being, confident in his ability to deal with others, quick to learn and quick to adapt to new techniques. The generalisation is a necessity for, as in any other area of engineering, there is more and more overlap between disciplines and between companies. The design and development engineer has to be aware of the whole design and development process and to be able to cope with difficult situations. Also it will often involve close liaison with a customer's own technical staff and the ability to quickly appreciate a problem outside of one's own experience and to act accordingly.

The design and development work is often carried out by multidisciplinary teams, and so to some extent in polytechnics. Much original work is also done in the very fine research laboratories of the many design and development companies. Some companies have complete teams of research and development engineers while others may use the services of several companies. The research and development work is often carried out by multidisciplinary teams, and so to some extent in polytechnics. Much original work is also done in the very fine research laboratories of the many design and development companies.
CAREERS IN THE ELECTRONICS INDUSTRY

Types of work available and what you need for them

by Ronald G. Slater, F.I.E.E. T.J.B. Electrotechnical Personnel Services

WIRELESS WORLD, MAY 1980

This review sets out some of the careers which the electronics industry has to offer, the academic qualifications which are needed and the possible rewards. It is intended to help those who are already employed in the industry, although it should also help those who are training for a career in the industry but who have not yet started work and, last but by no means least, the younger readers who, though they have an interest in radio or electronics, have not yet decided on their careers.

Perhaps the first question to be asked is 'Can the electronics industry provide a worthwhile career at all?' This question is not so absurd as it may seem, especially if it is qualified by the words 'in the UK'. Only a decade or so ago it may have been thought that the steel industry or the automobile industry might offer a worthwhile career; the position now is somewhat more doubtful. A young man or woman embarking on a career may have a working life of some 40 years ahead of him or her. It would indeed be rash to forecast the path of any industry over so long a period, especially one such as electronics where changes and advances in technology are so rapid. Yet, while it would be foolhardy to forecast the changes in technology, it can be predicted with almost complete certainty that more and more sophisticated forms of communication will be demanded, that more and more processes in commerce and industry will become automated, and that the use of electronics, in one form or another, will be more widespread in industry, commerce, and the home.

Hand-in-hand with this will go an increasing demand for electronics engineers and technicians at all levels to design, produce, test, install and service an expanding conglomeration of even more sophisticated equipment.

Education and qualifications

Twenty or thirty years ago formal qualifications were of very much less importance than they are today and many employers of professional engineering professions by dint of experience, perseverance and 'green fingers'. In the intervening years qualifications have assumed ever-increasing importance, partly due to the greater sophistication and complexity of technology and partly to the increasing availability of technical education and training. Although it is possible to succeed without formal qualifications it is increasingly difficult to do so and almost certainly the entry point on the career ladder will be determined by the educational course which has been followed and by the qualifications which have been attained.

Although in terms of employment there will be considerable overlap, technical personnel in the electronics industry can, in general, be divided into the three grades recognised by the Engineering Council, Board of Examiners, namely 'Technicians', 'Technician Engineers' and 'Chartered Engineers'. To become registered in any of these grades needs specified academic attainments plus a laid down period of training experience and responsibility. Registration will normally be made through an appropriate society or institution. For Technicians and Technician Engineers these are the Society of Electronic and Technicians (SERT) and the Institution of Electrical and Electronic Technicians (IEET); for Chartered Engineers there are also two institutions, being the Institution of Electrical Engineers (IEEE) and the Institution of Electronic and Radio Engineers. Any one who is seriously attempting to carve a career in electronics should strive for corporate membership of an appropriate professional society or institution; not only for the qualification and the letters it allows one to append after one's name but for the facilities it provides for mixing with persons with similar professional interests and for keeping up-to-date with advances in technology.

Full details of the requirements for registration as a Technician, Technician Engineer or Chartered Engineer are available from the organisations mentioned above, all of which are in the London telephone directory. Very briefly, the choice of 'academic requirements at present is as follows:

Technicians

Ordinary National Certificate (ONC) in Engineering, with at least one electrical subject, approved by the Engineering Council;

Approved TEC (Technician Education Council) Certificate in Telecommunications, Electronics Technicians;

Chartered Engineers

Engineering with at least one electrical subject, approved by the Engineering Council;

Certificate in Electronics, approved by the Engineering Council;

Some training courses in the Armed Services are also acceptable, e.g., Royal Air Force, Royal Navy, and Royal Armoured Corps.

Technician Engineers

Higher National Certificate or Diploma (HNC or HND) in Electrical and Electronic Engineering;

Chartered Engineers

A university or CCAA (Council for National Academic Awards) degree in Electronic Engineering;

Chartered Certified Accountants in Electronic or Related Subjects;

In all three grades there are certain other qualifications which may be acceptable. There are also several changes which have been made, particularly in the Technician and Technician Engineer qualifications. Full advice on these is readily available from the institutions.

