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Microprocessor d.v.m.
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Dual Trace Oscilloscopes

Low cost, compact British manufactured oscilloscopes for test, service or development engineers.

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DTS12 Our new digital storage 'scope - at a remarkably low price

Free colour brochure describes the range. Send for your copy now!
**Odder Response DC** - 45kHz ± 1dB
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- **1N4148** (100V, 1A)

**FUSES**
- **5A** (3.15A)

**FIBRESTRIPE**
- **200Ω**

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- **5441** (50MHz Variable Persistence Storage Oscilloscope)
- **5473** (500MHz Spectrum Analyzer)

**OSCILLOSCOPES**
- **TF2173** (Syncroser AM/FM)
- **TF2169** (Pulse Modulator for use with 10MHz-100kHz Waveform)

**SPECTRUM ANALYSERS**
- **TF2120** (0.0000Hz-100kHz Waveform Processing Scope)
- **TF2116** (0.0000Hz-100kHz Waveform Processing Scope)

**TEKTRONIX TV TEST EQUIPMENT**
- **5450** (100MHz TV Test Generator)
- **5451** (100MHz TV Test Generator)

**FIBER OPTICS**
- **2600** (Fiber Optics Line Monitor)
- **2601** (Fiber Optics Line Monitor)

**MULTIMETERS**
- **DM4** (5.5Volt, 20mA, 2000Ω, 10mA, 2000Ω, 10mA)

**TEKTRONIX PLUG-INS**
- **510** (BNC, Phase and Polarizer Processor)
- **530** (Regenerator)

**RECHARGEABLE BATTERIES**
- **12V** (12V, 4000 mAh)

**DIODES**
- **1N4148** (100V, 1A)

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- **510** (BNC, Phase and Polarizer Processor)
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**RECHARGEABLE BATTERIES**
- **12V** (12V, 4000 mAh)
Uninterruptible Power Supplies
UPS CVT Reliability 1.25 to 50kVA, 50 or 60Hz.

- STANDBY POWER: Invaluable in building a computer programme on mains failure and wherever continuous power is vital.
- STABILISATION: ±3% Vital to combat mains voltage fluctuations and the condition of equipment at peak efficiency. Frequency stabilised ±0.1% 47 to 63Hz.

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- STABILISATION: ±3% Vital to combat mains voltage fluctuations and the condition of equipment at peak efficiency. Frequency stabilised ±0.1% 47 to 63Hz.

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* DC Voltage: 200mV to 1000V

* AC Voltage: 0.1%, 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000V

* AC Current: 0.1%, 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000mA

* Input Impedance: 10MS1

* Resolution: 0.1mV, 1mV, 10mV, 1V, 10V, 100V, 1000V

* Power Supply: 2 x 3V Alkaline battery

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Tuning Keypad/Spin/Decade
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(b) SR 522 with Preselector for Point to Point/Transportable.
(c) SR 530 As (a) above but MICROPROCESSOR/KEYPAD controlled, 200 channel memory, Scanning.
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Specification... Versatility... Accuracy...
Price: In almost every major area the new 179A - a 4 1/2 digit bench-top Portable DMM from Keithley Instruments sets some pretty impressive standards:
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- IEEE option
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This is a trade only show, not for end-users.

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WW - 427 For further details
**RF Linear Power Amplifiers**

<table>
<thead>
<tr>
<th>Type</th>
<th>Frequency Range</th>
<th>Output Power</th>
<th>Price (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE 905C</td>
<td>1-200 MHz</td>
<td>4 watts</td>
<td>49.50+2p</td>
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**Low Noise Gasfet Preamplifiers**

<table>
<thead>
<tr>
<th>Type</th>
<th>Frequency Range</th>
<th>Gain (dB)</th>
<th>Variable Range</th>
<th>Price (£)</th>
</tr>
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<tbody>
<tr>
<td>TYPE 9035</td>
<td>2-20 MHz</td>
<td>2-35 dB</td>
<td>10-40 dB</td>
<td>65.00+1.50 p&amp;p</td>
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<tr>
<td>TYPE 9026</td>
<td>2-20 MHz</td>
<td>1.0 dB</td>
<td>10-40 dB</td>
<td>39.50+1.50 p&amp;p</td>
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**VMOS Linear Power Amplifiers**

<table>
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<tr>
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<th>Frequency Range</th>
<th>Output Power</th>
<th>Price (£)</th>
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<tr>
<td>TYPE 9038</td>
<td>1-200 MHz</td>
<td>10 watts</td>
<td>59.50+2p</td>
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**Telephone Linear Power Amplifiers**

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<th>Type</th>
<th>Frequency Range</th>
<th>Output Power</th>
<th>Price (£)</th>
</tr>
</thead>
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<tr>
<td>TYPE 9035</td>
<td>2-20 MHz</td>
<td>2-35 dB</td>
<td>65.00+1.50 p&amp;p</td>
</tr>
<tr>
<td>TYPE 9026</td>
<td>2-20 MHz</td>
<td>1.0 dB</td>
<td>39.50+1.50 p&amp;p</td>
</tr>
</tbody>
</table>

**VMOS Widerange Linear Power Amplifiers**

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<th>Type</th>
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<th>Output Power</th>
<th>Price (£)</th>
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<tr>
<td>TYPE 9038</td>
<td>1-200 MHz</td>
<td>10 watts</td>
<td>59.50+2p</td>
</tr>
</tbody>
</table>

**TELEVISION LINEAR POWER AMPLIFIERS**

<table>
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<th>Type</th>
<th>Frequency Range</th>
<th>Output Power</th>
<th>Price (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE 9035</td>
<td>2-20 MHz</td>
<td>2-35 dB</td>
<td>65.00+1.50 p&amp;p</td>
</tr>
<tr>
<td>TYPE 9026</td>
<td>2-20 MHz</td>
<td>1.0 dB</td>
<td>39.50+1.50 p&amp;p</td>
</tr>
</tbody>
</table>

**米ETER PROBLEMS?**

- 4 watts and 20 watts max. RF output. Without tuning, power gain 10 dB.
- 15 watts and 50 watts max. RF output. With tuning, power gain 10 dB.
- 20 watts and 60 watts max. RF output. Without tuning, power gain 10 dB.

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- Synthesizers
- Audio Equipment
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For Xenon Arc and Mercury Arc Lamps

Units available for lamps ranging from 5 to 400 watts. Lamp ratings and the system manufactured as standard to the test codes to specific ratings.

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This Nicolet digital scope can put a waveform in your pocket.

The two-channel 3091 is a simple and all-in-one advantage of a Nicolet digital scope. It is in a compact portable package. The two-channel, 10 MHz to 100 MHz, 40 dB, 10-100 MHz, 40 dB, and 50-100 MHz, 40 dB, diode-gate and 10 MHz to 100 MHz, 40 dB, 10-100 MHz, 40 dB, diode-gate, two-channel scope for use in the laboratory. The 3091 is a digital storage oscilloscope, a two-channel recorder, and a chart recorder all in one. It is a versatile instrument. Important data can be stored in the optical magnetic bubble chamber for instant recall in either your 3091 or someone else.

£3360
The microprocessor controlled EP4000 will emulate and program all the popular EPROMs including the 2764, 2708, 2716(3), 2508, 2758, 2516, 2716, 2532 and 2732 devices. Personality cards and hardware changes are not required as the machine configures itself for the different devices. Other devices such as bipolar PROMs and 2764 and 2564 EPROMs are programmed with external modules.

The editing and emulation facilities, video output and serial/parallel input/output provided as standard make the EP4000 very flexible to allow its use in three main modes:
- As a stand alone unit for editing and duplicating EPROMs.
- As a slave programmer used in conjunction with a software development system or microcomputer.
- As a real time EPROM emulator for program debugging and development (standard access time of the emulator is 300ns).

Data can be loaded into the 4k x 8 static RAM from a pre-programmed EPROM, the keypad, the serial or parallel ports and an audio cassette. Keypad editing allows for data entry, shift, move, delete, store, match and scroll, and a 1k x 8 RAM allows temporary block storage. A video output for memory map display, as well as the built-in 8 digit hex display allows full use of the editing facilities to be made.

Items pictured are: EP4000 Emulator Programmer - £545 + £12 delivery; BSC buffered simulator cable - £39; MESA 4 multi EPROM simulator cable - £98; 2764 Programming adaptor - £84; 2564 Programming adaptor - £64;

BP4 (TEXAS) Bipolar PROM Programming module - £190

Also available (not shown): VM10 Video monitor - £99; UV141 EPROM Eraser with timer - £78; GP100A 80 column Printer - £225; P1100 interface for EP4000 to GP100A - £65.

VAT should be added to all prices

**NEW PRODUCT**

- Checks, Programs, Compares up to 8 devices simultaneously
- Handles all NMOS EPROMS up to projected 128k designs with no personality modules or characterisers - See list
- Easy to use menu driven operation for blankcheck, program, verify, illegal bit check, checksum, self-test
- Constant display of device type, mode and fault codings
- Individual socket LED indicators for EPROM status
- Comprehensive EPROM integrity checks - Illegal bit check, data and address shorts, constant power line monitoring
- Full safeguard protection on all sockets
- Automatic machine self-test routine
- Powered down sockets
- Cost effective price - £695 + VAT
- Available from stock

Write or phone for more details
Advanced fault finding and diagnosis is just one of the many projects undertaken with the ELE microelectronic and microprocessor teaching system.

A complete range of projects can be taught, from building simple electronic circuits to advanced engineering applications such as intelligent robotics.

Features
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- Comprehensive - 46 items of equipment in the system

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Small enough to operate anywhere, and precise enough for any professional application.

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01-202 4366

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- Teaching system.
- Structured - provides a complete
- Modular - interchangeable equipment in the system.

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- **IT303TR** Variable Power: £16.95
- **AT1020** Deluxe plus Hfe: £36.00
- **3111TR** Large scale: £11.50

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- **PPM200** 200 MHz: £43.00
- **NH56R** 20K/V: £10.95

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- **LP1010** 0/300A: £28.50

#### Transistor Testers
- **TG1001** HZ - 100KHZ: £91

#### Logic Analyzers
- **TG1001** HZ - 100KHZ: £91

### Digital Multimeters
- **H030** £16.11
- **HD30** £44.90
- **ND31** £34.80

### Apps for further details
- **www.americanradiohistory.com**
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In keeping with ILP's tradition of entirely self-contained modules featuring, integral heatsinks, no external components and only 5 connections required, the range has been optimized for efficiency, flexibility, reliability, easy usage, outstanding performance, value for money.

With over 10 years experience in audio amplifier technology ILP are recognized as world leaders.

<table>
<thead>
<tr>
<th>Number</th>
<th>Power</th>
<th>PSU</th>
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<tbody>
<tr>
<td>HY124</td>
<td>120V</td>
<td>PSU21</td>
</tr>
<tr>
<td>HY241</td>
<td>120V</td>
<td>PSU53X</td>
</tr>
<tr>
<td>HY30</td>
<td>110V</td>
<td>PSU45X</td>
</tr>
<tr>
<td>HY242</td>
<td>220V</td>
<td>PSU53X</td>
</tr>
<tr>
<td>HY66</td>
<td>120V</td>
<td>PSU21</td>
</tr>
</tbody>
</table>

- **HY124**: Suitable for stereo and mixing modules in 18 different variations.
- **HY241**: Suitable for use with Aux + Voc and Treble Lead modules.
- **HY30**: Suitable for use with Aux + Voc and Treble Lead modules.
- **HY242**: Suitable for use with Aux + Voc and Treble Lead modules.

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Power</th>
<th>Price inc. VAT</th>
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<tr>
<td>HY124</td>
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<td>PSU21</td>
<td>£15.36</td>
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<tr>
<td>HY241</td>
<td>120V</td>
<td>PSU53X</td>
<td>£17.07</td>
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<tr>
<td>HY30</td>
<td>110V</td>
<td>PSU45X</td>
<td>£14.20</td>
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<tr>
<td>HY242</td>
<td>220V</td>
<td>PSU53X</td>
<td>£17.19</td>
</tr>
</tbody>
</table>

- **HY124**: 120V power supply. Suitable for stereo and mixing modules in 18 different variations.
- **HY241**: 120V power supply. Suitable for use with Aux + Voc and Treble Lead modules.
- **HY30**: 110V power supply. Suitable for use with Aux + Voc and Treble Lead modules.
- **HY242**: 220V power supply. Suitable for use with Aux + Voc and Treble Lead modules.

**MOSFET MODULES**

- **NEW to ILP**: In Car Entertainment Modules

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Power</th>
<th>Price inc. VAT</th>
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<tbody>
<tr>
<td>UC1</td>
<td>120V</td>
<td>PSU21</td>
<td>£11.93</td>
</tr>
<tr>
<td>UP3X</td>
<td>60W / 4-8J</td>
<td>MOS</td>
<td>£15.36</td>
</tr>
<tr>
<td>UP6X</td>
<td>60W / 4-8J</td>
<td>MOS</td>
<td>£15.36</td>
</tr>
<tr>
<td>UP5X</td>
<td>120W / 8J</td>
<td>MOS</td>
<td>£17.07</td>
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<tr>
<td>US3X</td>
<td>60W / 4-8J</td>
<td>MOS</td>
<td>£14.20</td>
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<tr>
<td>US2X</td>
<td>120W / 4J</td>
<td>MOS</td>
<td>£15.36</td>
</tr>
<tr>
<td>UC2</td>
<td>120W / 4J</td>
<td>MOS</td>
<td>£15.36</td>
</tr>
</tbody>
</table>

- **NEW to ILP**: Modular Amplifiers
- **MOSFET**: Suitable for use with Aux + Voc and Treble Lead modules.

**Hi Fi Separates**

- **UCI PRE AMP UNIT**: Incorporates the HY78 to provide a "no frills", low distortion, (<0.006%), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape/monitor facilities. The unit provides the heart of the hi-fi system and can be used in conjunction with any of the UP series of power amps. For ultimate hum rejection the UCI draws its power from the power amp unit.
- **POWER AMPS**: The UP series feature a clean line front panel incorporating on/off switch and control indicator. They are designed to compliment the style of the UCI pre-amp. Performance for each unit which includes the appropriate power supply, is specified on the facing page.

