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WIRELESS WORLD, APRIL 1980

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Science of the whole

The study of all creation and man's place in it was the only kind of science worthy of consideration, in Tolstoy's view. A school curriculum of sufficiently wide scope for such a purpose would take a little time to construct and a good deal more to practise, but at the conclusion of such a course of instruction a child would be well on the way to becoming a whole person, if not several. Newer to the modern scene, and considerably less ambitious in his requirements, was A. N. Whitehead, who remarked that wisdom is the fruit of a balanced development. In this context, the balance is not between the two specialisations in science or the arts, but between education and training.

One must recognise that, to a greater degree now than ever before, specialisation is necessary if potential engineers and scientists are to have a reasonably stable platform on which post-school training can be built. Merciless economics dictates that scientifically-aware youngsters are needed to enable this country to earn its living — even to stand still, let alone to grow. In the sixth form at school, and even earlier in some schools, the specialisation in science has been promoted for many years, with the result that university and technical colleges have received a steady stream of entrants, well grounded in the relevant disciplines. It is true that there is now a shortage of science teachers of the required level of competence, but that is a separate and more recent issue.

That is all as it should be. But while a pupil should be given a sound base of knowledge for his professional training (and there is no sexist meaning intended in that pronoun or succeeding ones) the 'balanced development' is unlikely to be obtained by an exclusive study of maths, chemistry, physics and a useful language, even though a token "art" (in the wider sense) may be tacked on for the sake of appearances. If one's entire two years of sixth-form experience is devoted to analysis that he cannot also perceive the pleasures of learning about life. Nor should one be excluded from the excitement of science. The whole of human experience outside the sciences is thus lumped together and labelled "supplementary subjects".

A tendency to segregate 16-plus pupils, and even younger ones in some cases, into science and arts groups has been evident for many years. C. P. Snow's Two Cultures is discernible long before the Second Law of Thermodynamics becomes a matter for discussion. But the balance is sought so that "other supplementary subjects as desired". The whole of human experience outside the sciences is thus lumped together and labelled "supplementary subjects".
The article describes the design and construction of a 3½ digit digital capacitance meter with six ranges of 195.9pF to 19.99mF full-scale. The maximum error of the instrument is ±1%, determined by the accuracy of the two calibration standards used. Accuracy is largely determined by the stability of the voltage or temperature variations, making battery power practicable. No voltage or temperature variations, ±0.1%, is inhibited for a time corresponding to the value of the strays.

Circuit operation
Turning now to the complete circuit diagram in Fig. 3, it will be seen that the counter used is the Motorola MC14553. This 16-pin, 3-digit b.c.d. counter with an internal digit multiplexer is an excellent choice for straightforward counting applications. The counter b.c.d. output is decoded by IC6 to provide a 7-segment display format. The requisite counting resistors are included in IC6, but normal 470Ω discrete components may be substituted. Digits 0 and 1 are provided by directly selecting resistors from IC6. Digit 2 is continuously driven, so that it is only required to display a 2 or a 3.

To explain the operation, assume that the unit is switched to Range 2 which has a full scale reading of 19.99 pF. In addition, assume that only a small capacitor is connected to the measuring terminals, for example, 500 pF. The last overflow/clear (OF/CLR) pulse will have reset IC6 to 000 and, at the end of the gate period, only 500 pF of the master clock will have been counted, thus no carry out (CY) pulse will have been generated and IC6 will remain in the reset state. The termination of the gate pulse will generate the latchable (LE) pulse, which will transfer the contents of the counter to the output registers within IC6. The positive edge of LE will, in turn, generate a 10µsec strobe pulse from IC7, which will store the current state of IC6 in the digit 4 of IC8. As an example, therefore, the contents of IC6 will be a 0, consequently Tr5 will be turned off and digit 4 will remain at 0.

Assume now that the capacitor connected to the input terminals is increased to 1200 pF. The positive edge of gate will enable the input to the counter, and after 1000 periods of the master clock a CO pulse will occur. This pulse will set IC6, and after a further 200 periods of the master clock, the gate period will terminate, generating LE, which will transfer the contents of the decade counters to the output latches. The positive edge of LE will generate the transfer strobe, and the state of IC6 will remain 1. Transistor Tr5 will turn on, and digit 4 will display the figure 1.

Power requirements
The choice of supply voltage for the unit was not entirely arbitrary, but was dictated by maximum count-rate considerations of the MC14533. I have used this device for a number of counting applications, and have obtained samples from many sources of these ICs, whilst meeting their guaranteed specifications, I had maximum counting rates which were somewhat lower than the "typical" figures given in the data sheets. To avoid the need to select devices, a supply voltage was chosen that would ensure sufficient speed margin, even with both a worst-case counter and a worst-case threshold voltage 

Construction
The unit is constructed on two 4cm x 8cm printed-circuit boards with a shielding plate interposed. The plate was included only as a precautionary measure, and is not required in all cases. It will be noted that no precision components are called for in the design.
only good quality, high-stability, metal-film resistors for $R_4$, $R_5$, $R_6$, and $R_7$. See R28 for the input terminals to the p.c. board should be screened, and not laced in with the wiring loom. Otherwise, construction is uncritical.

Calibration and use

The unit may be calibrated as follows. Apply power, short TP 1 to ground, and observe that the display shows 888. Set $R_{28}$ to mid-travel, and observe that the display reads 00.0, 00.1 or 00.2, and also displays correctly on Range 2. This completes calibration and adjustment.