In the grades there are other qualifications which may be acceptable. There are also several changes which have been made, particularly in the Technician and Technician Engineer qualifications. Full advice on these is readily available from the institutions. It is also a good idea to seek advice from them before embarking on a course of study.

The course of study followed by a young person may be influenced by personal circumstances, such as the mundane need to earn money at an early age, or availability of jobs in the locality. The Technician or Technician Engineer qualifications are part-time studies, e.g., evening classes, day release, block release, or a combination thereof. To obtain qualifications, the average Chartered Engineer level full-time study is about four years and this will usually be in the form of a sandwich course consisting of part-time and full-time study. In many cases, a fair degree of commercial awareness. Also it will often involve close liaison with a customer's own technical staff and the ability to quickly appreciate a problem outside of one's own particular discipline as instanced when electronic engineering is being employed to cure some other non-electronic function of process.

Research

The primary reason for research is to extend the frontiers of knowledge. A great deal of fundamental research is undertaken by government and, to some extent, in polytechnics. Much original work is also done in the very fine research laboratories of the larger manufacturers. Many research projects will require the services of multidisciplinary teams which may consist of materials scientists, physicists, mathematicians, electronic engineers, chemists, etc. To take an active part in research will generally require the acquisition of higher academic qualifications and training. Ambition is undoubtedly a very good thing, but it must be a realistic ambition. It is also all too easy to become frustrated and discontent. It really comes down to the not easy task of knowing oneself and one's capabilities. We do not all have the ability to become a great scientist or even a capable director of a large company. It is better, far better, to become a first-rate technician or manager. It is hard to be a first-rate technician or manager or director of research. It is also essential to have that fine judgement to know when you are making progress and which should be abandoned.

Design and development

The purpose of design and development is to produce something new and something which is man-made and sold. The 'something' may range from a single component such as a diode, which is man-made and sold, outside specialist companies in, for instance, the design and supply of large scale integrated circuits.

In most cases the precise objective will be known and the design and development work may be carried out within the constraints of a tight performance specification and against a rigid time scale while at the same time taking account of national, international and military standards.

The most usual qualification for a design and development engineer is a degree in electrical or electronic engineering or a related subject such as physics or computer science, but some qualifications such as HND and HNC are often acceptable, especially if backed up by relevant experience.

Apart from technical knowledge the design phase of the project will, more often than not, call for original and imaginative thinking and a disciplined and logical approach, plus in many cases, a fair degree of commercial awareness. Also it will often involve close liaison with a customer's own technical staff and the ability to quickly appreciate a problem outside of one's own particular discipline as instanced when electronic engineering is being employed to cure some other non-electronic function of process.

Between the original concept, design and development, and in some cases the actual production, the packaging and production of a product suitable for manufacture and manufacturing there is often a long path to tread; this is the
Some people stay in the industry a long time. Will Williams, a senior production technician at Eddystone Radio, has just celebrated his 50th year with the company. He started as a 15 year old "radio mechanic" in 1930. His first job was at Eddystone Radio, a small radio company in the UK. He worked in the production department and eventually became a production manager. He retired in 1977 and was still working as a consultant several years later.

Sales and marketing. A product without a customer is about as useful as a sick headache and, since few products sell themselves, lack of sales and marketing is a major concern for any company. Some people believe that it is more important to sell a product than to make it, while others think that sales and marketing are important but not as important as research and development. However, most people agree that sales and marketing is a crucial part of any company's strategy.

Cost. For many young technicians, the test equipment which is available is not as good as what they need to test. Many companies have to make do with what they have, but some companies are able to afford more expensive test equipment. The availability of test equipment can vary widely from company to company, and the cost of test equipment can also vary widely.

Installation and commissioning. In many cases, installation and commissioning of large equipment requires the expertise of an engineer or technician. In some cases, this work can be done by the manufacturer, but in other cases it may have to be done by the user. In any case, it is important to make sure that the equipment is installed and commissioned properly.

Service. Service engineers are responsible for maintaining and repairing equipment which has been sold by the manufacturer. They must have the knowledge and skills to do this work, and they must be able to work efficiently and effectively.

Some of the above remarks apply only when one is considering the various sectors of the industry such as communications, computers, electronics, and the like. However, for example, many engineers shy away from working in the aerospace industry whereas in fact this is the sector where many engineers are still working.