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Our power slaves, which have numerous uses i.e. instrument, dissipation, sound reinforcement, feature in addition to the hi-fi series, front panel input jack, level control, and a carrying handle. Providing the smallest, lowest cost, slave on the market in this format.

**Unicase**

Over the years ILP has been aware of the need for a complete packaging system for its products, it has now developed a unique system which meets all the requirements for ease of assembly, adaptability, ruggedness, modern styling and above all price.

Each Unicase kit contains all the hardware required down to the last nut and bolt to build a complete unit without the need for any special tools.

Because of ILP's modular approach, "open plan" construction is used and final assembly of the unit parts forms a compact assembly. By this method construction can be achieved in under two hours with little experience of electronic wiring and mechanical assembly.

**Hi Fi Separates**

- **UCI PRE AMP UNIT**: Incorporates the HY78 to provide a "no frills", low distortion, (<0.006%), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape/monitor facilities. The unit provides the heart of the hi-fi system and can be used in conjunction with any of the UP series of power amps. For ultimate hum rejection the UCI draws its power from the power amp unit.
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This high-performance correlation demodulator can decode data or picture information from the UOSAT spacecraft either directly off-air or from tape-recordings. It may be connected to a printer, v.d.u. or computer as the user wishes.

Since UOSAT’s digital data is sent as 1200Hz or 2400Hz tones, a possible method of decoding it is by cross-correlating the signal against correlation decoder: this matches the signal exactly with the replica, the output is at a maximum. 

Processing
Since the signal carries virtually no information in its amplitude, baud rate may be increased even though it seems to be buried in noise: for example, 45 baud data signals can be decoded without errors at a noise-to-signal ratio as poor as 5:1. This type of system is known as a matched filter.

The decoder described in this article comprises a channel decoder, a 1200 baud demodulator, a 300 baud demodulator, a lock detector and a line-synchronization detector. The system does not require the user does not require them. Alternative performance is dependent only on the way a signal can be decoded uncorrupted by noise and interference. Their signal-to-noise ratio, which is in turn directly dependent on the bandwidth; and the bandwidth cannot be reduced indefinitely without also attenuating the signal.

A more promising approach is to use a correlation decoder: this matches the incoming signal against synthesized replicas and in doing so extracts information much more effectively. In consequence its error performance is dependent only on the energy-density of the noise, which is independent of the bandwidth. In this way a signal can be decoded uncorrupted even though it seems to be buried in noise: for example, 45 baud data signals can be decoded without errors at a noise-to-signal ratio as poor as 5:1. This type of system is known as a matched filter.

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3300Hz. The filter is not essential when using de-emphasised signals from a typical F.M. receiver. However it must be used if wide-band noise is present during, for example, performance testing or with signals direct from the receiver's F.M. discriminator.

The limiter (IC5) will operate on a few millivolts of signal. The input polarity-invert switch S5 is needed as receivers and tape-recorders will have arbitrary connections built in, and the polarity of 1200 and 300 baud signals differs. A signal presented to the multipliers must be in the correct sense.

The main p.p.i. (IC2, IC3) operates at 19200Hz. It is followed by a four-bit divider and some logic to generate the reference timing pulses T1200, T2400, Q1200 and Q2400 together with the synchronous integrate-and-dump timing. The circuit has a low bandwidth of 20Hz.

An inspection of the waveforms entering the integrator (Fig. 8) shows that accumulation occurs only during the second and third quarters of the basic 1200Hz rhythm. (Because the tones have lost their sinu-
The amateur scientific satellite UOSAT, built at the University of Surrey, was launched by NASA on 6 October 1981. Its 516km-high polar orbit has a period of approximately 95 minutes. UOSAT's two main data beacons transmit on 145.825MHz and 435.025MHz; reception is possible during favourable passes on an ordinary amateur two-metre receiver, or with a quarter-wave whip aerial. A recorded news bulletin which also gives orbital predictions is available by telephone on Guildford (0483) 81200.

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The bit sync extractor will work satisfactorily on signals of only one baud or more during favourable passes on an ordinary amateur two-metre receiver, or with a quarter-wave whip aerial. A recorded news bulletin which also gives orbital predictions is available by telephone on Guildford (0483) 81200.

Most likely it will be found that the 1200Hz tone is of larger amplitude, and slightly retared (Fig. 10c). Most likely it will be found that the 1200Hz tone is of larger amplitude, and slightly retarded (Fig. 10c). Most likely it will be found that the 1200Hz tone is of larger amplitude, and slightly retarded (Fig. 10c). Most likely it will be found that the 1200Hz tone is of larger amplitude, and slightly retarded (Fig. 10c). Most likely it will be found that the 1200Hz tone is of larger amplitude, and slightly retarded (Fig. 10c).
I have called much evidence in the cause of physics that is not otherwise available. I have called much evidence in the cause of the Copenhagen School served to detach the modern quantum theory from common sense. The key to the aberration was the diehard refusal to admit that the traditional field-theory concept of continuity, on which the wave theories were based, is incompatible with discrete and discontinuous quanta, or particles.

by W. A. Scott Murray
B.Sc., Ph.D.

.physics with, and of measurement fact, not to have to redimish them to their consequences. However, there has always been a tendency to allo-

cate to physical theories an importance a mathematician. They would have to express, such as in classical mechanics and wavelike phenomena, that can be observed only when it is

"unobservable" (or "virtual") quantity to be (annihilating) matter waves by declaring them to be faith, it cannot be disproved, then one quhe like the waves of "real" particles - it/over the objection of the Copenhagen and asymmetric wave func-

tion theory fails in this way: The doctrine of the Copenhagen School served to detach the modern quantum theory from common sense. The key to the aberration was the diehard refusal to admit that the traditional field-theory concept of continuity, on which the wave theories were based, is incompatible with discrete and discontinuous quanta, or particles.

Physics, and concept of the physical reality of the Copenhagen School served to detach the modern quantum theory from common sense. The key to the aberration was the diehard refusal to admit that the traditional field-theory concept of continuity, on which the wave theories were based, is incompatible with discrete and discontinuous quanta, or particles.
IBM Selectric to TRS80 interface

This assembly language program, together with the inexpensive circuitry given in the April issue and a second-hand IBM Selectric typewriter, are all that is needed to produce a low-cost letter-quality printer

If you are not into assembly language programming then just skip this explanation. Unless you want to learn a little about this powerful method of controlling your computer, I had to use assembly language because of the speed necessary in such a process as printing. Any other language would be out of the question. So let's jump right in.

Lines 100 to 330 as shown in the listing, which by the way is how the TRS editor/assembly assembles a machine language program, give some useful information. If you use this program alone, you have to be sure that the line printer control block is initialized to point to this particular program. Locations 16422 and 16423 can point anywhere in memory, and it usually points to the printer block, but we definitely want it to point to where our program starts. So we have to initialize it to point to where we want. Lines 240 and 250 show what to poke where. If your own program is in a different part of memory, you'll have to change these two bytes. I have some other programs running at the same time as this one, such as a keyboard debouncer routine. What I usually do is to have these other small programs initialize these locations for me when I first load them. It is simple to do and you don't have to remember to do it all the time.

Line 330 indicates that this program uses an ANSI typing element, or typetall. This element has the special symbols 'greater-than' and 'less-than' as well as the crossed zero. This part lists the number of this block, and can be ordered from IBM for around $20. If you use a standard element, the modified listing shows what lines have to be changed to get upper and lower case.

So now we can really get to the meat of the program. Line 360 tells the editor/assembly where the origin or beginning of this program is to be assembled from. If all the addresses that will be referred to in the program, such as absolute or relative jumps and subroutine addresses, are given symbolic names, then to assemble this program in a different localization, the ORG is the only address that need be changed; a very handy feature. However, if you jump to a location in rom, you either have to give the address specifically or define a special breakpoint for it; but that is part of the assembler job and we won't go into that now.

The program has already put the character to be printed into the C register, so in line 370 the first thing to do is to put the A register, or accumulator, so that it can be worked on. The next instruction clears the flag register in case any computations have to be made. In line 390 we check for the ASCII character for top of form. This character will allow us to get to the top of a form or page. It isn't used in our printing process, but is there just in case we need to use it some day. If it was a carriage character, the program will jump to line 460. If not, we go to the next line, 410, which will check for a form-feed character. A form feed will allow line feeds to the end of a page. If it wasn't a form feed then the program will jump to line 530 which will output the character. Let's say it was a form feed, then in line 450 you see a fast way to zero the accumulator.

The line printer control block is initialized by rom. It normally puts the value 67 into the lines per page location at 16424. This is alright for continuous paper, but not very useful for single sheets of typing paper. So instead we have either stored the value 54 here, or have had another assembly language program initialize this section. The rom has also placed the printer control block address into the IX register, so in line 440, IX=3, which is the lines/page value, is or-ed with the accumulator to be sure there is something there, if not, a null is printed. As there is something there, in line 460 this value is put into the accumulator and subtracted with the line counter, which has been incremented by one for each carriage return. The result is put into the B register. Next, in line 490, the character for a line feed is put into the accumulator and printed by calling the output subroutine. Line 510 is a very useful instruction which will decrement the B register and jump to the indicated address as long as the B register is not zero. All we are doing is to output line feeds until the end of the page, and when it is all finished the program jumps to line 610 which calls the change-page subroutine.

Line 530 prints the character, of course, and the next line checks for a carriage return. If it was some other character, this section of the program is finished, and then we can return to the rom program. if it was a carriage return, the line count is incremented, and we get the line count and compare it to the lines/page value. In this case it is 54, either placed in this line as an assembly language instruction, or the value poked in the control block before the program was run. If the result turned out to be zero, the zero flag was set, then in line 590 we put the character back into the A register, because this is where the rom expects it to be. The next line will return to rom only if the zero flag was not set, otherwise we jump to the change page subroutine. Line 620 is skipped and we can now return; this part of the program is finished. All that was just to print one character, and it only takes a few hundred milliseconds. Any other language other than assembly language simply would take forever.

Now let's continue with the rest of the program and see how it works. This first part, by the way, is basically the same as the program in rom, with a few of our own modifications so it will work for us. The rest of it comes partly from Mr Barenman's program, and from my own efforts. Lines 630 to 790 lists the names and numbers of the ports used, and the delay times for the delay sub-routines used in the program. Line 790 is the delay work area.

The ASCII correspondence table, from lines 830 to 2100, is a list of values that is to be interpreted by the program to be output to the printer. We'll see how that's done shortly. The table starts at address 7F37H. Remember, H means hexadecimal. Each address position from that point represents an ASCII character. ASCII character values go from 00H to 7FH, but we need to translate this into a value our printer can use, which is IBM's own peculiar code. So let's go to line 2140 where it all starts. This is the ENTRY subroutine that was called from the other part of the program, remember?

We start by saving the AF register pair, because these registers are to be used by this subroutine and so are PUSHed onto the stack. They will be retrieved just before this subroutine RETurns. Line 2150 needs some explanation. Look at line 2250. This address is labelled CHAR. Now look at the address 7ECAH, and notice that the hex address at this address is DD, 7ECB in 7E, and 7ECC is 0H. Back to line 2150 and see that we are to load the ASCII character in the accumulator into CHAS + 1, or in other words, 7ECA + 2 or 7ECC. Thus, we have installed the ASCII

<table>
<thead>
<tr>
<th>ASCII</th>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>00H</td>
<td>DD</td>
<td>Deliberate delay 1 ms</td>
</tr>
</tbody>
</table>
IX register's offset. Back to line 2250. That was in the registers will be affected by whatever is at the address formed by adding the IX register with its offset, and finally turn off the shift sendox and add a delay, 3140-3190.

The delay subroutine is very simple, and is very handy, so let's look at it first. Load into the B register a delay value of FFH, or Z80D. This is temporarily pushed onto the stack, and then get the value we have been using in our work area, and put it into the accumulator, line 3250. Transfer that value into the B register, and use that handy instruction to decrement the B register as many times as was in the DEI/TIM address. When that part is finished, POP out of the stack the DEL1 time, decrement it by one, and then jump back to do the whole thing over again. The delay times can be varied, and multiple delays can be implemented to give almost any delay that one desires. A very useful subroutine.

The carriage movement subroutine at line 3340 is used to check what is happening with the carriage movement detector. First get the port address, and then implement a short delay to give the detector a chance to operate, remember, the program goes through the instructions in micro-seconds, so a one second detecto"r takes time. Line 3380 inputs the data on the data bus into the port that is addressed by the C register. Line 3390 then tests bit number one, which will be a zero in our case. If this line was low, inverted through the buffer, temporary put a one in the port line 3380. As soon as a one is detected, we get another short delay and continue.

The change-page subroutine shows that we can use some of the subroutines in rom if we want to. Lines 3480 to 3510 again save our registers, and in line 3520 we jump to a subroutine which will input a character from the keyboard. This subroutine is located at 002EH in rom, but I have a subroutine that debounces my keyboard located in another section of memory, so this is where I have to access this subroutine, and require the character into the accumulator, so in line 3530 check to see if it is a P. If it isn’t, jump back to line 3520 again and until we have a chance to change the paper. As soon as we input the P from our keyboard, we use the byte counter in line 3570, and finish this part of the program.

That’s the whole ball of wax, friends. You still have a lot of work to do, but that's fine, so let’s see what we can do. Let’s start with the Interrupt Service subroutine. This is where we have a subroutine that is activated by the hardware. In this case, the interrupt service routine is located in the C register. This merely turns on the LED for a small amount of time, and then jumps to the lower-case subroutine. This subroutine is very simple, and is used to get the character from the keyboard. The difference is, in this case we have to read the port to get the character, and then jump to the delay subroutine. On return, we zero-out the accumulator to release the sendox in line 3560. Next we implement another delay so that sendox has time to go back to a resting position. These delay times were chosen for my particular printer so that a firm pull-in is realized without multiple spaces being printed.