In use, it is only necessary to connect the unknown, switch on and adjust the range switch for the desired resolution. Certain points should be borne in mind.

In order for an accurate reading to be obtained, it is essential that the equivalent leakage resistance of the device under test is much higher than the range resistor. For ranges 1-3, this would indicate a very leaky component. For example, if a nominal 1800pF capacitor displays correctly on Range 4, but shows as over-range on Range 3, this would be cause for regarding the component with considerable suspicion.

Modifications

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

Fig. 4. General timing diagram.

Fig. 3. Complete circuit diagram of the meter. The instrument is build in two boards, equivalent to left and right-hand halves of the diagram.
the reading at +40°C was -0.7%, whilst at 0°C it was +6.7%, thus demonstrating the inherent stability of the instrument. With the push-to-read modification incorporated, the unit has indeed demonstrated its utility and ease of operation, and along with the ohms range of my digital multimeter has virtually replaced the LCR bridge. Now, if only there was a convenient analogue of inductance…

References
1. M.M34C14/M4MC4 Data sheet.

Printed circuit boards
A set of two single-sided p.c. boards is available for £7.50 inclusive of v.a.t. and UK postage from M. R. Sigini at 23 Kayes Road, London NW2.

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

The microprocessors used are the 6800 and are being used to control the flying surfaces and the other in a monitoring function. Different designs are used in the expectation that a software fault would not affect each in the same way.

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

How serious is multipath distortion? Effect on sound quality and bit-streams in broadcast reception
by Pat Hawker, Independent Broadcasting Authority

According to one broadcaster, multipath distortion is "one of the major factors which de- 45
teriorate the received sound quality, though noting that for many years its effect has been sufficiently masked by the relatively high band width of the signals and the fact that the difficulties are not always present. It is particularly noticeable in the UK over twenty years. This arose during the period of co-channel interference in both conventional broadcasting and systems using digital information; outlines a recent Japanes analysis of how it affects stereo reception; and finally considers what can be done, if anything, to minimise the problem.

In introducing his article "Audible amplifier distortion is not a mystery. (Wireless World, November 1977) Peter Baxandall quoted Bertrand Russell: "Some things are believed because people feel as if they must be true, and in such cases an interest in the systems of different type and by the provision of a certain amount of autonomy in operation to avoid the effects of crew error. Should a crew member attempt, for example, to close the leading-edge slats at too low an airspeed, or to extend the trailing-edge flaps at too high an airspeed, the controls will prevent the command being carried out.

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How serious is multipath distortion? Effect on sound quality and bit-streams in broadcast reception
by Pat Hawker, Independent Broadcasting Authority

According to one broadcaster, multipath distortion is "one of the major factors which de- 45
teriorate the received sound quality, though noting that for many years its effect has been sufficiently masked by the relatively high band width of the signals and the fact that the difficulties are not always present. It is particularly noticeable in the UK over twenty years. This arose during the period of co-channel interference in both conventional broadcasting and systems using digital information; outlines a recent Japanes analysis of how it affects stereo reception; and finally considers what can be done, if anything, to minimise the problem.

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of sites, showed that even on standard receivers there were few sites where at least "just noticeable distortion" was not observed when using indoor aerials; distortion could be reduced by ensuring that the a.m. suppression characteristics of the receivers were good and by using the outside aerials. It was also shown that distortion becomes more serious as the difference in path length (long-term echoes) increases. The amplitude of reflected signal compared with that obtained at a typical site using a correctly represented by a distortion and the relevant multipath direct (D) and indirect (I) processing was applied. "This way," the report states, "the a.m. suppression characteristic of v.h.f. broadcasting is one of the factors making distortion on solo piano was found to be about 35 per cent for a path difference of 18 km, however, in recent years the BBC has introduced its p.c.m. digital transmission system which provides subjective stereo quality up to about 15kHz throughout the UK. At the same time, the ILR stations are able to provide good quality stereo since the transmitters are seldom more than a few miles from the originating studios. These developments have increased rather than decreased the importance of multipath distortion.

The current work by both IBA and BBC, to evaluate various matrix systems of "round-sound" such as MEC and "mixing", using "2", "0", or "1" transmitters, these results do not appear to have included any practical assessment of the effects of multipath on the different systems, although IBA engineers are hoping to undertake a study shortly using the MEC (Mono-Stereo-Compatible) system.

The possibility of using charge-coupled devices in reducing ghosting on television pictures has been reported, but it is thought they have been given the wrong Media techniques could be usefully applied to v.h.f./f.m. reception.

Minimising multipath distortion

Propagating v.h.f. signals is a fact of life: it would appear that even at equal p.c.m. digital transmission system networks of v.h.f./f.m. transmitters, the upper limit of audio frequencies was defined by the "music lines" of the Post Office distribution circuits, this meant that audio frequencies much above 9kHz could not be guaranteed. These circuits also presented problems in handling stereo over distances exceeding about 20 km. However, in recent years the BBC has introduced its p.c.m. digital transmission system which provides subjective stereo quality up to about 15kHz throughout the UK. At the same time, the ILR stations are able to provide good quality stereo since the transmitters are seldom more than a few miles from the originating studios. These developments have increased rather than decreased the importance of multipath distortion.

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The BBC has investigated the performance of a range of television aerials and found that the best results are obtained when the aerial is correctly positioned.

The investigation involved moving the aerial in a small arc around the position that gives the best reception and noting the improvement or degradation in the signal strength. The results showed that an improvement in signal strength of up to 10 dB could be achieved by careful positioning.