Footnotes

1. Service engineers are of three types: technicians, engineers, and managers. The technicians are responsible for the hands-on work, the engineers are responsible for the design and planning, and the managers are responsible for the overall operation of the company.

2. Some types of equipment are more complex than others, and some types are more difficult to service than others. For example, some types of equipment are more prone to failure than others, and some types are more difficult to repair than others.

3. Fixing equipment is not always easy, and sometimes it takes a great deal of time and effort to get it working properly.

4. Nevertheless, fixing equipment is often necessary in order to keep the company running smoothly.

5. Service engineers are sometimes referred to as "service technicians," "service engineers," or "service managers."
Some people stay in the industry a long time. Will Williams, a senior production engineer at Edelstone Radio, has just celebrated his 50th year with the company. He started as a 15 year old "cable mechanic" in 1930.

Spheres of production and engineering.

"Factory" still conjure up pictures of the dirty, smoky, dingy places where prototypes are manufactured, for the maintenance of equipment is regarded as a dirty word. This is in direct contrast to the attitude of technicians and engineers in the electronics industry. As an industry it is far less poor in recent years. Indeed, it seems almost to regard engineers as assets rather than liabilities. Engineering graduates take up production engineering. Production is a part of the whole development of a successful product. Engineering is the ability to test a single component against the quality function is very much a job for the specialist. He or she needs to have a thorough understanding of the product being sold. Clearly, the more complex and advanced the product the more important the evaluation is to the customer. The 'team' may consist of large equipments or systems, a technician who is interested in statistics and engineers as separate department. Again, although many of the above remarks have been treated very briefly and some cases the design of special test equipment. Furthermore, with the increasing use of automated test equipment it may also call for further skills, such as computer program writing. Test engineering can offer a good career in its own right; the chief test engineer is usually a person of some importance in the organisation. It provides a good grounding for a career in other areas such as development or production engineering.

Sales and marketing. A product without a customer is about as much good as a salesman. They either see him as a smooth talking 'Flash Harry' who will almost certainly have a company car, but he or she will be very much a job for the salesman. The 'team' may consist of large equipments or systems, a technician who is interested in statistics and engineers as separate department. Again, although many of the above remarks have been treated very briefly and some cases the design of special test equipment. Furthermore, with the increasing use of automated test equipment it may also call for further skills, such as computer program writing. Test engineering can offer a good career in its own right; the chief test engineer is usually a person of some importance in the organisation. It provides a good grounding for a career in other areas such as development or production engineering.

Installation and commissioning. In most cases where a number of large equipments or systems, a manufacturer will supply a team to carry out and commission the equipment. This is the sector where many major developments have been made. The personnel will concentrate on analogue techniques or digital techniques? Is there any future in communications or computers or consumer electronics etc, etc? These questions remain unanswered. It is important to everyone in, or entering, the electronics industry whether they be specialising in production or service engineering. To attempt to answer them would need another article but a few general remarks may be helpful.

In the first place it will usually be necessary to specialise to some extent, even in a very broad area. In the case of the electronics industry this will be working round the clock and the salesperson will be expected to work on a shift basis - for which they will be paid. It is generally agreed that service engineers will be employed in servicing but in some cases, especially in dealing with the more sophisticated systems, such as diagnostic programming may be required. Service is a good career for people who like solving problems and putting things right. Field servicing, which provides direct contact with the customer, can be a good starting off point for a subsequent career in service engineering.

Service engineers. They are a big part of the electronics industry and with the emphasis on digital techniques, it is true that the microprocessor will make an impact in many areas of electronics and communications. However, there is a widespread demand for good analogue designers and this is likely to continue for some years. The enthusiasm with which so many young engineers have followed digital and microprocessor courses, especially those in the electronics industry seem newly to be given a renewed vigour. This is the reason that many young engineers are now beginning to show a scarcity value. In other words do not necessarily try to get on the next big thing. Other areas, such as radio and television, have always been popular areas may pay off in the long run.

The above remarks apply more when one is considering the various sectors of the industry such as communications, production, avionics, components. Excellent careers are available in most sectors and what you choose is really a matter of personal inclination and interest. It may be that you wish to go into an area not always the superficially most glamorous sector which offers the most interesting challenges. For example, many engineers shy away from the whole electronics industry whereas in fact this is the sector where many people stay in the industry a long time.
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TJB

Electronic Engineers – What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines – right through from design to marketing – at salary levels from around £4,000 to £8,000 p.a.

If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you. All applications are treated in strict confidence and there is no danger of your present employer (or other companies you specify) being made aware of your application.