The next subroutine, print carriage return/line feed, is very similar, except that we jump to the carriage movement detec- toon subroutine. Also, the print line feed subroutine works the same. IBM calls a line feed an index. The print character subroutine is a little more involved, so let’s examine this. First, in line 2900, we take the character in to the register, then we test the sixth bit of the character to find out if it has a 1 or 0. A 1 indicates an upper-case letter. So in the next, 2920, we will jump to line 2940 if there was no shift. Lines 2930 to 2970 is how we output a shift which by the way has been long delayed until the printing of the character is completed. Note that the character back-line, line 2980, and latch the character-select sendoxnids on, 2990-3050, turn on the print sendox. Next line 3060-3080 searches for the low-address and if a match is not found, then lines 3090-3110 turn off the character-select sendox and add a delay, 3140-3190.

Character classifies into the byte that represents the character’s offset. Back to line 2160 for a minute. Here, we add a value to the accumulator that will be sure it is indeed an ASCII character, and if not, will return. Lines 2200 to 2230 make sure that nothing was in the registers will be affected by our program, and then we are at line 2250. This line load the accumulator with a zero value at the address formed by adding the IX register with its offset, in this case, the string space, and the value of the ASCII character. Now the accumulator holds the value of the corresponding code. Line 2260 checks to see if the accumulator holds a character we don’t want, that is, an EIP. If so, the program branches to line 2410. Line 2280 checks for a space and will jump to line 2320 if it is, otherwise it will call the print space subroutine. The rest of this part of the program works the same, checking for various characters and then branching if it’s not the right one. Lines 2410 to 2460 will return all the registers to their original values and then return.

The print space subroutine at line 2500 is the first of our subroutines that will actually write something out to the printer. Here, in line 2500, we get the address of the port labeled SCPRT, and put it into the C register. The next line will then output whatever value is in the accumulator. In this case FEH, 1111 1110 binary into the port whose address is in the C register. This merely turns on the LED, driver to the signal, and out to the hardware section. Next, in line 2520, we load a delay value into the accumulator and then jump to the delay subroutine. On return, we zero-out the accumulator to release the sendox in line 3560. Next we implement another delay so that sendox has time to go back to a resting position. These delay times were chosen for my particular printer so that a firm pull-in is realized without multiple spaces being printed.

Converting to other computers

Generally this interface can easily be used on other computers, but you need to know your system. You must be able to determine the address and data bus of your computer as well as the signals that can produce the equivalent of an interrupt, in, and reset. The in and signals usually are a combination of the i/o signal and a read or write signal. You will also have to find a five volt supply, either in the computer or by purchasing or building one. A Z80-based computer has these signals at the microprocessor as IOB, IOA, and WR; they may or may not be combined and named as out or in. Other microproces- sors have them as well, but their names may be different — check with your computer manual to find out where they are located. The printer port usually has data lines and some control signals, but generally they don’t have address. Once you know the location, the next step is to find a connector that will connect to your computer interface port. From this point on, the hardware is relatively simple.

The software may be more difficult to convert. If you are not an assembly language programmer, you may want to find a friend who can. You should also have an editor/assembly program. Without one, a conversion may be very long process. Z80 and 8080 computer will have little problems in conversion. But again, you may have to be friendly with your own system. You should determine your normal printer driver is located, and it is essential that your computer is able to use another printer driver. It isn’t too difficult to modify the editor/assembly’s print routine. It’s just a matter of changing a few convolution codes to transfer to use this interface. The location that your present driver will have to be changed to point to this new one. If your system has a printer control block which holds this printer driver, then you will have to change the page count, etc., then there is no problem. If not, you’ll have to create one.

Next you will have to be sure that the port addresses in the program will not conflict with any existing ports in your own system. If so, you will have to change some of the hardware logic decoding, but this is not difficult.

To use other microprocessor based computers requires re-writing all the code to do the same functions as the 280 code. Here you need to know not only your own machine but also other microprocessor/assembly language systems, also the 8080 code.

LITERATURE RECEIVED

Gould Activator has issued data sheets describing a range of zinc-air button cells. Said to offer long life, high energy density, and to operate in ex- tended shelf-life. Suggested uses range from hearing aids to computer use. Gould Activator UK, 11 Ash Road, Wrex- ham Industrial Estate, Wrexham, Clwyd LL12 7UF.

The 1983 catalogue from Lambda describes the company’s range of power semiconductors and d.c. power supplies. There are many pages of application notes. Lambda Electronics Co., Abbey Barn Road, High Wycombe, Buckinghamshire WP4 1EE.

The Zevac range of desoldering tools in- cludes hand-held tools capable of removing multiple devices even from multi-layer printed circuit boards. For static-sensitive components there is a low-voltage model powered via an isolating transformer. Further information from Tony Chapman, Electronics, Electron House, Hennell Street, Epping, Essex CM16 4LS. WW402

The latest edition of the RS Components’ book has over 400 pages. Among many new products are a speech-synthesys system, a 16A mains plug incor- porating a multi-breaker, ferrite cores for switch-mode power trans- formers, 312andi f t i m e l a g s, and an installation-displacement wiring system. RS Components Ltd., P.O. Box 477, 13-17 Epworth Street, London EC2P 7JA. WW403

www.americanradiohistory.com
Cellular satellite

While the UK is planning the introduction of a network of small-amplitude radio systems for areas of high population density, NASA has been petitioning the FCC for use of the same frequency to reserve frequencies and define conditions for a satellite-based cellular system that would cover remote and sparsely-populated rural areas using frequencies between 400 and 900 MHz. NASA, in association with the Canadian government, plans to launch an experimental MSAT-X in 1987 using 311-825 MHz and 866-970 MHz. This would have a 10-metre u.h.f. satellite providing six spot beams, four directed at Canada and Alaska, and two at the USA.

The satellite would augment urban territorial cellular-type systems, but it would be used only by mobiles outside the range of ground-based transmitters. The main data base in which mobile locations are 120 km would direct calls to a satellite wherever appropriate. Territorial networks would have microwave feeder links with the satellite.

Japanese firms are beginning production of 900 MHz compact transceivers for the new "personal radio service", and one way or another it looks as though 800-900 MHz will soon be heavily used for mobile and personal radio systems.

Microwave or u.h.f.?

It is often claimed that 2 GHz seems to be a very attractive frequency band for mobile use. Is it? In any case, it is internationally internationally recognized that the boundary between u.h.f. and l.f. falls at 30 MHz. Some consider that only systems above 1000 MHz could be considered as mobile satellites.

Higher radar frequencies are reaching the high stratosphere, but until recently there was no evidence of terrestrial cellular-type systems, but it would be appropriate. Terrestrial networks would have their use in the form of multi-mode airborne radar systems, but it would be a good way to achieve high-quality images with high-bandwidth signals.

In 1993, 575 MHz transmitters at a distance of 168 miles and so conclusively demonstrated that terrestrial covering means that signals on these frequencies were not, at previously believed, limited to the optical line of sight.

Man-made problems

It is not only in the UK that amateurs are finding that the problem of operating a radio station in a residential or urban area appears to be growing. The problem is not peculiar to the UK, but is being experienced in many other countries.

Some American amateurs are finding that they are having trouble getting permission from their local authorities to operate on frequencies near or at 144 MHz. This is causing some concern among those involved in the field. The FCC is considering the elimination of all licensing for c.b. operation. In addition, the propagation over the years has been very poor, with the exception of some cases of propagation that were observed in 1972 and 1983. However, the propagation over the years has been very poor, with the exception of some cases of propagation that were observed in 1972 and 1983. However, these cases have been limited to propagation over the years.

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The problem of interference to Band 1 reception caused by visual display units, the question of the future use of Band 1 frequencies, surveillance, covert propagation and the use of miniature receivers with scanning facilities... terrestrial wireless telecommunications, are being considered to be returned to the levels experienced in the 1950s and 1960s. However, it is not only in the UK that amateurs are finding that they are having trouble getting permission from their local authorities to operate on frequencies near or at 144 MHz. This is causing some concern among those involved in the field. The FCC is considering the elimination of all licensing for c.b. operation. In addition, the propagation over the years has been very poor, with the exception of some cases of propagation that were observed in 1972 and 1983. However, these cases have been limited to propagation over the years.
Semiconductor noise analyser

Measures voltage and current noise densities of devices from 0.1Hz in decades to 10Khz.

by Ian Marshall and John Brydon

A brief summary of the noise sources is given here; for more detailed information the reader is referred to the literature contained in References 1 to 5. The three main sources are:

- Johnson noise, which arises from the thermal agitation of the charge carriers and leads to a noise voltage $v = \sqrt{4kTBR}$ in a bandwidth $B$ across resistance $R$;
- shot noise, which is brought about by the discrete nature of the charge carriers giving rise to a noise current $i = \sqrt{2eI}$ where $e$ is the electronic charge and $I$ is the mean current flow;
- flicker ($1/f$) noise, which dominates the low-frequency behaviour, its spectral noise density increasing as $1/f$.

It is largely due to surface effects in semiconductors.

In junction FETs (Fig.1(a)), there is Johnson noise in the resistive (source-drain) channel, of order $\sqrt{4kT/2R}$ per root Hertz. There will also be shot noise in the gate current, $\sqrt{2eI}$ at frequency $f$. Since $I$ is typically a few $\mu$A, $i$ is extremely small (0.01pA).

Fig. 1. Models of a FET, a bipolar transistor (b) and an op-amp.

- Bipolar transistors (Fig.1(b)), shot noise in the base current is developed across the input resistance ($r\approx \frac{Vb}{Ib}$). Shot noise in the collector current is represented by an equivalent noise voltage at the base ($V = \frac{V}{\sqrt{2r}}$); and there is a further contribution from Johnson noise in the base resistance $R_b$.

At low frequencies (<1kHz), flicker noise becomes significant.

Both authors are in the Department of Medical Physics and Medical Engineering, Edinburgh Royal Infirmary.

Noise characterization

The information required for a full noise characterization of a semiconductor device is the spectral density as a function of frequency. The total noise is then found by integrating the spectral density over the relevant bandwidth. Unfortunately, these figures are not always readily available from manufacturers' data sheets. For example, it is quite common for a noise figure (in dB) to be given without clearly specifying the bandwidth or source impedance appropriate to the measurement.

Furthermore, a broadband figure intended for audio-frequency users can be misleading for low frequency measurements (<1kHz) design calculations, as Fig. 2 illustrates.

This shows the form of the voltage (or current) spectral noise density $(s_n/d)$ of a typical op-amp (see also Fig. 1(c)). At higher frequencies, the n.s.d. is independent of frequency and relatively low in amplitude; this is referred to as the "white noise" region. However, at lower frequencies the n.s.d. rises as the frequency decreases, following a $1/f$ law. The intersection of the asymptotes, the "corner" frequency, should usually be below the signal frequency otherwise noise can become troublesome in critical applications.

The lower the s.n.d. amplitude is below the "white noise" region, the lower the corner frequency, the better the op-amp can perform at a low-level amplifier.

Fig. 2. Spectral noise density of typical op-amp.

Noise in bipolar transistors (Fig.1(b)), shot noise in the base current is developed across the input resistance ($r\approx \frac{Vb}{Ib}$). Shot noise in the collector current is represented by an equivalent noise voltage at the base ($V = \frac{V}{\sqrt{2r}}$); and there is a further contribution from Johnson noise in the base resistance $R_b$.

At low frequencies (<1kHz), flicker noise becomes significant.

All resistors generate Johnson noise, and, apart from wirewound and bulk metal resistors, the base resistance $R_b$. At low frequencies, the base current noise is developed in the base resistance $r_b$. For example, it is quite common for a noise figure (in dB) to be given without clearly specifying the bandwidth or source impedance appropriate to the measurement.

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Fig. 3. Block diagram of noise analyser.

Typical figures are 20nV/\sqrt{Hz} and 30Hz (quoted by Signetics for the 74151 chip) compared to 3nV/\sqrt{Hz} and 2.7Hz (the manufacturer's noise voltage for the OP-27 chip). The noise analyser enables the s.n.d. to be measured at spot frequencies of 0.1Hz and decades to 10KHz. The circuit under test can be configured to allow its voltage noise and current noise to be studied separately.

Figure 3 shows the noise analysis system. Connected to the circuit under test, it consists of a low-noise preamplifier stage with fixed gain, followed by a switched gain stage and a bank of bandpass filters feeding the r.m.s.-to-d.c. converter circuitry. The source resistance $R_s$ may be shunted to allow measurement of the front end noise voltage. With $R_s$ in circuit, the resulting noise is the r.m.s. sum of voltage, current and resistor noise.

$$V_r^2 = V_n^2 + i^2R_s^2 + V_b^2$$

**Circuit function**

The test circuit output is taken to a preamp, shown in Fig. 4, which has as its first stage an OP-27 ultra-low-noise op-amp. This is followed by two further gain stages and buffers, which altogether provide a voltage gain switchable from 100 to 10,000 in 1.25 steps.

The amplified noise "signal" from the front end is passed to six "biquad" bandpass filters, having centre frequencies of 0.1Hz, 1Hz and successive decades to 10kHz. The bandwidths and passband gains of the filters are scaled such that the gains decrease as the square root of bandwidth; the requirement for equal amplitude outputs when fed with broadband white noise. To arrive at spectral noise density figures it is thus possible to divide all six outputs by the same constant and obtain directly readings in terms of $nV/\sqrt{Hz}$.

The filter outputs are selected as required by a rotary switch and applied to an r.m.s.-to-d.c. converter which drives a meter calibrated directly in spectral noise density, with a full scale of 100nV/\sqrt{Hz}.

The reading is divided by the gain switch in (between 1 and 100) to arrive at the noise present at the noise analyser input socket.

A seventh position (TEST) of the rotary switch is used to calibrate the HAD output of the circuitry, the preamplifier being the r.m.s.-to-d.c. converter. By cancelling the filters, a monitor output socket is provided to enable viewing, with an oscilloscope, of the signal reaching the meter drive circuitry.