The investigation also found that the choice of aerial type and orientation can have a significant effect on reception. For example, a directional aerial may provide better reception than a omni-directional aerial in certain situations.

The BBC recommends that viewers should position their aerials carefully, possibly with a degree of experimentation, to ensure the best possible reception.

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### Table 1. Facilities included in driving software

<table>
<thead>
<tr>
<th>Control Code</th>
<th>Char.</th>
<th>Function Description</th>
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<th>Char.</th>
<th>Function Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>@</td>
<td>NULL — routine returns carry set</td>
<td>16</td>
<td>P</td>
<td>BLA — black</td>
</tr>
<tr>
<td>1</td>
<td>A</td>
<td>DOT — graphic dot at X, Y (next two characters)</td>
<td>17</td>
<td>Q</td>
<td>RED — red</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>VCT — vector from X, Y, to X1, Y1 (next 4 chars)</td>
<td>18</td>
<td>R</td>
<td>GRN — green</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>CXY — positions cursor to X, Y (next 2 chars)</td>
<td>19</td>
<td>S</td>
<td>YEL — yellow — colour</td>
</tr>
<tr>
<td>4</td>
<td>D</td>
<td>BKG — next colour control sets background</td>
<td>20</td>
<td>T</td>
<td>BLU — blue control</td>
</tr>
<tr>
<td>5</td>
<td>E</td>
<td>EDL — erase to end of line</td>
<td>21</td>
<td>U</td>
<td>MAG — magenta</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>STS — define colour status byte (next char)</td>
<td>22</td>
<td>V</td>
<td>CYN — cyan</td>
</tr>
<tr>
<td>7</td>
<td>G</td>
<td>BELL — externally generated tone</td>
<td>23</td>
<td>W</td>
<td>WHIT — white</td>
</tr>
<tr>
<td>8</td>
<td>H</td>
<td>TAB — tabulate 8 cols</td>
<td>24</td>
<td>X</td>
<td>PRT — print page to list device</td>
</tr>
<tr>
<td>9</td>
<td>I</td>
<td>HS — cursor left</td>
<td>25</td>
<td>Y</td>
<td>RGT — cursor right</td>
</tr>
<tr>
<td>10</td>
<td>J</td>
<td>VT — cursor down</td>
<td>26</td>
<td>Z</td>
<td>HOME — cursor to home position</td>
</tr>
<tr>
<td>11</td>
<td>K</td>
<td>VT — cursor up</td>
<td>27</td>
<td>ESC</td>
<td>— routine returns cursor off, carry set</td>
</tr>
<tr>
<td>12</td>
<td>L</td>
<td>CLR — clear screen</td>
<td>28</td>
<td>INT</td>
<td>— re-initialize</td>
</tr>
<tr>
<td>13</td>
<td>M</td>
<td>CR — cursor to left-hand side</td>
<td>29</td>
<td>CON</td>
<td>— cursor on</td>
</tr>
<tr>
<td>14</td>
<td>N</td>
<td>BL — blink</td>
<td>30</td>
<td>COFF</td>
<td>— cursor off</td>
</tr>
<tr>
<td>15</td>
<td>O</td>
<td>BLO — blink off</td>
<td>31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Fig. 1. Display logic converts 16-bit data from memory array into colour signals.](image1)

![Fig. 2. Memory array and management logic to interface array with microcomputer bus and display logic.](image2)
combined sync. signal which is then generated to a convenient fully interlacing, internal or external sync. (giving optional superposed displays) – text case (5 x 10 dot cell), – upper and lower case (5 x 10 dot cell), – R, G, B, black/white and sync. outputs – connects directly to a modified colour TV via opto-isolated buffer – teletext compatibility

Circuit design and operation

A sync-generator chip is employed to generate a convenient fully interlacing, combiner sync. signal which is then used to drive the timing and addressing logic, although any external sync. source may equally be used for this purpose. Addressing logic provides dot and character clocking pulses at a rate determined by the astable oscillator. The frequency determines the width of the sync. pulses and it also generates a four-bit line count which increments from zero to nine in the course of a character row, together with a character column count (0 to 63) and row character count (0 to 20). The row and column addresses are then passed to the memory array via the memory management logic. This is achieved via the microprocessor accessing the memory memory locations.

When the microprocessor accesses the memory locations the memory management logic will immediately transfer control to the processor bus. The display logic is informed that its incoming data is invalid when the display of the v.d.u. appears on the screen. A character word consists of 16 bits 0 to 7 dictate whether each character sub-cell is to be displayed in the foreground or background, and bits 8 to 15 dictate whether each character is considered to be a foreground or background. The foreground and background colour bits determine the character configuration of that character whether it be a character, foreground or graphic, and similarly the flash bit determines whether or not the character is to blink.

In the graphics mode the character cell is divided into eight sections and bits 0 to 7 dictate whether each picture sub-cell is to be displayed in the foreground or background, and bits 8 to 15 determine whether the character cell is to be displayed in the foreground or background. A 16-bit character word stores the ASCII code of the three-bit foreground colour field, three-bit background colour field, the flash and graphic flag bits, see Table 2.