TJB ELECTROTECHNICAL PERSONNEL SERVICES,
12 Mount Ephraim,
Tonbridge, Kent, TN9 1BD.
Tel: 0892 93938

Please send me a TJB Appointments Registration form:

[ ] Name: ____________________________
[ ] Address: ___________________________

TJB

Audio Visual Aids Technicians

Two experienced technicians are required by the Coventry Education Service.

One to maintain and repair language laboratories in schools. Knowledge of other visual equipment would be an advantage.

Salary £4,700-£4,923 per annum depending on qualifications and experience.

The second technician will maintain and repair systems of audio and video equipment in the TV, Radio, and Projection units in schools.

Salary £5,034-£5,475 per annum inclusive according to qualifications and experience.

A D say in writing giving details of age, qualifications, present position, experience, and name and address of present employer should be sent to The Superintendent, Education Service Centre, Prince Charles Road, Coventry.

The Daily Press, Tettenhall, Wolverhampton.

Salary. We offer a range of salaries. We will negotiate on a salary in accordance with the qualifications and experience of the applicant.

Please ring Ms Trimagin in the Personnel Department on Wokingham 6731.4433 for an appointment for a full interview. You will have the opportunity to make a special contribution as a member of a small and dedicated team. You will have the scope to use your initiative and entrepreneurial skills.

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Degree Level Electronics Engineers

£9115
Manchester-based

to work on special projects at our studies.

The work will involve installation and troubleshooting on advanced video and sound equipment and the provision of specialist maintenance advice and assistance to our operational engineering staff. Some travel to manufacturers in the UK and possibly overseas will be involved.

The right people, men or women, will be under 28; graduate or HND, with a thorough knowledge of sophisticated digital and analogue technology, ideally in broadcast or CCTV applications.

Conditions of employment include 20 days holiday with generous pension, and free life assurance benefits. Assistance with re-location is available. Write to me with full details of your qualifications and experience by Wednesday April 23rd.

Bob Connell (Ref. G7), Granada Television Ltd., Manchester M60 9EA.
GRANADA TELEVISION

DOLBY SYSTEM

Technician

Dolby Laboratories manufacture professional audio noise reduction equipment which is widely used by major recording studios.

Working closely with our application engineers the person appointed will maintain studio and theatre replay equipment in our listening room as well as assisting in the construction of specialised equipment.

The successful applicant will be familiar with audio equipment and will be able to construct prototypes from circuit diagrams with the minimum of supervision. Aged between 18 and 30 years or so, he will probably have experience in the service or manufacture of audio equipment.

Salary is negotiable dependent on experience.

Write or telephone:
John Iles or Elmar Stetter
DOLBY LABORATORIES INC.

346 Clapham Road
London SW9 8AP
Telephone: 01-720 1111

How to cut through the old boy network

You can’t possibly cover all the job advertisements by those you ask us not to.

And what about all those jobs that are never advertised because they don’t want people to know about them first? – YOU MISS OUT.

Break into that circle by enrolling with Lansdowne. We’ll thump your career details onto the desks of senior managers at thousands of companies – except those you ask us not to.

They’ll consider you for the immediate jobs and they’ll keep your file for the future. When they want you they’ll ring you – not us – and you’re immediately shortlisted for a job you might never have heard about.

Just fill in the coupon and send for our Career Summary Form and explanatory leaflet. And do it at once because it’s the only one that’s worth thousands of applications.

Stuart Tate, Lansdowne Appointments Register, Design House, The Mail, London W8 5LS.
Tel: 01-579 2282 (24 hour answering service).

Our clients would like to meet men and women aged 20-40, earning between £0,000-£3,000 in any of the following areas:

TEST ENGINEERING CALIBRATION ENGINEERING ELECTRONICS ENGINEERING ELECTRONICS SALES SERVICE ENGINEERING DEVELOPMENT ENGINEERING

Mr./Mrs./Miss.
Address

Stuart Tate, Lansdowne Appointments Register, Design House, The Mail, London W8 5LS.
Tel: 01-579 2282 (24 hour answering service).

TEST ENGINEERS NEEDED

By Electronic/technological leaders in the fields of lighting control and audio visual systems. Will involve dealing analogue, digital and microprocessor circuits. Applicants should be qualified to ONC or HNC level and have experience in analogue and testing digital techniques.

Salary will be around £5000, please contact:
Mr. A. Kidd
Electrosonics Ltd.
81-85 Woolwich Road
London SE1
Tel: 01-855 1101 ext. 37

www.americanradiohistory.com
Degree Level Electronics Engineers

£9115
Manchester-based

to work on special projects at our studies.

The work will involve installation and troubleshooting on advanced video and sound equipment and the provision of specialist maintenance advice and assistance to our operational engineering staff. Some travel to manuregists in the UK and possibly overseas will be necessary.