Circuit description

**Preamplifier.** The first stage in Fig. 4 uses an OP-27 low-noise amplifier which, together with its input bias resistor, is the limiting factor in the measurement of test circuit noise. Its "white noise" voltage spectral density is typically 3nV/\sqrt{Hz}, extending right down to 2.7Hz, while the integrated low-frequency voltage noise from 0.1Hz to 1Hz is typically 90nV. To this must be added the current noise developed across the input bias resistance ($R_b$), and the thermal noise of the resistor itself. The 1MΩ resistor will normally be shunted by the (low) value of the output impedance of the front end; and the specification gives the equivalent noise for a grounded input.

In the second stage, a low-noise buffer with a gain of 5 in a.c.-coupled to the first stage and thus allows input offsets of up to ±250nV from the test circuit. The diodes limit excessive voltage swings and allow it to come out of saturation more quickly.

Type 3140 op-amps are used for the rest of the circuitry, the preamplifier being a seventh position (TEST) of the rotary switch is used to calibrate the HAD output of the circuitry, the preamplifier being the r.m.s.-to-d.c. converter. By cancelling the filters, a monitor output socket is provided to enable viewing, with an oscilloscope, of the signal reaching the meter drive circuitry.

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Type 3140 op-amps are used for the rest of the circuitry, the preamplifier being
completed by an inverting stage with gain and dual buffers after further a.c.-coupling.

**Calibration**

Each filter input resistor \( R_f \) (in Fig. 5) is made variable to aid calibration. If a bandwidth noise generator of known spectral noise density is available, then this can be used to set up the filters. Otherwise, the best method is to measure the -3dB points and then scale the peak gains accordingly: that is, Gain = \( 100/\sqrt{10} \) V to the "CAL IN" socket provides buffered unity gain to the filters, the gain control being inoperative if this is selected.

(1) The device to be investigated is set up with a gain of typically 20 to 100 (see Fig. 7). For op-amps, the non-inverting configuration is most convenient since the source resistance \( R_s \) can be varied independently of the gain. As with any amplifier stage, the following procedure must be taken:

- the gain-bandwidth product of the device should not affect the selected gain at the measurement frequencies of interest;
- the input impedance of the circuit layout (typically a few pF) may limit the high-frequency response of the circuit under test when very high values of \( R_f \) are used. This effect can be tested by applying a sinusoidal signal in series with \( R_f \), and sweeping through the frequency range to investigate the fall in gain. This factor can then be taken into account during noise measurements, or measurements can be restricted to lower frequencies.

(2) Select \( R_f = 0 \) by shorting the source resistor to ground. This enables the input noise voltage to be measured.

(3) To avoid overloading the first stage of the noise analyser, check with an oscilloscope that the broadband noise output is in the range 100V/10V (r.m.s.), and that the d.c. offset at the output is less than \( \pm 250\mu V \).

(4) Connect the test circuit to the Input socket of the noise analyser, and switch the gain control to the minimum.

(5) At each selected frequency, the gain control is adjusted until the Monitor Output signal is in the range 14V pk-pk. It will then be necessary to wait about 20 seconds, the time constant of the AD336 circuit, before a reading can be taken. At 1kHz and below the reading will be seen to fluctuate due to the lower frequency components of the noise, and an average must be taken "by eye".

(6) This completes the readings necessary for an analysis of the noise voltage.

(7) Now switch in a source resistor \( R_s \) to obtain noise levels at least twice as large as before, and so enable separation of the voltage and current contributions: \( 100k\Omega \) is suggested as an initial value. Devices with very low current noise (e.g. JFETs) may require large values (but see precautions above regarding input capacitance). Wirewound resistors are recommended as they produce no significant component noise above the thermal contribution. The front end output should always be less than \( \pm 250\mu V \), and it should be shielded to eliminate mains interference.

(8) Step 5 is repeated with \( R_s \) in circuit.

(9) Steps 7 and 8 can be repeated with different values of \( R_f \) as required.

**Operation**

The meter reads directly in pV/VHz. Calibration measurements can be restricted to lower frequencies.

**Analysis**

Each meter reading of spectral noise density is referred to the input of the device under test by division by the noise analyser switched gain (1 to 100) and by the test circuit gain itself. For example, on OP-37 with circuit gain 50, noise analyser gain 20, a reading of 20pV/VHz at 1kHz.

\[ V_n = \frac{V_f}{50} \]

**Fig. 8.** Spectral noise densities of four op-amps and a resistor plotting at frequencies from 1Hz to 10kHz.
Two simple modifications to the Wireless World decoder are described which enhance its operation and brings the performance closer to the standard of commercial units.

The W.W. Teletext Decoder still gives good service and, to those who have added the subsequent modifications to the equipment, provides the more recent facilities, has provided a performance close to that of commercial units. However, there are still some features outstanding which could ease page selection and improve acquisition.

Fig. 1 shows a modification to the remote control decoding board (W.W. May 79) which simply removes the necessity for any new page number selection to be preceded by a "Page" key depression. Operation is then identical to that of the Time mode (in terms of numeric key entry) which is unaffected. The number of key depressions is thus reduced and, to change magazine number only involves two key depressions e.g. from 100 to 200 requires '2' then 'Reveal'. A 4 input NAND gate detects the presence of the first digit (i.e. magazine number) of the new page number and simulates the reception of a page depression ("Page") key. The selected time-coded page. This is based on the general requirement that when the page headers stop rolling a clear cycle should take place before the new page is written into memory. This strategy enables the user to initiate a page clear cycle in the time mode which cannot be simply provoked by the normal clear page bit depression and is most useful when being used as a page selector.

The second modification is based on the remote control 'Spare' command. This is normally used by the 10 second pulse of (i) which minimises the risk of accidentally exciting the sound as two key depressions are then required for this function. The 'Spare' key may then be labelled 'S' which is pressed once for "Status" (revealing the cut-box information of (i)) and twice for "Sound Mute" which has a toggling action.

Operation is as follows. Receipt of a correctly decoded remote control command which triggers the 10 second timer output (403,6) via (305,1) (402,3) and (401,1). Triggering also occurs via (402,2) (78,6) goes high (i.e. stop roll headers), indicating that the newly selected page-time has been detected. The output is gated with Row 0 at (402,4) and, after buffering, sets the 'cut-box latch' at (51,10) which enables Row 0 to be visible in the TV/Text mode. Tr 1 is included to reset the timer period, thus allowing a full 10 second display from the last key depression. The 10 second timer output is also gated with a 100ms spare command pulse at (402,4) which clocks the bistable (404,3). A buffered output is provided at (401,15) with the capability of driving a TTL input. In the author's unit, two spare open collector inverters were used to drive a green 'Mute' on led and a spare analogue gate. The pulse at (401,4) sets the selected page. It is still possible to be viewed whilst a new page or time is displayed in the selected (sub) page, and is most useful when being used as a page selector.

Referring to the original circuit, the 054B9 hex buffer which incorporates a bistable is no longer required. The new circuit requires the removal of the IC10-51 and 78,14 types. The circuit of Fig 2 may be built on a small piece of vero board approx. 5cm x 5cm and the number of interconnection, may be kept to 13 (including power). If the 054B9 is removed the necessity of having to replace existing ICs 51 and 78,14 is eliminated. The circuit of Fig 2 in its final design and all the other authors for their contributions.

source resistance (Rj). One such graph is prepared for each measurement frequency, with volts being calculated from the measured values of v0 and i, using (1). Immediate comparisons are possible if the results from several devices are plotted on the same graph.

Reproduced below is a selection of graphs covering 1Hz to 10kHz, and comparing the following op-amps: 741, "industrial standard" bipolar input type. 3140, fet-input type. Very low current noise but poor voltage noise. OP-07, low-noise bipolar type. OP-37, ultra-low voltage noise, but poor current noise.

Using the graphs readily allows the best device to be chosen for a particular application (all other considerations being equal), or to see what trade-offs result from using alternative devices.

Specimen graphs

At low frequencies, the OP-37 has the lowest noise (approximately 100nV/√Hz) for source resistances up to a few kohms. Above this, the OP-07 is best until around 100 kohms, where the 741 almost matches its performance. For Rj greater than 1MΩ, the 3140 input comes into its own, contributing the lowest noise (~ 800nV/√Hz).

There is less difference between the various devices at frequencies of 1kHz and above. The OP-37 still provides the best performance for Rj up to 20kΩ, after which the 07 and 3140 are about equally good at Rj = 200kΩ. For source resistance greater than a few hundred kilohms, the 3140 once again becomes the best device, adding little significant noise to the thermal noise of the source itself. At 10kHz, the OP-37 is still the lowest noise op-amp studied for Rj less than 20kΩ. The other three devices are all comparable for Rj up to 200kΩ, above which the fet-input of the 3140 once again provides the best performance.

For applications requiring low source resistances, say less than 10kΩ, the OP-37 can be used to advantage. For source resistances higher than a few 10kΩ, the 3140 has the best noise characteristic because of its fet input. Overall, the 741 performs very well, being almost as good as the OP-07 "low-noise" op-amp except at low frequencies.

Fig. 1. Simple additions and removals from the remote control board reduce the number of key depressions for page selection.

Fig. 2. On the same board as Fig. 1, these additions enable the viewing of the tv picture while the page is being selected; the generation of a clear page picture when the selected page is detected and the choice of a sound mute facility.

References
10. AD536 Data Sheet. Analog Devices.

Fig. 3. On the same board as Fig. 1, these additions enable the viewing of the TV picture while the page is being selected; the generation of a clear page picture when the selected page is detected and the choice of a sound mute facility.

WIRELESS WORLD MAY 1983

WIRELESS WORLD MAY 1983
Microprocessor voltmeter has eight channels

Some circuitry used with single-chip microprocessors requires processor time to enable controlling functions. It makes more sense to use processor time for important functions and allow peripheral circuitry to work by itself until an input or output is called on.

The single chip microprocessor is finding its way into more and more of today's products and as such, some circuitry used with the microprocessor requires processor time to enable controlling functions. It would make more sense to use processor time for important functions, allowing the peripheral circuitry to work by itself until an input or output is called on. Such circuitry can be in the form of latching multipliers, d.v.m. chips, and telephone diallers. With this in mind, this eight-channel d.v.m. was designed using a Z8 microprocessor with DG528 multiplexers and an LD120, LD121A d.v.m. chip set, the last-mentioned two chips relieving the

microprocessor of the a to d conversion.

In the configuration used, the digital voltmeter has a full-scale reading of 1.9999V, but even when it over-ranges, indicated by a blinking on the local display, the reading is still obtained and can be displayed by the Z8.

Interfacing of the LD121A to the Z8 is achieved with the use of one or-gate, IC4. This gates together the outputs of digit strobes D1 to D4. The LD120, LD121A require ±12V and ±5V to operate, available from the Z8 power supply. The clock required is approximately 16.3kHz, generated by IC4, to save tying up one of the Z8 internal timers.

The LD120/LD121A are allowed to free-run and the start conversion pin is left to float. The d.v.m. samples the input voltage approximately ten times a second. When a reading is required by the Z8, the appropriate channel has to be selected. To

displayed by the Z8.

Nigel C. Gardner
This section looks at 6805 microprocessor instructions and how they are represented. Each assembly-language instruction consists of an operation-code mnemonic, of which there are 61, which produces one machine-code byte when assembled. The instruction indicates the addressing mode to be used (which modifies the op-code byte) and may also require an operand giving either data or an address.

A one- or two-byte data or address in the operand is added to the op-code to complete the instruction hence each assembled instruction will be between one and three bytes long. To be able to program in assembly language one has to learn how to use the various instructions and this is best done by trying them out in small programs on the Picotutor and seeing how the operations modify data. But it is not essential that you become familiar with every instruction before starting out; programs can be written using a small proportion of the instructions. Some instructions are used more than others, and some hardly at all. Emphasis here is placed on the most commonly used instructions; instruction tables published in the April issue of Wireless World or by Motorola in the MC68070PS data sheet and MC68070PS(AC1) reference card are needed. Instruction functions fall into one of five categories.

Register/memory

The application shown here uses the d.v.m. board to monitor eight channels, each given a fixed minimum and maximum in the program. This could be modified to allow the user to input the values when the program is executed. When a reading falls out of range, the minimum and maximum values are displayed on the terminal. An additional program for dialling up on a telephone line when the minimum and maximum values are exceeded could be incorporated, to send an alarm message to a host computer.

Remote display interfacing circuits use either common anode led displays, giving ±28,672 counts maximum without blinking (BS257 when common cathode displays, giving a maximum count of ±19,999 with blinking bottom)

The d.v.m. board is now ready for interfacing to the Z80. The appropriate Basic program can now be entered using the machine-code program, which when run will display the voltage appearing on the selected input if outside the preset values.

Applications

Look at the full memory map of 000 to 7FF, e.g.

Table 1 (use addresses between 24 and 48F)

In his third tutorial, Bob Coates illustrates how before writing assembly-language programs one must understand microprocessor instructions; but only a few of these need be learnt to start programming, as Bob Coates illustrates in his third tutorial.

by R. F. Coates

The interrupt instruction SWI passes control back to the monitor when the program run is completed in the same way as the JMP 60 instruction used earlier but it also places the contents of the processor A and X registers, condition codes and the address of the instruction following SWI in a temporary store called the stack. This information may then be retrieved and displayed on the Picotutor using the register function (reg) which is especially useful to program debuggers since SWI interrupts may be placed anywhere in the program allowing the register status to be examined at each point.

Pressing the register key after such a break has passed control back to the monitor, who will display the condition codes as five bits (H, I, N, Z and C). If the letter is displayed the bit is set (1); if a dash is displayed on the bottom line the bit is clear (0). Pressing the step-up key will reveal the register indicated by letter H.

Another step up will show the three-digit program counter value indicating the address of the instruction following the SWI interrupt which caused the break. A final step up returns the stack-pointer position which indicates the position before the interrupt was encountered.

This is because the stack pointer is moved down when the SWI interrupt routine calls the e.p.m. registers. Pressing any key will return the dash prompt.