The display incorporates two character generators, one alphanumeric and one graphic. Bits 0 to 7 are sent to both generators but the value of bit 8 determines which output is displayed. The foreground and background colour bits determine the colour configuration of that character whether it be a foreground or graphic, and similarly the flash bit determines whether or not the character is to blink. In the graphics mode the character cell is divided into eight sections and bits 0 to 7 dictate whether each picture sub-cell is to be displayed in the foreground or background, and bits 8 to 15 determine whether the character cell is to be displayed in the foreground or background. A 16-bit character word stores the ASCII code of the three-bit foreground colour field, three-bit background colour field, the flash and graphic flag bits, see Table 2.

Interfacing with the microprocessor

The objective is to make the v.d.u. appear on the processor as 4K x 8 bits of static r.a.m., although internally the r.a.m. is arranged as 2K words of 16 bits with each character represented by a 16-bit word. The processor can only access 16-bit words; only 4K x 16 memory addresses are used owing to the practical limitation of 28 character rows in a 625-line raster (each character row takes 10 lines per frame). A 16-bit character word length stores the graphic ASCII code, the three-bit foreground colour field, three-bit background colour field, the flash and graphic flag bits, see Table 2.

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Circuit analysis by small computer — 2

Programming and modelling techniques for common passive and active circuits

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

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

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

The computer program used throughout this article for circuit analysis is called Dirac. Dirac runs a Commodore Pet, which uses BASIC and occupies 14K bytes of memory. The earlier version of Dirac could perform adequate circuit analysis for under 3K bytes. The current Dirac program is considerably more versatile than shown here.) The essence of the procedure that Dirac follows is shown below. Methodology for setting up the YF matrix, the equations for its reduction and the equations for the calculation of the gains and impedances of a circuit were discussed in the previous article, so this article is confined to examining the way Dirac manipulates the YF matrix.

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

\[
Y_F = \begin{bmatrix}
Y_{R}(O,0), Y_{R}(O,1), Y_{R}(O,2), \ldots \\
Y_{R}(1,0), Y_{R}(1,1), Y_{R}(1,2), \ldots \\
Y_{R}(2,0), Y_{R}(2,1), Y_{R}(2,2), \ldots \\
\end{bmatrix}
\]

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

FOR X = 0 TO STEP -1
FOR P = 0 TO X - 1
FOR Q = 0 TO X - 1
A = Y_{R}(X,0) + jY_{I}(X,0)
B = Y_{R}(X,0) - jY_{I}(X,0)
Y_{R}(X,0) = \frac{Y_{R}(X,0) - B*Y_{I}(X,0)}{A}
Y_{I}(X,0) = \frac{Y_{R}(X,0) + B*Y_{I}(X,0)}{A}
NEXT X
\]

Table 1. Hybrid-s circuit elements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_e</td>
<td>35 x 10^3 (A)</td>
</tr>
<tr>
<td>V_e</td>
<td>0</td>
</tr>
<tr>
<td>\omega</td>
<td>0</td>
</tr>
<tr>
<td>\phi</td>
<td>0</td>
</tr>
<tr>
<td>Z_b</td>
<td>\frac{Z_b}{Z_b}</td>
</tr>
</tbody>
</table>

where \( Z_b \) is the gain-bandwidth product and \( \phi \) is the voltage at which \( C_b \) was measured.

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

Hybrid-s model

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

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

Guidance for Reading Stations

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

The book costs £1.25, including postage, and can be obtained from General Sales Department, Room CPH4, Dorset House, Stamford Street, VDON SEI 9LU.

Stephen Marchant, at 25, is joining Nottingham University as manager of a new microprocessor applications laboratory in the electronics department. Currently studying for a Ph.D. in the business application of microcomputers, he has designed and constructed many microprocessor-based projects which - he assures us - will form the basis of future articles.

with the RGB isolation to provide extra flexibility should the u.h.f. link not be favoured.

Teletext and Prestel compatibility

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

A double-sided glass-fibre p.c.b. for the colour graphics circuit inside TV chassis will be available from M. R. Sagem at 23 Keynes Road, London NW2 for £18.50 inclusive of v.a.t. and UK postage. Roller tuned and drilled board measures 235 x 305mm.

Fig. 4. Physical interface to TV
Small-signal oscillator and v.c.o. analysis

Using the YF matrix, from which we will ultimately derive gains and impedances, the criterion for oscillation is best viewed in terms of negative resistance. Referring to the diagram below oscillation occurs when $\frac{dV}{dI} < 0$, and the resulting amplified signal out power amplifier design

Large-signal design usually involves non-linear operation, e.g. classes AB, BC. When this is the case there is no simple YF matrix to describe the circuit. For power amplifiers we have to limit the analysis to considering only how to get the drive power into the transistor, and the resulting amplified signal out into a load. As an example take a v.m.o.s. power f.e.t. operated at 100W at 145MHz. To use it one must power-match its output to 50 ohms, see below. The input matching network does much the same job, but the output match is the

important of the two, as the higher power levels on the output can more easily destroy the $100$ f.e.t. by mismatching. The model adopted assumes the input impedance of the f.e.t. is described by

$$V = \frac{R}{2\pi f C + \frac{1}{2\pi f M}}$$

where $P_{o}$ is the rated output power of the f.e.t. and $C_{o}$ the drain-to-source capacitance. (The f.e.t. input impedance is given in the data sheet.) Fig. 4 shows a network breadboarded on Dac and the network finally used, the amplifier having $100\$ gain when run in class AB.

Economics of small computer aids

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

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

For and against

The YF matrix provides a method of circuit analysis amenable to the computer. Other methods exist, but after a year of experience in industrial R&D the YF matrix has proved superior for all but passive ladder networks. For versatile usage of analysis programs modelling techniques become essential, although modelling ultimately is synonymous with a sound understanding of circuitry.
Pulse induction metal detector — 2

by J. A. Corbyn.