The right people, men or women, will be under 30, graduate at HND, with a thorough knowledge of sophisticated digital and analogue technology, ideally in broadcast or CTV applications.

Applications or equivalent. Consideration will be given to providing generous paid vacation and travel at the applicant's request. Assistance with relocation is available.

Write to me with full details of your qualifications and experience by Wednesday April 23rd.

Bob Connell (Ref. G7), Granada Television Ltd., Manchester M60 9EA.

GRANADA TELEVISION

TRAiNING iN BROADCASTING OPERATIONS

The BBC requires technical staff to instruct at its Training Centre near Evesham, Worcestershire.

Qualifications or equivalent. Consideration will be given to providing generous paid vacation and travel at the applicant's request. Assistance with relocation is available.

Write to me with full details of your qualifications and experience by Wednesday April 23rd.

Bob Connell (Ref. G7), Granada Television Ltd., Manchester M60 9EA.

GRANADA TELEVISION

Radio Communications

Electronics Engineers and Software Designers

Salaries up to £8,000

To join our expanding R&D Laboratories covering a wide range of R.F. spectrum, from L.F. to M.F. Equipment will include design and recovery for marine and land-based radio, radars and radio monitoring remote computer-controlled systems.

Electronic Engineers should have a background in transmitter or receiver design, analogue or digital circuit design, microprocessor applications. Software Designers should be reasonably familiar with assembly programming, in control, signal processing or navigational software.

Attractive salaries are complemented by excellent prospects and generous benefits.

Contact: David Bird, Radifon Telecommunications Limited, Bromwell Road, Woodwards, London, S.W.18. Phone: 01-874 7281 (reverse charges).

LEEDS BRADFORD AIRPORT

AIR TRAFFIC ENGINEER

Vacancy exists for a Nay Traffic Engineer to undertake the following duties:

1) To ensure that the highest standards of service are maintained.
2) To ensure that all air traffic is processed in an efficient and safe manner.
3) To ensure that all air traffic is processed in an efficient and safe manner.
4) To ensure that all air traffic is processed in an efficient and safe manner.
5) To ensure that all air traffic is processed in an efficient and safe manner.
6) To ensure that all air traffic is processed in an efficient and safe manner.
7) To ensure that all air traffic is processed in an efficient and safe manner.
8) To ensure that all air traffic is processed in an efficient and safe manner.
9) To ensure that all air traffic is processed in an efficient and safe manner.
10) To ensure that all air traffic is processed in an efficient and safe manner.

The successful applicant will be required to hold a valid Air Traffic Control Certificate and have experience in the operation of air traffic control systems.

Salary is negotiable dependent on experience.

Write or telephone: John Iles or Elmar Stottner

DOBY LABORATORIES INC.

346 Clapham Road
London SW9 9AP
Telephone: 01-720 1111

Technological and Operational Training

Thomas Television will be running its Technical Training Scheme beginning September 1980. The course will be of 9 months duration and will be available in the following areas:

1) Technicians covering VHF, Telecine and VSS Control Operation applicable to the above.
2) Engineering, covering planning, design and installation.
3) Television Sound Operations.
4) Television Sound Operations.
5) Television Sound Operations.

The course will consist of 9 months broad based training and 4 months specialist training and will take place at the Training Centre, Teddington, with additional experience gained on attachment at each of the Company's studios.

Salary during training will be £3.50 per annum.

Successful Trainees will be absorbed into operational departments at one of the Company's sites and go in to a salary structure applicable to the post.

Traineeship should preferably be 20-30 years of age and have academic qualifications, specialist training or experience relevant to their chosen area.

For an application form and full details please write (indicating area of preference) to:-

Miss Pat Evans, Staff Relations Dept., Thomas Television Ltd., Teddington Lock, Middx. Tel: 01-977 3032, ext. 325.

TEST ENGINEERS NEEDED

By Electronic leads in the fields of fighting and audio visual systems. Work involves dealing with analogue and digital microphone circuits. Applicants should be qualified to professional level and have experience in analogue and digital techniques.

Salary will be around £15.00, prior to contact:

Mr. A. Kidd
Electronic Ltd.
81-95 Woburn Road
London SE1
Tel: 01-355 1101 ext. 37
**Radio Engineers**

If your trade or training involves radio operating, you may be considered for a Radio Engineer post with the Composite Signals Organisation. A number of vacancies will be available in 1980/81 for suitably qualified candidates, to be appointed as Trainee Radio Officers. Candidates must have had at least 2 years' radio operating experience or hold a PAM, MPT or MRIC certificate, or expect to obtain this shortly. Registered disabled people may be considered.