Direct. This version of the LIA instruction loads the accumulator with the contents of the memory location between 000 and OFF as in

B680 LDA $80

In this example the accumulator is loaded with the contents of address 80. Again two bytes are required, one for the op-code and one for the two hexadecimal digits of the page-zero address. The absence of a hash symbol in the operand field indicates that direct (or extended) addressing is to be used. Try running this instruction followed by SWI on the Picotutor, and the accumulator should be loaded with 08, which is part of the e.p.m. monitor program.

Extended. This is similar to direct addressing except that two address bytes are required to allow access to any location in the full memory map of 000 to 7FF, e.g.

C6080 LDX $60

is the same instruction as in the direct-address example above. As extended-mode addressing expects two bytes following the op-code byte, much additional packing is needed. The assembly-language mnemonic and address are written in the same way for both direct and extended modes.

A computer assembler will look at the source code instruction to see if direct addressing can be used. If it cannot, i.e. the address is above OFF, extended-mode addressing will be used. The same principle applies when assembling by hand.

*If Picotutor does not display the stack pointer but returns the dash prompt after the program has been run, check that the program memory area (which only displays registers if SWI is not placed in a subroutine).
Use direct mode wherever possible because it uses only one byte of memory space. In the previous example direct mode would be used although extended mode was used. In this example extended mode must be used.

Try running this (followed by SWI) and it will load the accumulator with 02, again exactly the same way as LDA so this mode gives access to the index register. This mode gives access to the first 256 memory locations from the table.

Which of the three indexed modes to be used, e.g. for the index register. Indexed, no-offset mode requires only the index register to point to the first value in address. Add and subtract instructions cannot operate on memory directly so the HL register pair is used as a pointer.

The indexed, 16bit-offset mode operates in exactly the same way as LDA so the contents of the accumulator in a memory location dictated by the addressing mode used, e.g.

The only exception is that immediate addressing cannot be used with this mode because the accumulator is incremented repeatedly, access can be gained to the successive values of addresses up to 256 long. This means that no addressing modes can be used with this mode.

Other instructions

The same basic principles apply to other instructions in section one if the instruction set, so for the other instructions we will just use one of the addressing modes to demonstrate the operating system. LDX, the instruction for loading the index register, has already been covered.

Store accumulator, STA. This stores the contents of the accumulator in a memory location dictated by the addressing mode used, e.g.

It should give the same results as in the previous example.

and then examine the registers. Index register will store the accumulator contents in address location 40+7. The only exception is that immediate addressing cannot be used with this mode because the accumulator is incremented repeatedly, access can be gained to the successive values of addresses up to 256 long. This means that no addressing modes can be used with this mode.

Other instructions

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Store accumulator, STA. This stores the contents of the accumulator in a memory location dictated by the addressing mode used, e.g.

The cost of developing control software and language application packages is the reason why low-cost microprocessors have become so successful. It is not that a microprocessor has no limitations, but that the software support of the PDP-11! Further, when designing a home computer from the scratch one does not have the support of other computers to develop the software on and one cannot afford to design the software alone. For these reasons the control program was chosen from those already available. This also applied to the choice of language. I was not willing to start from the bottom and design the whole system but it's 'hooks' which allow it to be expanded into a multi-operation, multitask system. A single operation system is restricted by the combination of the programmer's knowledge of Forth and the abilities of the computer. Then a minicomputer costing tens of thousands of pounds would have a processor is the same as for the index register.

Memory size: 56k (64k ram, 8k rom)

Memory speed: 66ns

Access time: 4.6us

Input peripherals: parallel standard keyboard (RS232)

Output peripherals: parallel standard printer (RS232)

Disc storage: 2000byte/sector

Cost: $2000

53
Having worked in Hewlett Packard's production and systems-engineering departments, Brian Woodfrede currently works with the company's South Queensferry research and development group and has recently been involved with designing the microprocessor control section of the HP37245/25/26A baseband analyser. Brian obtained a BA degree in engineering and economics at Downing College, Cambridge in 1970 and an MA in 1979. His computing interests include real-time control, languages and microprocessor graphics but outside electronics, his main interest is rifle shooting, in which he has represented Scotland in full bore - has been curtailed through part-time studies for an M.Sc degree in computer systems engineering at Edinburgh University.

Machine code in the computer emulates Forth operation, the Y register taking on the role of the Forth program counter, and the Forth instruction-fetch cycle is a 'next' machine-code routine. So you can see that the processors choice is dominated by the speed and memory cost of the 'next' operation. Equivalent Forth 'next' operations for some microprocessors are listed below. Because the 8089 'next' operation is so short, it may be copied in line as required resulting in improved performance thrown avoiding the JMP NEXT instruction required for most processors.

Secondly, the 6809 instruction set is particularly suited to code the crucial Forth word 'next'. The speed at which 'next' is executed determines the performance of the Forth system since this word controls the indirect-threaded code. 'Next' is called the inner (or address) interpreter to distinguish it from Forth's text interpreter which performs the function of a compiler.
The 6809 processor with gates used to form Vee Vee Vbb -5v used for refreshing the dynamic ram contents. Other timing signals coordinate the system.

Timing generator

Row address generator

Column address strobe generator

Address decoding

Wait-state generator

C.p.u. section of the Forte computer showing the 6809 processor with gates used to form timing signals and memory-address decoding. Row-address-strobe, column-address-strobe and multiple signals are used for refreshing the dynamic ram contents. Other timing signals coordinate the system.

Memory and RS232 circuits. One device in each of the three banks of dynamic ram (only one bank shown) is used for parity checking.
Having chosen Forth and the processor to run it on, other design requirements are naturally determined. These were selected to maximize the number of peripheral devices that can be easily driven. First a floppy disc was included to provide a mass memory, at least as fast as a magnetic tape recorder, with much faster operation than tape recorders. Mini floppy discs were chosen for two reasons. Firstly, they are cheap and secondly because the data rate of eight-inch discs is much higher than, and more recently introduced SOSS devices noted has an 8-bit arithmetic and logic unit (ALU). (1)

Peripheral performer

CABLE AND AMATEURS

As our very good friend Peter Hawker (GIV) has mentioned in previous issues one question of the cable tv (c.a.t.v.) being installed for tv links and its possible (GIV)istance to the amateur bands between 5MHz and possible infinity (GIF) is looming. With the recent beginnings of the RFI Bill 5.929 last September, it would appear that we 're in the same situation as if a干扰 was dragged out some time. Naturally, as I am the only person who is going to write up this problem in the "Letters". The problem is rather important to the amateur and could almost be written in some of the J. K. H. Communications and satellite TV.

RETHERICAL PHYSICS

Of those of us who are approaching the age of 80 can hardly bear to wait a month to find out what kind of New Year's idea is going to turn up in the "Letters". With all the ideas we are losing out to progress without the parties must get together quickly. It not only affects the amateur and/or industry-at-large but in some cases the J. K. H. Communications and Home Office.

ELECTROMAGNETIC DOPPLER

In your March 1983 issue, your correspondent J. Kenneth asks how the Doppler shift is produced in electromagnetic waves. Specifically quote the references to the above caption at the end of this issue. J.A. Holmes, G4KMS Emergency Station, London.

STEPPE MOTOR DRIVE

The "Steppe motor drive circuit" article (I.F. Potter) describes the circuits of one-off applications which is certainly not new. I.e. an electric motor drive circuit, whilst efficient, was not only a one-off effort but also very expensive to reproduce (up to 4MHz) when fitted to a circuit, so I designed a compact polycarbonate circuit using the same principles as in Mr. Bailey's article. A simplified circuit is shown below, it is a standard high-precision real time set at one second per hour. Vcc, and gated by the pulse train to pin 8. One circuit is required for each phase of the motor which in this case is a large V.E. Type.

This circuit has been in use since early 1971, I had no reason to suppose it was novel. B. S. Beddoes, Windsor, Dorset.

References

2. Forth Interest Group (FIG), PO Box 1105, San Carlos, CA94070, USA.

Cable and Amateurs

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Electronic Magnetics

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Steppe Motor Drive

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Since this approach relativist Doppler shift equation and aberration equation. Thus having both are entwined by relativity one never has to ask the questions I have raised. Now the relativistic Doppler equation is written

\[ \frac{v}{c} = \frac{v}{c} \]

The second term is time dilatation, which for modest values of \( \nu \) is equal to unity. My question is: what is the consequence of time dilatation? It is the first term which appears to be the most difficult in the mathematical sense and the same is true of both observers is effectively stationary in their frame of reference at one another. Time dilatation is the consequence of different observers having different frames of reference. And if the first term is due to a difference in velocity of wave of light is due to a difference in the time since time dilatation is the same wave. They both observe that it is travelling at the same velocity relative to them, yet the difference in frequency because their clocks are ticking at the same rate. But whose clock is ticking faster. It depends on which observer is using the clock to decide which one gets to the destination first and in this way we get the mathematical absurdity.

\[ \frac{v}{c} + \frac{v}{c} = \frac{v}{c} \]

This type of "paradox" has been mentioned in W.F. before but such a result must be rejected because it doesn't conform to the laws of mathematics, as the attempt to use the same numbers, as in W.F. case are in automatic mathematical law.

Appendix

For these unfamiliar with this piece of evidence the idea in that if the velocity of light was constant there would be no question as to why the change from a star in a binary system which is travelling towards us would tend to speed up that from the star going away from us with the result that their observed orbits would seem irregular. Sitters observed double stars and no orbital irregularity. I have yet to find out where in his text book these observations took place, the magnitude of the published programmes was sufficient to record a reasonable, and why didn't he get a Nobel prize for this obviously valuable work.

C. R. C. Sitters

DIMENSIONS

The authors who appear in the letters in Wireless World on the validity of discussing the validity of the concept of "dimensions" in e.m.u. and e.s.u. systems and their present sway skewed symmetry appealed to the astrophysicist who counselled me on the meaning of the symmetries. At that time the standard technique seems to be to ignore such evidence: most books seem to be very bad guides to the world. I have found in my reading that of star aberration. In 1729 Bradley showed that the "paradox" has been mentioned in W.F. before but such a result must be rejected because it doesn't conform to the laws of mathematics, as the attempt to use the same numbers, as in W.F. case are in automatic mathematical law.

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physical entities having real, free-standing existences independently of each other and of any observer, human or deity. Such a paradigm fails to provide any account even of the simplest interactions between such entities, and I am afraid it suffers the same fate as all other attempts to explain the obscure in terms of the more obscure.

Indeed, this must be the fate of all attempted explanations which may be produced in accordance with Dr Murray's own criterion of demarcation between physics and mysticism (physical phenomena to be physically explained). Thus, any attempted physical explanation will involve physical phenomena, but the criterion demands that these be explained physically, and so we either end up with an infinite regress or (a circularity) of physical explanations after all with something that is not explained at all, or at least not physically! I think we need a better criterion for scientific acceptance.

In summary, I am afraid that Dr Murray seems to show basic confusion about what is and is not capable of being measured and explained by a physical theory. I am unable to say what is the essence of a better approach to making, using and understanding theories, but anybody who would like to discuss this with me at any time will be very welcome. I do very well believe, to consider the views of Frank Newton, which are expressed above, to be based on the nature and origins of the interactions involved as the phenomena of universal gravitation, for which he had provided his celebrated mathematical account: (Concerning such matters) I trust he would not consider me to be bound by anything not implied by the phenomena as it is to be considered a hypothesis; and hypotheses, whether physical or metaphysical, whether of occult things or mechanical, belong to the methods of philosophy.

However, "experimental philosophy" is none other than what we now call science. I suggest that hypotheses, which are physical or metaphysical, also have a place in a scientific journal such as Wireless World.

Terry Stansfield
Wimbledon
London SW19

WIRELESS WORLD MAY 1983
Sound-generator interface

With a minimum of components, this circuit produces signals required to interface the General Instruments ZY-4910 sound i.c. to standard 8bit microprocessor buses using a single m.a.i. — t.i.l. device. The output enable of the 74153 dual 4-to-1 multiplexer i.c. provides an inactive bus-control state for the sound-generator i.e., which is disabled when its bus-control inputs are low.

When selected, the multiplexer behaves as a simple ram addressed by A0 and the status of the R/W line, producing outputs determined by the logic levels on the 74153 inputs. In use, one writes the port address to an odd location and one reads or writes data from an even location.

Resistors shown are pull-downs required if a 74LS253 is used, as this is a three-state output device. A version using a 74LS253 has successfully been used on a 4MHz Z80A system where it was mapped as an I/O port, the auto-wait state feature of the Z80 J/O port ensuring that the timing of signals is longer than the minimum specified in the data sheet. Another has been built into an M6809 system. M. James Herne Bay Kent

16K dynamic ram

Cost of this circuit, designed to expand the ZX81 memory by 16K, is around £10 as opposed to between £25 and £50 for a commercial unit. Illustrating how easy it is to use dynamic ram, this memory may be used with any Z80 system with only slight modifications. I did not need a capacitor since my computer is in a large box.

Noise effects, generated by a NAND gate, O/P resistor and diodes, is not more than 3V and this is sufficient. Positive supply to gate of the 4114 is taken from the raw supply, hence the 100µF smoothing capacitor.

R. Merson Taunton Somerset

**Cascadable one-bit arithmetic module**

*The module shown adds one, subtracts one or transfers the input to the output. Cascaded modules, with Cc connected to Cn of a more-significant module, operate with binary-weighted inputs giving Q0 = Q0 + 1; Q2 = Q2 + 1 + Qn + N where N is plus one, minus one or zero.

There are two control inputs, C0 which selects add/subtract or transfer, and N which selects add or subtract. When operation is limited to +1 = 1, gate may be an inverter and when -1 = limited to zero, gate may be omitted. The binary-to-BCD circuit uses +1 = 1 for bits zero to two and +1 = zero for bits four to six.

R. Merson Taunton Somerset

Dividing by fractions. Some readers have found the 4722 timer used in this circuit idea (Jan. 1983) difficult to obtain. The 4722 may be replaced by an XR-2270 (Fair) or a 4722NO (Texas) without circuit modifications. An XR-2212, XR-215 or NE555 may be used in place of the p.I.