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

The output is displayed by a voltmeter, and an audible signal is provided by an oscilloscope and a loudspeaker to permit a gain of up to 900Hz. The output is displayed by a voltmeter, and an audible signal is provided by an oscilloscope and a loudspeaker to permit a gain of up to 900Hz.

Fig. 11. Bandpass amplifier. All op-amps are LM351 or similar and are shown in Fig. 14 which, with a BU 326A non-saturating common emitter output, can supply up to 1.5A. Two transmit coils were used in the prototype because a rugged high-voltage p-n-p transistor was not available at a reasonable price. The regulated power supply is shown in Fig. 16. As well as the capacitors shown, extra decoupling should be provided on each circuit.

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

Conclusion

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

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

Due to magnetic viscosity effects and possible feedback loops, metal detectors need to be tested in operation to determine their sensitivity. A 600 mm radius coil assembly, as shown in Fig. 5, satisfactorily detected a piece of brass 50 mm in diameter at a depth of 750 mm, and a 15 mm diameter brass target at a depth of 50 mm. In both cases a peak transmit current of 1A was used with a delay of 250 µs and a ground speed of 1 m/s.

Fig. 13. Analogue display and audible output. Both oscillators are based on 555 timers, and run continuously at 900Hz and 1400Hz.

Fig. 14. Generation of timing waveforms.

Due to availability, the prototype used c.m.o.s. and t.t.l. components with a single transistor interface. One logic family can be used and the interface omitted. The complete circuit is powered from the 7805 regulator and all outputs are protected by series resistors.

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Awards and certificates

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

One long-time critic of the furiously competitive "dx-chasing" that may be encouraged by awards has been Bill Scarr, GZS/2. In his presidential address to the RSGB in 1956 he claimed: "Much more would be achieved if the amateur could shake off his feverish thirst for "dx" which in its most sinistral form can transform him into a scarcely human animal devoid of all sense of time and utterly lacking in consideration for his family or his hobbies". That was 30 years ago but I see from Radio Communication that he is still as critical as ever of such practices, particularly of what he refers to as the new parlour game of "working squares" (squares on a map) which he compares to collecting the numbers of railway engines or catalogue cards! For those not convinced by his arguments, the RSGB has recently published a new edition of its book "Amateur Radio Awards" by C. R. Emary, GOGH. This provides details of almost 100 of the more significant certificates and awards.

From all quarters

A link with the pioneering says of the "short waves" has been severed by the death at the age of 87 of Miss Brenda Bell, sister of Frank Bell, Z4AA (later ZL4AA). A skilled telegraphist, she was considered the most dextrous operator of almost all the more significant "squares" on a map which she compared to collecting the numbers of railway engines or catalogue cards! For those not convinced by his arguments, the RSGB has recently published a new edition of its book "Amateur Radio Awards" by C. R. Emary, GOGH. This provides details of almost 100 of the more significant certificates and awards.

Propagation speculations

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

But if one theory is dented, two others are reinforced. Two years ago E. B. Dörting of Mullard Space Science Laboratory in a letter to Wireless World (Letters, April 1978) described the evolving theory of Sporadic E: tiny metallic particles caught up in descending wind shears becoming ionized in summer to form a highly reflective layer. He noted the belief that these metallic particles were "probably the remains of burned-up meteoroites". New evidence to support this view has been presented by G. Brown, GH4CD, in collaboration with the French amateur FRAI and the University of Dundee has shown from observations over the past two years a positive link between meteor showers and Sporadic E.

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Amateur satellite news

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

The first Phase III amateur satellite is now due to be put into a highly elliptical orbit about the end of May. A Russian amateur satellite(s) has been predicted for early this year, possibly by the time these notes appear.

In brief

Transatlantic 50MHz signals continued to be well received in the UK during the first half of January... An Australian 50MHz two-way record has been confirmed between VK0K and XE1EG, Mexico, a distance of over 14,000km... George Cole, G4A... lost his sight on active service in Italy during 1943 has made a member of the First-Class Operators Club... The GB2RN station on board HMS Belfast, moored near the Tower of London, will be active on all h.f. bands April 13... The date for the North Midlands mobile rally at Drayton Manor Park, near Northampton has been changed to April 13... "East Suffolk Wireless Revival 1980" mobile rally is on May 25 at the usual site at Ipswich Area Civil Service Sports Association, Straight Road, Budleigh Salterton, or Ipswich... The Welsh amateur mobile rally will be held at the Barry Memorial Hall on April 20...
are held in exact position by a small magnet G which is attached to the tracking arm so that in the central position neither electrode touches the mercury spheroid. A small displacement of the electrodes caused by movement of the magnet to either left or right causes contact with the mercury and completes a circuit via electrode H. It is worth noting at this point that small vertical movements of the magnet do not affect the electrodes E and F, neither do small fore-and-aft movements. This is all to the good, as movement in these directions can only arise from play in the suspension of the arm.

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

The only forces acting on the cartridge with the switch in or near the central position are the minute lateral forces required to press the electrodes E and F into the surface of the mercury, and to overcome the friction of the arms. This is all to the good, as movement is only necessary to operate the cut-out relay which stops the turntable and servo-motor.