On successful completion of 4 weeks' specialist training, appointees move to the Radio Officers Grade.

**Salary Scales:**

<table>
<thead>
<tr>
<th>Trainee Radio Officer</th>
<th>Radio Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 19 £3271</td>
<td>Age 19 £4493</td>
</tr>
<tr>
<td>Age 20 £3382</td>
<td>Age 20 £4555</td>
</tr>
<tr>
<td>Age 21 £3485</td>
<td>Age 21 £4844</td>
</tr>
<tr>
<td>Age 22 £3611</td>
<td>Age 22 £4989</td>
</tr>
<tr>
<td>Age 23 £3685</td>
<td>Age 23 £5249</td>
</tr>
<tr>
<td>Age 24 £3767</td>
<td>Age 24 £5559</td>
</tr>
<tr>
<td>Age 25+ £3856</td>
<td>Age 25+ £5899</td>
</tr>
</tbody>
</table>

then by 5 annual increments to £7592 inclusive of shift working and Sunday elements.

For further details telephone Cheltenham 21491 Ext. 2269, or write to the address below.

**Recruitment Office**

Government Communications Headquarters

Oakley, Priory Road, Cheltenham GL52 5AJ

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**Video Recording Equipment Service Engineer**

With the outstanding success in marketing a new range of airborne and high speed video tape equipment we need to appoint a top rate video service engineer. Full product training will be given in either America or Japan to a suitably qualified or experienced person.

The successful applicant will probably be aged between 25 and 35. A Company car will be provided, after a probationary period; 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' annual holiday, free life assurance, sick scheme and free catering facilities. For further details and application form please apply to:

**JHPI**

Mr. D. Abbott

Engineering Product Manager

Rediffusion Consumer Electronics Ltd

Fulper Way South

Cheshunt, Herts, EN8 1NJ

Telephone: 01-397 5411

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**Electronic Engineers**

To work in their Projects Dept. The work will include the selection, purchase, installation and commissioning of the electronic equipment used in television studios and D.B. vehicles. Applicants should be H.N.C. standard but engineers with suitable Broadcast Television experience will be considered. Salary will be in the range of £2571 to £7487 rising to £8325 p.a. increasing July 1, 1980 to £8716 to £9495 rising to £9645 p.a. Applications to be made to:

**Personnel Department**

LONDON WEEKEND TELEVISION

Kent House, Upper Ground, London, SE1 9LT

---

**Land a good job!**

If you're thinking of a shore-based job, here's where you'll find interesting work, job security, good money, and the opportunity to enjoy all the comforts of home which you appreciate them most at home!

The Post Office Maritime Service has vacancies at Portishead Radio and some of the other coast stations for qualified Radio Officers to undertake a wide variety of duties, from Morse and teletypewriter operating to traffic circulation and radio telephone operating.

To apply, 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 £335, offer a years' service this figure rises to around £7067. If you are between 19 and 24 your pay on entry will vary between approximately £2291 and £4397. Overtime is additional, and there is a good pension scheme, sick-pay benefits, a 4 weeks' holiday a year, and excellent prospects of promotion to senior management.

For further information, please telephone Kathleen Watson on 01-432 4869 or write to her at the following address:

E Maritime Radio Services Division (OBN 109/26), GL52 1SAJ

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**COLOUR TELEVISION**

If you have experience in television or test equipment engineering, there could be an interesting and rewarding future for you at Rediffusion Consumer Electronics Ltd. We are currently manufacturing an advanced range of colour television receivers at our factories in County Durham and Cleveland and wish to make the following appointments.

**GROUP LEADER — Test Equipment**

Effective testing of television receivers plays an important role in ensuring that our very high quality standards are maintained, and we now wish to appoint an experienced engineer of proven ability, to control a team of engineers and technicians responsible for all aspects of production test equipment.

Responsibilities will include the calibration and maintenance of a sophisticated range of test and signal generation equipment, employing both digital and analogue techniques. Although some test gear is designed and constructed locally, close liaison will be required with the design team, based at Chessington, Surrey, both to keep abreast of new developments and influence the new design of equipment in the light of production experience.

**SENIOR ENGINEER — Production Support**

A senior engineer with a sound understanding of television systems and receiver circuits is required to assist production departments with technical problems arising during television manufacture. Responsibilities will include investigation of design problems, component fault assessment and the elaboration of quality assurance procedures to check that the finished product conforms to design specifications.

Both positions are based at our factory in Bishop Auckland, County Durham, which is within easy reach of all parts of the country and has excellent road, rail and air connections. A wide range of good housing is available and assistance with relocation expenses will be available where appropriate.