Continued from page 35 in terms of continuity — the potential can always be described in terms of position by means of a smooth, broadly-gener

...al mathematical curve. A barrier of this type must obviously be completely leak-proof, but this is not what is observed as Nature. The concept may sometimes suf

...ce to describe the behavior of matter in the vacuum, but it fails to take into account the essential granularity of matter on the microphysical scale. These barriers are

...composed of particles. The often-quoted tunnel effect is not to be explained as a manifestation of matter waves, mysteriously, but by a down-to-earth physical

...properties of the particles involved at particles, and of the real, physical forces that act between them. The insufficiency is not quite impervious to current, nor the radioactive nucleus quite stable, given time. That is what the quantum hypothesis implies, and its realisation defines the coverage re

...quired of any successful quantum theory of matter.

Now the failure of the wave theory which is evidenced here is a conceptual failure, far more serious than any exposi

...tional or mathematical failure. Instead of being just wrong the theory is seen to be useless to try.

The point may be paraphrased and repeated in

**metrically opposed in logic: any true quantum theory must therefore be the antithesis of any field theory, whereas electromagnetic theory often provides good and useful analogies, the wave theory of matter consistently offers bad ones. Over and over again we have been misled by it. It has proved to be a bad habit. Should we not consider giving it up?**

**Probably the most insidious of all Copenhagen doctrines is the doctrine of Complementarity, which was concocted to explain the dotting of the Observer with the aid of a liberal sprinkling of Indeterminacy. The idea was that as Nature is indeterminate and essentially statistical, and as (quoting Landé before his conversion) Einstein's quantum mechanics is "unphysical," it cannot work on situations that can never be observed, which is followed that the Copenhagen quantum theory, which incorporates these restrictions, must be "complete," which is the Ultimate Theory of microphysics.**

Einstein challenged this doctrine on general grounds on its first formulation, but the argument was side-tracked by Bohr into a discussion of the "correctness" of the wave-mechanics (which we can now see to have been an irrelevant issue), and see to have been an irrelevancy issue, and see to have been an irrelevancy issue.

**The point may be paraphrased and repeated in view of its philosophical importance. The so-called quantum theory of Copenhagen, involving as it does the concept (and mathematical equation) of waves in a continuous medium, is essentially a field theory. As such, it is not a true approximation of the behaviour of matter in bulk, but it is a true approximation of the continuity and any discontinuity "or quantum" phenomena.**

This logical contradiction, both as an expression of the concepts of Niels Bohr, lies at the very heart of the Copenhagen aberration.

- WIRELESS WORLD MAY 1983
- WIRELESS WORLD MAY 1983
Low-cost servo accelerometer

A design simple enough for home construction, yet capable of an accuracy better than 0.1% of full-scale. It can also be used as a precision force balance.

In recent years analogue and digital electronics have advanced very rapidly and it is now possible to perform complex measurements in electronic signals at low cost. Unfortunately these advances in electronics have not been paralleled by similar advances in the design of the transducers required to convert other physical quantities into electrical signals. It is particularly frustrating for an amateur to have a project which he can easily handle electronically but which is stopped by the high cost of suitable transducers.

The accelerometer described here was developed as part of a low-cost accelerometer and braking performance measuring instrument. Other potential uses include an angle-of-heel indicator for a yacht, a precision level, an earthquake detector, or an alarm for a home intruder alarm based on measuring the deflections and accelerations of the floor structure. The transducer can also be used to measure forces up to 0.1 newton (0.02 lb) directly, or higher values if a suitable lever system is added. In addition to the obvious application to weighing machines the force measurement capability could also be useful for the measurement of low velocity air, where the drag of a small vessel could be sensed, and for pressure measurements where a flexible diaphragm could be used to convert the pressure to a force.

Operating principle

The transducer described is based on the servo-balance or force-balance principle. A mass is suspended by a system of flexures which constrain it to move relative to the transducer body. Minimum movement of the mass will be measured in exactly the same way as an applied acceleration.

This simple system would tend to oscillate at a frequency determined by the size of the mass and the stiffness of the feedback system. To cancel this it is necessary to include some mechanical or electrical damping. It is common practice to produce at least some of the damping electrically by incorporating a phase-lead network in the servo amplifier. The servo loop should have the highest possible gain to produce the greatest effective stiffness and therefore the highest frequency response and smallest movement of the suspended mass. Minimum movement of the mass is important because the linearity of all practical force generators deteriorates with displacement. The highest gain that can be used is usually limited by stability considerations.

Transducer construction

The transducer design was prompted by the realization that the magnet and voice coil out of a loudspeaker make an ideal force generator. A general application to this type of force generator is described in an instrument patent by Roberto and Kapoor. The voice coil was fabricated from scraps of aluminium sheet, double sided printed circuit board, solder and epoxy glue. Figures 2 and 3 show the overall arrangement. The voice coil was then glued to the base board with the magnet gap concentric with the voice-coil windings. The voice coil assembly can now be mounted with a spacer of appropriate thickness and the base board so that the voice coil is axially centred in the magnet gap with the flexures undeflected. The spacer thickness may be determined by measuring the various pieces prior to assembly.

Fig. 1. Outline of the force-balance accelerometer. The a.m.f. generator sets to cancel movement of the mass resulting from acceleration of the transducer body.

Fig. 2. Mechanical arrangement of the transducer. The a.m.f. generator is adapted from a cheap loudspeaker unit of the type used in pocket radio sets.

by Neil Pollock
opto-interrupters can be fitted. The temperature compensation opto-interrupter is screwed to the base board with a pre-settable cut-off shutter made from thin aluminium sheet (Fig. 3). The active opto-interrupter is mounted on long screws so that its height above the base board can be altered easily. A thin aluminium foil attached to the centre screw of the moving mass (by tightening the nut firmly and then gluing it) extends to the gap in the active sensor. When in use the transducer should be enclosed in a box, both to exclude ambient light and to prevent metal particles finding their way into the magnet gap.

Circuit description

The circuit diagram for the servo-amplifier is shown in Fig. 6. The two opto-interrupter outputs are applied to unity gain buffers which drive a unity-gain differential amplifier. This amplifier feeds a passive lead-lag compensation network formed by C2, R2, C3 and R4 which in turn feeds a variable gain (0 to 60) amplifier. The output from this amplifier passes via Link 1 to a bridge-connected power stage. By removing Link 1 and adding Link 2, an additional amplifier can be brought into the circuit; the function of this amplifier is described below in the section on compensation. A circuit board pattern and component layout are presented in Fig. 7 and Fig. 8. It is possible to mount the circuit board adjacent to or remote from the transducer, according to the requirements of the application. The system output, which is the output voltage across R25, is

- Floating and not referenced to ground; a floating meter or a differential amplifier must therefore be used to measure this voltage.
- Since the opto-interrupters have widely varying current gains it is necessary to select the value of R1 for the specific components used. To do this the opto-interrupters as shown in Fig. 6 before mounting them on the transducer. With the optical path of the sensors obstructed, find the maximum value of R1 for which the output voltage on pin 4 of the less sensitive of the two sensors is less than 0.3V (measured with a meter with an input impedance of at least 1MΩ). The value of R1 found in this way is the appropriate one to use. The output voltage of the more sensitive sensor will be lower than the less sensitive one. To avoid damage to the sensors R1 should not be less than 200Ω.
- The sensor with the higher gain should be used as the temperature compensation sensor and the one with the lower gain, and therefore the greater linear range of operation, for the moving mass position sensor.
- When R1 has been selected the two sensors can be mounted on the transducer and connected to the servo-amplifier. The cut-off of the temperature compensation sensor should be adjusted so that the voltage on pin 4 is near 4V. The height of the position sensor above the base-board can then be adjusted so that the voltage on pin 4 is approximately 4V at mid-travel of the moving mass.
- With R2 set to zero, connect the voice-coil and then slowly increase R25 until the mass moves to either stop and stays there, the sign of the feedback is correct and the voice-coil connections must be reversed. If all is well the mass will assume a stable position between the two stops. As R25 is further increased the moving mass will probably start to oscillate, emitting an audible tone at 100 to 200Hz. R25 should then be reduced until the oscillation just ceases and then approximately halved in value. If necessary the height of the position sensor can be adjusted to centre the moving mass between its stops. If the arrangement of the transducer is similar to the one described this procedure should produce a system with good stability and performance. If the design is altered significantly the compensation network may require changing.

The prototype transducer had a full scale range of ±2G, or ±0.1 newton (±0.022lb) when used to measure forces. This range was selected so that accelerations of ±1G could be measured while allowing reasonable headroom to accommodate the electrical damping introduced by the phase-lead network. To increase the transducer range R25 should be reduced, taking care not to exceed the voice-coil dissipation limit. To reduce the transducer range R25 can be increased or the moving mass increased in size.

Compensation

The stability of a transducer such as this depends critically on the gain and phase-angle versus frequency characteristics of the servo-amplifier. This problem is dealt with in great detail by books on control system theory. In simple terms the amplifier must produce a phase-lead near the transducer resonant frequency to produce damping. Unfortunately all the networks which produce a phase-lead also introduce a rising gain with increasing frequency and this can lead to unacceptable low gain at
low frequencies. To overcome this problem some gain boost is provided, inevitably accompanied by a destabilizing phase-lag. Fortunately this phase-lag is not critical since the system has a considerable margin of stability at low frequencies.

The desired lead-lag compensation is provided by C1 and R4 for the lead and C2 and R6 for the lag. Two methods of arriving at appropriate compensation networks will be described, the first of which is suitable for constructors without access to normal test equipment. Leaving R4 and R6 at their normal values set a low value (22nF) to provide some minimal damping and C2 to a large value (47pF) to the lag compensation only has effect at very low frequencies. Increase R5 until audible oscillation occurs, or if it fails to do so increase the gain further by reducing R6. When oscillation occurs determine its frequency by comparing the note with a piano. Select C1 and C2 such that 1/(2πRC1) is about half the observed resonant frequency and R2C2 is between six and ten times R1C1. Then adjust R3 to about half this value which produces the onset of oscillation.

The second method of compensation is for those who desire a more detailed insight into the stability of the system and have access to an audio oscillator or square wave generator and an oscilloscope. To optimize the performance of a feedback system it is necessary to apply sinusoidal or step inputs and observe the system response. A suitable amplifier has been provided which can be inserted before the power stage by removing link 1 and inserting link 2 (Fig. 6). Since this amplifier inverts, the connections to the voice coil must be reversed when it is in circuit. Any signal (Test In) applied to this amplifier through a suitable resistor (R6) will force a current in the voice coil which can be regarded as an input acceleration. Under these circumstances the output voltage 'Test In' can be regarded as an input acceleration, and the system output effectively appears as pin 7 of IC2. With the aid of an oscilloscope or c.v. voltmeter or oscilloscope it is possible to measure the system frequency response. To examine the step response of the system, a square wave generator and oscilloscope are needed. Frequency response measurements carried out on the prototype system with various values of lead-compensation capacitor C1 are plotted in Fig. 9. For comparison the step response for two of the cases shown in Fig. 9 are reproduced in Figs. 10 and Fig. 11. The aim is to select a value for C1 which produces an acceptable response overshoot at the highest possible frequency. When changing C1 it will be necessary to vary R2, remembering that increasing gain increases phase frequency and reduces the effective damping of the resonance. When a suitable value of C1 has been determined, C2 (which should have been initially set to a large value) should be reduced until the measured response just starts to deteriorate. The effect of large excursions of the moving mass should be checked by deflection of it to one of its stops and then releasing it. This is necessary because it is possible to have a...
Software

It would not be instructive to provide a complete assembly language listing of the program as it stands in the prototype; not only is it very lengthy and it contains many complicated programming tricks to reduce the memory requirement to fit into the 1K of program memory available, but it has also been specifically developed to meet my requirements. The software must be tailored to each individual application. However, it is worth explaining the subroutines which access the display RAM and load RAM, and sends commands to the video generator, as these would be required in any implementation of the display module. A knowledge of 8048 assembly language is assumed in the explanation of these subroutines.

Firstly though, consider the overall structure of the whole program, see flowchart. When idling, the processor continually looks at the input buffer waiting for commands or display data. This buffer, consisting of 24 of the ram locations within the 8048, is supplied with data as it arrives from the host processor by the interrupt routine which decodes the serial data and stores it in the next free buffer location. (Software decodes the serial data stream.) When the main program detects that a new data word is available it is loaded from the buffer. If this data is not the second or third byte of a multiple byte command, in which case execution of the command in progress continues using the new data received, its most significant bit is tested. If this is zero, the data is assumed to be a character for display and is therefore directly stored at the cursor position in the currently-addressed page store. The cursor position is then incremented by one, which may involve moving the cursor, or scrolling if necessary, to make room for the display if the cursor was positioned in columns 40 of row 24. If the most significant bit of the data word is set to one, it is a command and the first five bits of the command are used in a look-up table to determine the required processing to the required command execution routine. After execution of the required command, or displaying the character and incrementing the cursor as necessary, processing returns to the start of the main program again.

Apart from the scrolling operation, and the clear page function (which requires at least one command), most of the commands and data display are executed by the 8048 via the display module. The module can directly display data from a viewdata command structure.

I didn't specifically consider the execution time of the program during development, but it seems likely that the time required to execute the 800μs time could be reduced by careful program design to perhaps 250μs. However, some avoidable time wastage of up to 64μs (the time for one video line) each time the display is cleared, which seems likely to make the time to execute past the second line sync test, which is zero, the data is assumed to be a character for display and is therefore directly stored at the cursor position in the currently-addressed page store. The cursor position is then incremented by one, which may involve moving the cursor, or scrolling if necessary, to make room for the display if the cursor was positioned in columns 40 of row 24. If the most significant bit of the data word is set to one, it is a command and the first five bits of the command are used in a look-up table to determine the required processing to the required command execution routine. After execution of the required command, or displaying the character and incrementing the cursor as necessary, processing returns to the start of the main program again.

executes past the second line sync test, the pulse must be 10μs wide, set by the monomeric timing constants R1 and C2. If the host processor starts to send a data word during a read or write operation there may be up to 64μs delay before the 8048 responds, as the interrupt has to be disabled. This will affect the correct decoding of data at 4800 baud or less and the possibility has been accounted for in the arrangement of the sampling points of the decoding hardware. Alternatively, for faster rates, or parallel input, the data output line (port 2 bit 7) can be set low during a read or write operation to indicate that the 8048 is busy and cannot accept a new data word. Operation of the read and write subroutines is comparatively straightforward.