When a switch is operated, the servo-motor is driven by current from the servo-system to a position where the arm's pivot is in the region of 200 mg per 1 gm of tracking force, with an exceptionally low coefficient of friction. The long-term chemical properties are good — it does not decompose or turn gummy, and is unaffected by mercury.

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

The electrodes are made of nickel as this is the only commonly available metal with the necessary properties i.e. low solubility in mercury (only 2 x 10^-6% wt.%), strongly magnetic, resistant to oxidation, and easily worked into the required shape. Iron may be a satisfactory material, but has not been tried in practice.

Regarding the mechanical layout, this is very similar to that of the opto-electronic system already described, except that the reference arm is now attached to the lower part of the gimbal ring, and carries the mercury switch, Fig. 3.

The tracking arm carries a miniature magnet over the top of the switch. The reference arm inertia is added to that of the tracking arm in the vertical plane. However, the position is no worse from this aspect than that of the conventional arm, as the extra mass offset by the shorter length of the tracking arm, as previously explained. Of course, it will not provide a pure reduction in inertia as the opto-electronic system does, but it is envisaged that there are other applications for a switch with these properties, not necessarily in the field of record-players — proximity switching for example.

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

Care is needed in handling mercury, which is poisonous by skin absorption and when the vapour is breathed in. Mercury is surprisingly volatile and the lungs absorb its compounds. Mercury vapours are produced when the vapour. Work should be done out of doors and any spillage cleared up at once and dusted with flowers of sulphur.

Drill three holes to suit gauge of nickel being used. A filler hole 6BA is also made in approximate position shown. Polish swaged and round holes. Insert centre electrode to give mercury ball a stable 3-point suspension. Adjust outer electrodes so that they just project above surface. Araldite all three in place.

When resin has solidified, knock out brass pattern. File off excess resin to shape shown. A "gruzzy disc" attached to an electric drill does this in a few minutes.
According to a paper presented at the Society of Motion Picture and Television Engineers' 14th annual conference in Toronto, all-digital telecine machines may be a reality by 1985.

Richards sees the head of the Image Science Department at the University of Edinburgh as one of the key researchers who is working on the development of these machines. He and his team have developed an all-digital telecine machine which allows photographic images to be digitally processed, enabling high-speed storage and retrieval. The system is described as being exceptionally clear and uniform picture. The system is a 1024-element linear array which scans the film image in sequence to 34 or 24 frames to produce a single 625 or 525-line sequential television signal.

The new machine has the potential to revolutionize the film industry by allowing for faster processing and easier storage of footage. It is expected to be commercially available in the near future. More information on the topic can be found in the conference proceedings or by contacting the author for a more detailed explanation.
Citizens’ Band moves

The lobby for citizens’ band radio in the UK has been regrouping in the hope of putting stronger pressure on the government. One important move has been the formation of a National Committee for the Legislation of Citizens’ Band. This combines the efforts of all the smaller bodies (such as the Citizens’ Band Association) to make one large pressure group for the whole of the UK. Chairman is Theo Yard, a councillor at Lewisham, and treasurer in James Bryant, president of the CBA. Clubs with at least 100 members are encouraged to join. A meeting of the National Committee was held in Cheltenham on 16th March.

In conclusion, the Citizens’ Band Association has applied to the Radio Regulatory Department of the Home Office for a licence for a private mobile radio (p.m.r.) communication system — the kind of licence devoted to taxi firms, etc. Ostensibly it is for a self-help group of motorists, the principle being that it will help to save fuel, but the CBA was really intending to be a “foot-in-the-door” from which a larger system may grow. Initially it is intended for about 50,000 users, but the association hopes to get about a million users in 2½ years. According to James Bryant, lawyers have advised the CBA that the Home Office cannot refuse to give such a licence, but at the time of going to press the association had not even received an acknowledgement of its application.

Finally, the CBA has written to the Home Office Secretary, telling him that the government need not worry about appointing extra civil servants to administer a citizens’ band radio service. The association is willing to provide the staff to do this. The accountants have told them they would have no difficulty in raising the money to form a limited company to take on such a task.

Noogami Electric announce unique device

THE British subsidiary of the Japanese Noogami Electric Corporation has recently announced the introduction of a “Ford” line inverter line feed. The item results from a ten-year test programme which enquired into base-conducting material for inverter transformers. The resulting form of a current-controlled, bi-directional circuit element is virtually eliminating electrical problems.

Although the full method has not yet been revealed, Noogami believes that the heart of the forming process is the introduction of a unique solid state component. This component is the key to the new technology and has several advantages over its predecessors. The new device is claimed to exhibit extraordinary electrical properties such as a totally unique switching threshold, a form of a current-controlled, bi-directional circuit element and unimpeded current flow. The device is expected to be used in a variety of applications where the device is suited to applications where virtually unimpeded current flow is required.

The new conducting device undergoing extensive environmental tests in the manufacturing a “clean” room at Yokohama by English workers in training. Staff are checked for stray capacitance before entering the area.

NEWS IN BRIEF

A display of early wireless equipment, under the direction of Barry Collett, will be held at the pistol Museum, Bridgewater, Somerset, starting on 5th April 1980. The exhibition is intended to provide a view of some of the hardware of pioneering days in broadcasting.

The IEEE has a series of lectures and other events planned for the next few months. On 27th March the Fintimmon Report will be discussed at a meeting in the Ariel Suite, Royal Angus Hotel, Southampton at 7.30 pm. Tom Stonier will be introducing the audience. Also present will be a member of the National Physical Laboratory staff. The meeting will be confined to a senior post. Applications should be made to the London Regional Management Centre for free tickets for the session.