Attractive salaries will be offered, together with the benefits of a good pension scheme, free life assurance and 4 weeks' holiday with a choice of leave period.

If you are interested in these challenging positions and would like more details, please write to or telephone: Mr. D. Abbott, Engineering Product Manager, Rediffusion Consumer Electronics Ltd, Fulper Way South, Cheshunt, Herts, EN8 1NJ, Telephone: 01-397 5411.
**“Whoever heard of a Resident Field Engineer?”**

--- Major Installation

If you're an experienced Field Engineer and you're tired of travelling, this is an ideal opportunity to enjoy the best of both worlds.

To ensure our Burroughs equipment is professionally maintained we are now looking for a resident FIELD ENGINEER.

You will be part of a team responsible for the maintenance of 3 large scale (B9800), 3 medium size (B1800), 24 small scale (B90) computer systems and peripherals and over 150 terminals which are linked to these various systems.

For this challenging position, we prefer that you are qualified to HNC or equivalent level. Engineers experienced in the maintenance of any major computer systems will be considered.

We will provide all necessary training on our mainframes and peripherals as part of the successful applicant's personal development.

You will be offered an attractive salary and excellent conditions of employment.

If you're looking for more stability and excellent career prospects contact:

Recruitment Manager, Ref. WW,

Burroughs, Cumbernauld G68 0BN.

Telephone 023-67-35457.

An Equal Opportunity Employer.

---

**RADIO OFFICERS**

If your trade or training involves radio operating, you qualify to be considered as Trainee Radio Officers with the Composite Signals Organisation.

A number of vacancies will be available in 1980/81 for suitably qualified candidates to be appointed as Trainee Radio Officers. Candidates must have had at least 2 years' radio operating experience or hold a PAM, MPT or MRIC certificate, or expect to obtain this shortly. Registered disabled people may be considered.

On successful completion of 40 weeks' specialist training, appointees move to the Radio Office Grade.

Salaries:

- **Trainee Radio Officer**
  - Age 19 £3271
  - Age 20 £3832
  - Age 21 £3885
  - Age 22 £3611
  - Age 23 £3865
  - Age 24 £3767
  - Age 25 £3856

then by 5 annual increments to £7892 inclusive of shift working and Saturday, Sunday elements.

For further details telephone Cheltenham 21491 Ext. 2269, or write to the address below.

---

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**GROUP LEADER — Test Equipment**

Effective testing of television receivers plays an important role in ensuring that our very high quality standards are maintained, and we now wish to appoint an experienced engineer of proven ability, to control a team of engineers and technicians responsible for all aspects of production test equipment.

Responsibilities will include the calibration and maintenance of a sophisticated range of test and signal origination equipment, employing both digital and analogue techniques. Although some test gear is designed and constructed locally, close liaison will be required with the design team, based at Chessington. Sufforto keep abreast of new developments and influence the new design of equipment in the light of production experience.

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To apply, 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 £3290, offer a 3 years' service this figure rises to around £2187. If you are between 19 and 24 your pay on entry will vary between approximately £4229 and £4397. Overtime is additional, and there is a good pension scheme, sick-pay benefits, at least 4 weeks' holiday a year, and excellent prospects of promotion to senior management.

For further information, please telephone Kathleen Watson on 01-432 4899 or write to her at the following address: E Maritame Radio Services Division (OBE), 511.2. Room 6.43, Union House, St. Martin's-le-Grand, London EC1A 1AR.

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**POLICE OFFICERS**

If you are interested in a police career in one of the newly created Greater London police forces, you will have to apply to one of the forces shown opposite. You will then be called in for interview, and, if successful, will be offered an appointment to serve in the Metropolitan Police Force.

---

**ELECTRONIC ENGINEERS**

To work in their Projects Dept. The work will include the selection, purchase, installation and commissioning of the electronic equipment used in television studios and O.B. vehicles. Applicants should be H.N.C. standard but engineers with suitable Broadcast Television experience will be considered. Salary will be in the range of £2591 to £7487 rising to £8355 p.a. increasing July 1, 1980 to £8716 to £9495 rising to £9496 p.a. Applicants to be made to:

**Personnel Department**

**LONDON WEEKEND TELEVISION**

Kent House, Upper Ground, London, SE1 9LT.

---

**REDIFFUSION**

If you are interested in television, then you've come to the right place! We have the most sophisticated range of test and signal origination equipment, and a good range of digital and analogue techniques. We have a wide range of television receivers at our factories in County Durham and Cleveland and wish to make the following appointments.