After calling the setup subroutine, the read subroutine sets the address, page and address latch output enable outputs on port 2 (data and address buses are now free) and uses an external move instruction (MOVX) to read the currently-addressed display RAM (the low-order address held in R0 is automatically latched in X by the 8048 during execution of the MOVX instruction). Bits 0 to 4 of port 2 are then set to their high impedance state again so that the video generator can have access to the data and address buses again. The resulting data is then inverted, as the video generator uses inverted logic data, the in
Deaconhouse Ltd., of 57 Guildford Street, Chertsey, Surrey tel 09326 6061) say they will supply the £9 x 1866mm double sided printed board shown opposite.

interrupt is enabled, and the subroutine returns.

The write subroutine operates in a similar fashion except the character to be displayed (held in the accumulator on entry) is inverted and stored in register R3 again just before execution of the MOVX instruction to store the character.

The subroutine to send commands to the video generator, called DISPLAY, operates as follows: the first two instructions find the rising edge of the 8048 TI input – this represents the start of the 20us page slot when the video generator can receive commands. The most significant bit of port 2 is set to low to complete the 1111XX0XXXX address required for the video generator to respond to a command.

The command data is sent to the video generator held in the accumulator as follows: the next instruction finds the rising edge of the 8048 TI output – this represents the page slot when the video generator can receive commands. The 20us page slot is set when the rising edge of the video generator's command input is detected. The command data is then sent to the video generator held in the accumulator.

Construcational notes

The original was constructed on a half-Eurocard prototype wiring board. Apart from the usual considerations as to the placement of the decoupling capacitors no special precautions were taken, nor was any attention paid to the component of the wiring layers. The only hardware problem met so far is that the video generator i.e. sometimes does not power-up correctly. On the software side, I recently used different versions of the display generator – one which automatically displays the cursor when initially set to the text mode and one which does not. The most significant bit of the parallel port could be used as a keyboard strobe (the strobe pulse width should be arranged to be less than the transmit time of one 75baud character). The least significant bit can be used as a keyboard strobe (the strobe pulse width should be arranged to be less than the transmit time of one 1200baud character). This ensures that the strobe will be recognised even if it occurs whilst a character is being received.

The problem with this method is that if a character is received whilst one is being transmitted, the transmitted character will be corrupted because the processor will be interrupted by the incoming character. To ensure full duplex operation therefore, it may be wiser to employ a separate UART to generate the 75baud signal.

On the software side, the following changes would have to be made.

- Change the software delays in the interrupt routine to decode 1200 baud data rather than 4800.
- Change the serial transmit routine delays to send 75baud data (if port 1 is used to connect the keyboard).
- Perform a parity check on the incoming data using the most significant bit and display the parity error character (7F hex) if an error occurs.
- Change the command look-up table to perform only the required viewdata cursor controls (such as back space, carriage returns, clear screen, etc.).

Set a flag on receipt of an ESC code.

- If the ESC flag is set convert the next received character (if it is between 40 hex and 60 hex) to a text erase control code (clear bit 7 of the character) and display it, or ignore it if it is not in the above range. The ESC flag is then cleared.
- On receipt of the ENQ character (05 hex) to send the required log-on data (which should be programmed into the 8748 rom).

To have enough program space to incorporate these changes would require the deletion of some of the editing facilities described in Table 1, such as scrolling, part page display, etc.

A modem would of course be required in any stand-alone application of the display module to transmit/receive the correct i.a.k. signals.

1200baud data. It is possible to connect a keyboard with a parallel ASCII output to the parallel port on the module, and use the data line out (port 2, bit 7) as the 75baud data line. The most significant bit of the parallel port could be used as a keyboard strobe (the strobe pulse width should be arranged to be less than the transmit time of one 75baud character). The least significant bit can be used as a keyboard strobe (the strobe pulse width should be arranged to be less than the transmit time of one 1200baud character).

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- Set a flag on receipt of an ESC code.
Digital filter design procedure

These examples of the design of a simple digital filter and, in contrast, that of a digital version of a fourth-order Butterworth filter, show how laborious mathematics may be simplified and the "recurrence formula" for the filter written without having to solve a fourth-order equation.

Many digital filters can be designed simply on their own merits. But in the case of the digital equivalent of an analogue filter, such as the Butterworth filter, the situation is complicated by the need to use a bilinear transformation, resulting in laborious algebra. This can be largely avoided for a fourth-order filter by following this procedure, substituting cut-off and sampling frequencies, and by using the tables suggested.

The end product of filter design procedure is the recurrence formula in a form which can readily be entered into the computer or microprocessor program that constitutes the filter. In addition it is desirable to plot the cut-off frequency spectrum in terms of the sampling frequency to check that the filter has the desired characteristics.

Two starting points are considered:

- where the z-transfer function and the z-plane diagram have to be derived from an analogue filter using a bilinear transformation. The example chosen is the digital equivalent of a Butterworth low-pass filter.

- where the pole positions are arbitrary with the sampling frequency, and the other with pole positions chosen for arithmetic simplicity with a simple microprocessor in mind (e.g. the MMDI).

Method

The process for the design of a digital filter is:

- choose a suitable transfer function
- derive the recurrence formula
- write the recurrence formula into the program for the relevant hardware (computer or microprocessor) that will be used to make the filter.

One multiplier with a coefficient of one third of a revolution (0.3333) is designed, the z-plane diagram being the digital equivalent of a simple tuned circuit, Fig. 1. The jω spectrum or cyclic frequency spectrum are derived from a Butterworth s-plane diagram involving a bilinear transformation, and the delays are involved.

The recurrence formula is usefully illustrated as a realization diagram, shown for each example. Finally, in each case the operation of each filter is demonstrated by generating the impulse response using a desk-top computer and a simple Basic program to give input and output signal diagrams.

Design digital filter equivalent to a parallel tuned circuit

The tuned circuit will have one pole only, at its resonant frequency, and we can assume zeros at zero frequency and at infinity. To be stable, the pole must lie within the unit circle on the jω-plane. (In other words the analogue circuit must contain some resistance.) The position of the poles is dictated by the resonant frequency in relation to the sampling frequency, and to the Q required.

Two examples are worked, one with pole positions chosen arbitrarily with the resonant frequency any value less than half the sampling frequency, and the other with pole positions chosen for arithmetic simplicity with a simple microprocessor in mind (e.g. the MMDI).

Step 1 - draw the z-plane diagram. Suppose the sampling frequency has already been chosen as 12 × f0, where f0 is the required resonant frequency of the tuned circuit. The digital filter is designed by locating a pole on the z-plane at an angle of ½π of a revolution, as one complete revolution of the z-plane represents the sampling frequency. There will automatically be another pole at an angle of ¼π of a revolution, as the poles come in conjugate pairs. The radius of the poles is found from the formula

\[ z = r \exp(j \theta) \]

where z=r. exp(jθ) is the z-plane diagram being the digital equivalent of a simple tuned circuit, Fig. 1. The jω spectrum or cyclic frequency spectrum is found directly from the z-plane diagram and is shown in Fig. 2.

Because the transfer function H(z) is zero when z=+1 or -1 (the zeros) and is infinite where z=-r. exp j(θ), the transfer function can be written directly as

\[ H(z) = \frac{1}{(z-1)(z+1)} \]

where z=r.exp j(θ). The transfer function is shown in Fig. 3.

Fig. 1. Z-plane diagram shows how the microprocessor performs the signal processing. Boxes labelled z−1 are delays of one clock pulse and the small triangles are multipliers for the coefficients shown. x(n) is the input sample at the instant "now" or "n" and y(n) is the output sample at the same instant.

Fig. 2. Response |H(jω)| of the filter in Fig. 1 is plotted against frequency divided by sampling frequency.

Fig. 3. Realization diagram shows how the microprocessor performs the signal processing. Boxes labelled z−1 are delays of one clock pulse and the small triangles are multipliers for the coefficients shown. x(n) is the input sample at the instant "now" or "n" and y(n) is the output sample at the same instant.

Fig. 4. Input of 32 samples is shown with the corresponding output as (a) a column of values on the left and (b) as a diagram, for the filter whose recurrence formula is shown between the input and output diagrams. A single pulse is shown as the input, resulting in a decaying oscillation at ¼ of the sampling frequency.

Fig. 5. Z-plane diagram has been chosen with very simple ratios to simplify arithmetic in the microprocessor.

Fig. 6. Realization diagram only contains one multiplier with a coefficient of 1/4 so the angle in the microprocessor is very simple.

WIRELESS WORLD MAY 1983
The present output sample $y(n)$ in terms of Signals, then at Catterick Camp in used as the digital filter within a suitable.

The general form of the recurrence for-

and in this example the Output Values

Fig. 8. Oscillation caused by the impulse at the input soon dies away, as one would expect from a low-Q circuit.

British Telecom equipment. Physically small, it is the transmitter and amplifier is preset through a hole in the lid on two p.p.ms, one for each channel. The input level is set by the input control for the level from the generator is one of a series of standard Burst to stable waveforms. Timer but with the same safety features, for £35 (+ v.a.t.)

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The first of a series of d.c.-to-d.c. converter versions of a similar size. One application developed by the standard safety of the kit which comes complete with Thirty-one different experiments and configurations.

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corrected if necessary.

Standard Forth language is used with additional commands for the screen editor and for some functions, for example timing. Any function not included can, of course, be added by the user.

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£49.95 incl. VAT plus p&p at £1.00

ALL THESE INSTRUMENTS ARE WARRANTED AGAINST DELIVERY, MATERIALS AND MANUFACTURING DEFECTS FOR 12 MONTHS from the purchase date. If not satisfied, please return within 14 days for full refund.

The telephone number for Access/Barracclay orders, service and literature is 0030 98632, Ext. 122.

Test Instruments from Sifam

WWW = 94 FOR FURTHER DETAILS

WWW = 96 FOR FURTHER DETAILS

WWW = 98 FOR FURTHER DETAILS

WWW = 100 FOR FURTHER DETAILS

WWW = 102 FOR FURTHER DETAILS

WWW = 104 FOR FURTHER DETAILS

WWW = 106 FOR FURTHER DETAILS

WWW = 108 FOR FURTHER DETAILS

WWW = 110 FOR FURTHER DETAILS

WWW = 112 FOR FURTHER DETAILS

WWW = 114 FOR FURTHER DETAILS

WWW = 116 FOR FURTHER DETAILS

WWW = 118 FOR FURTHER DETAILS

WWW = 120 FOR FURTHER DETAILS

WWW = 122 FOR FURTHER DETAILS

WWW = 124 FOR FURTHER DETAILS

WWW = 126 FOR FURTHER DETAILS

WWW = 128 FOR FURTHER DETAILS
MARK 1983 WITH GAPS IN CIRCUIT FILES WELL-PLUGGED

WIRELESS WORLD CIRCARDS last year benefited many 'new generation' readers who bought at 1976 bargain prices + 10% discount for 10 sets! Most sets are still available although companion volumes 'CIRCUIT DESIGNS 1, 2 and 3 are out of print (CIRCARDS sets 1 to 30).

The Offer stands, so order your sets of 127 x 204mm cards in plastic wallets. These unique circuit cards normally contain descriptions and performance data of 10 tested circuits, together with ideas for modifying them to suit special needs.

To Electrical-Electronic Press
General Sales Department
Room 108
Quadraunt House
Sutton
Surrey SM2 5AS

Please send me the following sets of Circuit cards.

<table>
<thead>
<tr>
<th>CIRCUIT</th>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basic Active filters</td>
<td>2 each</td>
</tr>
<tr>
<td>2</td>
<td>Switching Circuits, comparators and Schmitts (But these gaps cannot be filled)</td>
<td>2 each</td>
</tr>
<tr>
<td>6</td>
<td>Constant current circuits</td>
<td>2 each</td>
</tr>
<tr>
<td>7</td>
<td>Power amplifiers</td>
<td>2 each</td>
</tr>
<tr>
<td>8</td>
<td>Astable circuits</td>
<td>2 each</td>
</tr>
<tr>
<td>9</td>
<td>Optoelectronics</td>
<td>2 each</td>
</tr>
<tr>
<td>10</td>
<td>Micro power circuits</td>
<td>2 each</td>
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<tr>
<td>11</td>
<td>BASIC Logic gates</td>
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</tr>
<tr>
<td>12</td>
<td>Wideband amplifiers</td>
<td>2 each</td>
</tr>
<tr>
<td>13</td>
<td>Alarm circuits</td>
<td>2 each</td>
</tr>
<tr>
<td>14</td>
<td>Digital Counters</td>
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<tr>
<td>16</td>
<td>Current differencing</td>
<td>2 each</td>
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<tr>
<td>22</td>
<td>Amplitude modulation and detection</td>
<td>2 each</td>
</tr>
<tr>
<td>23</td>
<td>Reference circuits</td>
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<tr>
<td>24</td>
<td>Voltage regulators</td>
<td>2 each</td>
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<tr>
<td>25</td>
<td>RC gates</td>
<td>2 each</td>
</tr>
<tr>
<td>32</td>
<td>Transistor arrays</td>
<td>2 each</td>
</tr>
<tr>
<td>33</td>
<td>Differential and bridge amplifiers</td>
<td>2 each</td>
</tr>
<tr>
<td>34</td>
<td>Analogue gate applications</td>
<td>2 each</td>
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<tr>
<td>35</td>
<td>Analogue gate applications</td>
<td>2 each</td>
</tr>
<tr>
<td>36</td>
<td>RC Photocopies only:</td>
<td>3 each</td>
</tr>
</tbody>
</table>

*Photocopies only: 3 Waveform generators 4A.C. measurement 5 Audio circuits (3.20 each set.