The Byte Shop assets have been acquired by Comert (Computer Mail Order and Retail) Ltd. and the original premises in Throgmorton Court Rd, Ilford, Ilford, Birmingham, starting at 7.30 pm. Tom Stonier will be introducing the subject of “The Byte Shop” and all branches are currently running turnkey microcomputers and systems for off-the-shelf computer assistance. The Byte Shop will operate as an entirely separate business within the Comert group and the company intends to retain its independent dealer network.

A new company, called Metrolog Systems, has been established in Guildford, Surrey. The company is in the process of developing a number of microelectronic subsystems for industrial and process industries for applications in the control and measurement of manufacturing systems.

The 10th European Solid-state Device Research conference will be held at the University of Loughborough, UK, under the auspices of the IEEE, on 17-20th September 1980. The main aim of this conference is that of bringing together scientists and engineers working in the broad field of solid-state devices and to provide a European forum for the presentation and discussion of the latest research and technology.

A conference on low-frequency noise and its applications will be held from the 7th to the 10th May 1980 in Aalborg, Denmark. The conference will be held under the auspices of the European Space Agency and will be attended by experts in the field of low-frequency noise.

The Department of Electrical Engineering Science at the University of Essex will be running its annual electronics Summer School for teachers between 7th and 11th July 1980. Three courses will be run simultaneously and each circuit design course is concerned with the use of transistors and operational amplifiers in electronic circuits, and the basic elements of the hi-fi amplifier. The courses are open to teachers and students, and the basic elements of the hi-fi amplifier are considered in the first course.

Kisukumi wire in UK

Kisukumi wire in UK

Two well known electronics giants, one well known in the UK, the other in the USA, have founded a joint venture company in the UK. The new company, called “Signal Technology Ltd,” will be based in Swindon, UK. The company will be involved in the design of software and the development of hardware for signal and control systems. The company will concentrate on the development of software and the development of hardware for signal and control systems.

Obituary

Cecil Goyder

Cecil Goyder’s death has occurred in Princeton, New Jersey, USA, of Cecil Goyder, who, until his retirement, was concerned with the United Nations communications and radio services. Previously he was engineer-in-chief of All India Radio but it was as a young P.E.T. student that he founded the Goyder, a highly-esteemed university centre.

The solicitor’s role will continue to develop into a legal service to assist clients and provide them with legal advice on their chosen field.

The proposed solar power satellite would convert solar energy into electrical energy and beam it by microwave to the Earth’s surface. The satellite would be launched from the ground station and then fed into the national grid.

Kisukumi wire and flat-tube meter

In addition to its activities in the field of shipbuilding, the company has also been involved in the development of a new type of flat-tube meter. The company is now running a series of shipbuilding projects in the UK and the USA.

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Amplitude-modulated signals

A survey of amplitude-modulation detectors, with a classification of types

by S. W. Amos, B.Sc., M.I.E.E.

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

The word detector has been in use since the early days of radio and it was an unfortunate choice of term because it is by no means an attempt at classifying them. It doesn't detect the presence of a radio signal because the aerial and/or first tuned circuit of a receiver do that. It doesn't detect the presence of modulation because an a.g.c. detector is a circuit of amplification and modulation and to give an output related to unmodulated carrier amplitude. According to B.S. 4727 the job of a detector is to abstract information from a radio wave: the waveform of the audio modulated waveform as in a demodulator or it may be the information derived from a high-value capacitance as in the a.g.c. detector. Thus a demodulator is an example of a detector but a detector isn't necessarily a demodulator.

Since those early days the number of modulated waveforms and the complexity of the important characteristics has apparently grown enormously. It is possible to name 30 or 40 a.m. types without great effort. Terms such as envelope detector, square-law detector, envelope-detector and product detector are frequently encountered in electronics literature and examination of the various types can be greatly facilitated by the demodulator's output waveform: this can be a sine wave, a square wave or a pulse, and even in the latter case it is the nature of the output signal which is important and not the method of detecting it. The word detector may be defined as a circuit whose output voltage may be made to depend non-linerly on the amplitude of the input waveform: it is unnecessary for the circuit to amplify or distort the input waveform in any way. The term detector is therefore a useful one to use when considering the various types of demodulator and it will be used in this article.

We shall now examine this classification in detail.

Sampling detectors

Series-diode circuit

The simplest example of a sampling detector is the series-diode circuit shown in Fig. 1. It is similar to a half-wave rectifier circuit with the capacitor C1 able to be regarded as a reservoir capacitor. The output of the circuit relies on the charging rate of C1 through the low-value forward-resistance and the sub-sequent discharge through the high-value reverse-resistance of R1.

Diode D1 conducts during positive half-cycles of r.f. input and charges C1 to the peak value of the r.f. signal. The reverse-biased half-cycle of the input signal is cut off and C1 begins to discharge through R1. The ratio of the time constant RC1 to the period of the carrier is, however, so chosen that very little of the charge on C1 is lost before D1 begins to conduct on the next positive half-cycle of input and C1 is again charged to the peak value. Thus D1 maintains a constant DC voltage which depends only on the r.f. peak and is independent of the time instant when the input signal changes its sign. In r.f. circuits the period of the cycle is so much smaller than the time constant that the assumption is justified.