**GROUP LEADER — Test Equipment**

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**ANN JAMES**

**PROFESSIONAL OFFICE**

**JOHN HEDLAND (P.) LTD**

**NEWHOUSE LABORATORIES**

**NEWHOUSE ROAD, RUSHINGTON**

**HERALD HAMPSTEAD**

**Herts. HP3 0LL**

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**WIRLESS WORLD, MAY 1980**

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**JVPHI**

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**WIRELESS WORLD**

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**LONDON WEEKEND TELEVISION**

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**REDIFFUSION**

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**WIRELESS WORLD, MAY 1980**
Support Engineer

SWINDON

We are looking for a Support Engineer to become involved in professional technical support to a sophisticated production test area in the semiconductor industry. The position would be mainly involved in servicing and repair of computer based test systems and instrumentation.

You should hold HNC/City & Guilds Tech. Certificate or equivalent in electronics. Experience of SPC, and audio tape and similar equipment would be desirable but training will be given where necessary.

The normal range of fringe benefits expected from a large company plus a competitive salary and a good working atmosphere are part of what we have to offer. In addition you would be working in the industry of the future. The exciting world of microelectronics. Write or phone for an application form to Shirley Care, Recruiting Officer, Philips Semiconductors Limited, Cheney Manor, Swindon, Wilts SN2 0QW. Tel: Swindon 3251.

PLESSEY

Product Evaluation Engineer

Dixons are Britain's leading and most successful photographic and home entertainment specialists. We are now looking for a product evaluation engineer for audio, video and similar electronic products.

This interesting vacancy, based at Edgware, has arisen from an internal promotion. You would be responsible for accurately assessing the specifications of consumer electronic products that the company market. You would be responsible for giving brief details at Dixons Photographic Ltd., Princess Victoria Street, London, W.1.

The person we are looking for will have the technical skill and ability to devise and implement appropriate test systems. He or she will also need to be self-motivated and able to work unsupervised.

Preference will be given to applicants who possess a City & Guilds (Full Technical Certificate), ONC or HNC qualification or equivalent. Test and calibration experience, preferably in audio and TV, will be a great advantage.

Some knowledge of current safety specifications for consumer electronic products would also be useful.

The successful applicant can expect an attractive salary which reflects the importance and responsibilities of the job. Other benefits include a subsidised restaurant, four weeks' holiday, mountain walking and insurance schemes and generous staff discount.

If you are interested in this opportunity to broaden your career with a dynamic and rapidly expanding company, contact Janet Gearing on 01-437 4371, or write to her giving brief details at Dixons Photographic (UK) Ltd., Camera House, Cartwright Road, Stevenage, Herts.

Dixons

A GREAT COMPANY TO WORK WITH

Electronics R&D

These opportunities are in the Scientific and Technical Branch which provides the scientific, engineering and other professional services essential to the provision of medical apparatus, instrumentation and supplies to hospitals.

The successful candidates will join a London-based team working on the specification, laboratory testing, inspection and quality control of a wide range of medical electrical and electronic equipment used in the National Health Service. Some UK travel required.

Candidates must have a degree or an equivalent qualification in electronics or electrical engineering, at least 3 years training in electrical engineering, and subsequent experience in the design, testing and/or inspection of electronic equipment.

Experience of medical electrical equipment advantageous.

Salary under review starting between £8955 and £10680 depending on qualifications and experience. Promotion prospects. Non-contributory pension scheme.

For further details and an application form (to be returned by 25th June 1980) write to Civil Service Commission, Alencon House, 52-54 Finsbury Circus, London, EC2M 4EZ. Tel: (01) 632 1091.

Medical Equipment for Hospitals

A vital role for Electrical/Electronic Engineers

The Electronics R&D Department has an immediate need for the following professional engineers with considerable experience of the design and development of microwave and telecommunication systems, and a specialisation in passive electronic components and supply into the control systems of medical equipment.

C1VIL SERVICE COMMISSION

Senior Technical Officer

You are invited to apply for a Senior Technical Officer post in the Department of Health and Social Security, London, with responsibility for systems covering fire alarms, call systems etc. This involves work within a London-based team working on the design, testing and installation of fire protection equipment in hospitals.

You will report to the Head of Department and in general will be responsible for commissioning, maintenance and monitoring of telecommunications and electronic equipment in the hospitals and the efficient management of staff. The role involves a considerable amount of travel and will be available for the Service outside office hours.

The person appointed will have at least an ONC or ONC, but an HNC in electronics or telecommunication systems engineering, and good experience in prototype construction and design and testing. He will also be required to provide technical advice on a large number of technical matters relating to fire alarm and call systems and have knowledge of Project management techniques.

Salary will be equivalent to Ph.D. Free on the London living grade.

APPLICATIONS

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