Address (Please print).

Company Registered Number: 151537 (ENGLAND).
Registered Office: Quadrant House, The Quadrant
Sutton, Surrey SM2 5AS

To order add carriage at the following rates: Monitor £12, Drives and Case £7, Board free; and V.A.T. at 15% to total, send your order to: WIRELESS SUPPLIES, 10 BECKENHAM GROVE, SHORTLANDS, KENT

TELEPHONE: 01-646 5040 or 01-646 1598

WIRELESS WORLD 1983

WIRELESS WORLD 1983
Advertisements accepted up to 12 noon Tuesday, May 3rd, for June issue, subject to acceptance.自然科学

Electronic Professionals
The 1980s herald a new era in personal communications development.

We’re determined to turn state-of-the-art theory into world-class quality products. Join our team now!

Section Head
a demanding role for a mature and very determined professional to lead a design team creating our next generation of successful products. You’ll need to be a senior electronic engineering professional who has progressed through to management via technical achievement.

Senior Software Engineer
to be closely involved in all aspects of new product development from planning through to realisation of software. A minimum of 5 years’ experience with microprocessors and software engineering is essential.

Senior Digital Engineer who must be capable of taking a lead responsibility for the hardware design of the digital section of our product range. A broad experience of digital circuit design including microprocessors is essential.

ELECTRONICS PROFESSIONALS

STC Telecommunications

With a respected pedigree of world leadership in advanced communications, STC are breaking new ground in the exciting and fast expanding field of personal communications. Achievements in this high technology area have already earned recognition with the 1982 Design Council Award for the STC Radiopager — one of the smallest and most highly attractive pagers on the market.

We are determined to build on this success by taking our micro engineering expertise through into a new era of personal communications.

To continue innovation in this challenging field, we intend to strengthen our successful team by appointing a select number of talented professionals.

Our salary package is first-class and is further enhanced by a full range of valuable benefits including life, health and pension schemes, and, where appropriate, generous assistance with relocation to our location on the fringe of London’s northern green belt. Future career prospects are excellent with progression being on a ‘dual ladder’ basis, where both technical and management abilities achieve equal recognition.

So join the STC team and help lead our drive into a new era of personal communications technology.

For more information, please write or better still telephone: Vaughan Hartridge, Standard Telephones and Cables plc, Oakleigh Road South, New Southgate N11 1HB. Tel: 01-368 1234, ext. 2215.

Junior Radio Officers

The Royal Fleet Auxiliary has a number of vacancies for Junior Radio Officers. These appointments are for short term engagements of 6 months duration, (with the possibility of extension) and other recently qualified personnel the opportunity to gain the required badges.


ITN SENIOR ENGINEER ENG/0B Maintenance
Salary in the range £14,000—£17,800

Independent Television News Limited has a vacancy for a Senior Engineer in their ENG/0B Maintenance Section at ITN House, London W1.

The successful candidate would join the specialist team responsible primarily for the maintenance of ENG equipment, including Sony BVU series U-matics, Sony BVPC30 cameras, TBCs and associated portable equipment. The section is also responsible for the long-term maintenance of our two camera OB unit.

The work may occasionally involve travel with ENG teams to remote locations.

Please telephone the Personnel Office on 01-637 3144 quoting reference number 303806.
Appointments

CUT THIS OUT! 
Clip this advert and you can stop hunting for your next appointment. We are the direct connection at the appointments in Digital, Analogic, RP, Microcosm, Microprocessor, Computer, Datacomms, and Medical Electronics and we're here to serve your interests.

Call us now for both in house and freelance positions at all levels £6,000-£16,000.

ADVANCED TELECOMMUNICATIONS: 
careers with extensive scope at Cheltenham.

Join the Government Communications Headquarters, one of the world’s foremost centres for operational and theoretical training for a range of roles ranging from HF to satellite – and ITN technicians are highly regarded. There is substantial emphasis on creative solutions for solving complex communications problems using state-of-the-art techniques including computer/ microprocessor applications. Current opportunities are:

Telecommunication Technical Officers

Two levels of entry providing two salary scales:
£2,323-£2,500
£3,032-£3,200

Minimum qualifications are TEC/SCOTEC in Electronic Telecommunications or a similar discipline. A GCSE in Maths B. Small signal modelling and/or digital communications Transmission B or Computers B or equivalent. DNC in Electronic Engineering or Telecommunications Systems Engineer C or C-Path Pass, or formal approved Service Technical training. Additional, at least four years’ lower level or seven years’ higher level (higher level) appropriate experience in either Radio, data, computer or similar communications techniques. A basic knowledge of high technique supervisory control of technicians involves “hands-on” participation in all aspects of high technique nature. The higher level involves application of technical knowledge and experience to planning work involving implementation of medium to large scale projects.

Radio Technicians

£2,523-£2,560

To provide all aspects of technical support. Promotion prospects are good and linked with active encouragement to acquire Higher National Diploma or Advanced National Diploma or equivalent qualifications. There is a TEC Certificate in Telecommunications or equivalent qualification. In the Physics and Radiotherapy Departments. Required in the Physics and Radiotherapy Departments. Two levels of entry providing two salary scales; within the range of £5,642 (at 18) rising to £7,109 at age 20. A tax free allowance of £15,000 and have relevant technical experience particularly with Philips linear accelerators. To be appointed on to the Foundation Apprenticeship Training Scheme. To be considered, you must have an HND/Degree in electronics together with between 2-5 years’ experience in a comparable or related technical field. Application forms are obtainable at the Personnel Manager, The Personnel Manager, Personnel Department, GCHQ Oakley, Priory Road, Cheltenham, Gloucestershire, GL54 5DX. Please apply in writing to the Personnel Manager, GCHQ Oakley, Priory Road, Cheltenham, Gloucestershire, GL54 5DX or by telephone: 01-367 3144 (2084)

BROADCAST ENGINEER

Required by the Broadcast Division of The Services Sound and Vision Corporation, who provide broadcast television and radio services to H.M. Forces and their dependants abroad.

Candidates (preferably aged 22-35) should be educated to Higher National Diploma or equivalent in electronic engineering and have work experience in the broadcasting industry.

Their work (most overspill) includes the installation, operation, repair and maintenance of professional radio studio equipment and TV and VHF broadcast transmitters. A tax free salary in the range of £7,914 to £9,994 is paid, plus Maths and Science qualifications.

Applicants should hold ONC, HNC or similar qualification in electrical engineering (or preferably in electronics). They should have relevant technical experience particularly with Philips video and microwave equipment. To be appointed on to the MPT 2 level two candidates should have served at least 2 years as MPT 3 or equivalent. Salary scale from 1st April 1983 £3,380-£3,510 per annum.

Applicants and successful candidates will receive an attractive package of career opportunities and benefits. Applications for both positions should be addressed to Personnel Manager, The Services Sound and Vision Corporation, Cheltenham, Gloucestershire, GL54 5DX.

TELEPHONE: Fullers Way South, London W1P 4DE. Telephone: 01-367 3144 (2084)

RADIO ENGINEERS

The Company’s manufacturing and marketing. As far as the future is concerned there are opportunities for very positive career progression within this successful and dynamic organisation.

For the full story about the Company of the future in RF technology. Please telephone Kevin Long on 01-366 6538 in complete and elevated, high-rise block with apartments to Moynol Dolphin & Kery Ltd., 176-228 Great Portland Street. London W1N 3TR. quoting ref. ITN 306.

RF Engineers & Senior Engineers

Our client is an internationally successful Company that you’ll both know and respect. A world renowned force in advanced communications products, they have a track record of technological innovation and commercial success that is second to none.

The applications at the fast expanding personal communications market are considerable – and their product range covers all wide angles – both in the market and also within the industry. Now to maintain this momentum of success they need to lead the way in developing the next generation of advanced, high technology personal communications products.

The need is for experienced professionals to become involved in projects which will fully exploit the latest state-of-the-art technology in the ever-advancing field of circuit integration. You will initiate designs for larger projects or major project workload – and when you are ready for more responsibility, there are opportunities in both project and man management.

To be considered, you must have an HND-Degree in electronics together with between 2-5 years’ experience in an analogue circuit VHF/UHF design and application. A background in mobile, military or aerospace radio would be an advantage – but most importantly you must demonstrate the ability to liaise with related engineering disciplines, manufacturing and marketing.

We are recruiting for a “true breed” of Engineer – and the remuneration package will reflect the importance of your role. Initial salaries will be highly attractive and individually negotiable, further enhanced by a full range of benefits. As far as the future is concerned, there are opportunities for very positive career progression within this successful and dynamic organisation.

In the race to develop the next generation of personal communications products...

...Join the Company that will win!
Civil Aviation College (Gulf States)
Doha, Qatar
requires for September 1983:

**INSTRUCTOR**

AVIATION ELECTRONICS

University Degree and Professional qualifications in Aviation Electronics, qualified and experienced in installation and maintenance of Modern Radio Systems. Must have minimum ten years' experience with three years' instructional experience at an ICAO recognised Training Centre. Salary and Allowances up to US$3400 per month

Applications to:
The Principal
Civil Aviation College (Gulf States)
P.O. Box 4050
Doha State of Qatar

---

**Officers**

Botswana

Assistant Force Communications Officer

Up to £16,647 p.a. substantially tax-free

A challenging post with the Police in a democratic, multi-racial developing country of Southern Africa. Candidates, preferably aged between 30 and 45, must possess Civil and G Std Part II or equivalent and have at least five years experience in police or armed forces communications with HF, SSB and VHF (FM) communications equipment.

Duties include the maintenance, installation and fitting of communications equipment and the training of junior technicians for C & G examinations.

Benefits include free passages, generous paid leave, children's holiday visits and education allowances. Basic salary attracts 15% tax-free gross on completion of three year contract.

For further details and application form ring Linda Mitchell on 01-632 7272 or register 3244 or write quoting YX/103 WW.

Crown Agents

The Crown Agents for Overseas Governments & Administrations, Recruitment Division, 4 Millbank, London SW1P 3JD

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**Appointments**

**HOSPITAL MEDICAL EQUIPMENT TECHNICIANS**

C. £15.400 Tax Free

...plus substantial benefits in Saudi Arabia

As a leading international healthcare company, staffing and managing several hospital projects in the Middle East, the efficient maintenance of medical equipment is a vital part of our operation. Currently we are seeking additional male technicians with the following experience to join us at one of these hospitals in the Kingdom of Saudi Arabia.

You must hold an HNC in Medical Electronics or Electronic Engineering and have at least 3 years' post qualification experience of hospital medical equipment including microprocessor controlled patient monitoring and X-Ray equipment.

The substantial tax free salary offered (paid in US dollars and converted in this instance at a rate of US$1.55 = £1.00) is supported by the wide range of benefits outlined below:

The Whittaker Benefits Package

- Choice of 1 or 2 year contracts
- 7 weeks holiday
- Mid-year holiday allowance
- Return air fare
- Comprehensive insurance cover
- Free local transport
- End-of-contract bonus
- Storage allowance
- Free recreation facilities
- Free furnished, fully-equipped, air-conditioned accommodation.

You'll be ideally placed to make the most of your holidays, travelling even further afield to Nairobi, Singapore, Hong Kong or Bangkok for example.

If you hold a UK or Irish passport and are due to move to Saudi in the near future, please send your CV and the date of availability for your first assignment in Doha to:


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**Telecommunications Technicians**

*Up to £9403*

The posts available are varied, but broadly they fall into 2 groups at 3 different locations.

**HANNSPKE PARK (MILTON KEYS) and CENTRAL LONDON**

for installation, maintenance and other work associated with HF communications equipment, VHF and microwave lines and associated test equipment; teleprinters, telephone subscribers' apparatus, PMRXs, FAXs, PABXs and other equipment including that using analogue and digital techniques and voice frequency telegraphy.

**CROWBOROUGH, SUSSEX**

for maintenance and operation of high power, medium and short wave broadcasting transmitters and associated equipment.

Applicants should normally have 4 years' relevant experience and must hold one or more of the following:

- ONC in Engineering
- ONC in Electrical Engineering
- TEC/SCOTEC certificate
- City & Guilds Telecommunications Technicians Certificate Part II (Course No. 271) or Part I plus Math 'B', Telecommunications Principles 'B' and one other subject
- Pass in the Council of Engineering Institutions Part I examination
- An equivalent or higher relevant qualification.

Ex-Service personnel who have had suitable training and at least 3 years' appropriate service (as Staff Sergeant or equivalent) will also be considered.

Salary: £5983 to £8183. London £1220 more. Starting salary may be above minimum for those with additional relevant experience. Promotion prospects are good.

Relocation assistance may be available.

For an application form to be returned by 19 May write to: Foreign & Commonwealth Office, Hanseop Park, Milton Keynes MK19 7BH, or telephone Milton Keynes 961644 Ext. 152. Please quote reference YHU/727/63.

Foreign & Commonwealth Office

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**Electronics Design Engineers**

**Communications**

R/F VHF UHF Systems

Microwave Equipment

Analogue Digital Circuitry

Message Switching

Cryptographic Systems

Marconi Space and Defence Systems, Communications Division, are expanding their civil and military projects. Additional experienced staff qualified to PhD/Degree level are required to assume responsibility for software/hardware development in the above areas.

Our salary scales match the high standards of qualifications, experience and ability demanded. We offer a comprehensive range of benefits together with relocation assistance if required.

Phone Portsmouth 674019 For further information and an application form. Alternatively, you can write to Such Burton, Marconi Space and Defence Systems Limited, Browns Lane, The Airport, Ports­mouth, Hants, PO5 4SB.

(All posts are open to men and women)

---

**EVTR is looking for a young Video Engineer**

EVTR is a broadcast television facilities company specialising in the use of computer editing equipment.

We need a qualified electronics person who is willing to work a shift system and gain experience of broadcast, video tape recording and operational engineering.

Please telephone Andy Thompson on 01-631 4421

21 Great Tichfield Street

London, W.1
<table>
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<th>Code</th>
<th>Description</th>
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