The circuit of Fig. 1 is known as an a.m. detector and is operated as a synchronously modulated carrier amplifier and peak detector. When the carrier frequency is modulated this circuit has a high degree of selectivity for the a.m. signal: it is not sensitive to any carrier-frequency components. The a.m. signal modulated carrier amplifier circuit has a high degree of selectivity for the a.m. signal: it is not sensitive to any carrier-frequency components.

A simple series-diode circuit or a sampling detector.

Fig. 1. The simple series-diode detector.

Fig. 2. Infnite-impedance detector.

Anode-bend detector

The infinite-impedance detector is a circuit in which the detector is replaced by two diodes and a high-value capacitance. The detector is a circuit in which the detector is replaced by two diodes and a high-value capacitance. The circuit is shown in Fig. 2. The anode-bend detector is a circuit in which the detector is replaced by two diodes and a high-value capacitance.
duce a grossly-distorted output. The synchronous detector operates strictly at carrier-frequency intervals and samples the positive peaks during one half-cycle of the modulating signal and negative peaks during the other half-cycle, thus correctly reconstructing the waveform of the modulating signal. The output has positive and negative swings and, for a symmetrical modulating signal such as a sine wave, has a mean value of zero. Thus, there is no d.c. component in the output of the prototype non-synchronous series-diode detector. This type of circuit can be used to demodulate the quadrature-modulated colour signals in a colour television receiver. Here the modulated signal has two carrier components in quadrature, each amplitude-modulated by a different signal. The circuit of Fig. 4 can demodulate one of these signals without interference from the other, because, during the time it is sampling the peaks of one signal, the other is passing through zero and so has no effect on the detector output. A second detector, with the second signal in quadrature with that of the first is required to demodulate the second colour-difference signal.

For some applications the components $R_1C_1$ and $R_2C_2$ can be omitted.

The diodes then connect $C_1$ to the source of modulated r.f. for the whole of one half-cycle.

A typical circuit is shown in Fig. 6. The modulated r.f. signal applied to the grid and the carrier signal, suitably phased with respect to the grid signal and of much greater amplitude, is applied to the cathode. The components $R_1$ and $C_1$ act as a d.c. load and hold the voltage cut off except during the negative peaks of the half-cycles of the signals applied to the cathode. When the voltage is conductive the anode current takes up a value determined by the amplitude of the signal and the grid at that instant. As the voltage is provided with an anode load, corresponding anode signals can be obtained from the anode.

Clamping detectors

Shunt-diode circuit. In the circuit of Fig. 6, the output of the detector is taken whole of the reservoir capacitor, but it could alternatively be taken from the detector circuit being replaced as shown in Fig. 7 to enable one leg of

Grid-leak detector. One well-known type of clamping detector which provides amplification is the grid-leak detector. In this version of the circuit, known as the shunt-diode detector or the reservoir capacitor circuit, the cathode is connected to the reservoir capacitor. The circuit diagram of which is shown in Fig. 8. The output is taken whole of the reservoir capacitor. The waveform of the grid voltage for a sinusoidally-modulated r.f. input signal (positive peaks being

Synchronous clamping detector. Figure 11 gives the circuit diagram of a synchronous clamping detector. It is much in common with the synchronous sampling detector of Fig. 4 except, of course, that the diodes are arranged to produce a short circuit once per carrier cycle. The diodes and the resistor in the base circuit form a balanced circuit chosen to minimise anode current in the detector output and the time constant of the output circuit can be minimised.

Additive (non-linear) detectors

In all the detectors so far considered, a reservoir capacitor has played an essential part: it is charged during part of each cycle of carrier component and discharges during the remaining part of the cycle. Thus the shape of the input-output characteristic is a consequence of the non-linearity of the $I_{an}$ characteristic. In the more practical case, the anode voltage should be high to further the current through the detection less important. This variant of

The detector output characteristic is less critical and the a.f. component becomes anode-bend detection.

The way in which the detector demodulates a synchronous carrier signal is illustrated in Fig. 12, in which the vertical dashed lines indicate the conduction periods. For a synchronised carrier these coincide with positive peaks of the modulated-r.f. signal during one half-cycle of the modulating signal and with negative peaks during the other half-cycle. Thus the output signal has positive and negative swings as shown in Fig. 2C. For the prototype non-synchronous shunt-diode detector there is a very large r.f. ripple
a device with a linear characteristic, the output has only two components and these are at the frequencies of the two input signals. If, however, two such signals are applied to a device with a non-linear characteristic, the output contains components not only at the frequencies of the two input signals but also at multiples of these two frequencies and are given by

\[ f_i \pm f_j \]

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

### Multiplicative (Product) Detectors

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

\[ \sin (\alpha + \beta) = \sin \alpha \cos \beta + \cos \alpha \sin \beta \]

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

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

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

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

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

#### Table of Detector Types

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<th>Classification of a.m. detectors</th>
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*See, for example, J. W. Herbert: “A Homodyne Receiver” Wireless World Sept. 1973.*

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PROGRAMMABLE NOTES FOR KEYBOARD INSTRUMENTS

Regarding M. Robson's letter in the November 1979 issue, one way of overcoming the problems with key changes while allowing a "natural" scale to redefine the function of the keyboard. The following is a suggestion to overcome the limitations of current keyboard instruments, which are tuned to an "equal-tempered" scale. The letter is ready a compromise, basically due to the fixed number of physical notes available. If we had a much larger number, true musical intervals (i.e. subjectively correct) could be played in any key as fact early keyboard instruments had "split" notes to resolve this problem. For example, A) and G2 should strictly be different frequencies, depending on the scale key being played, but have now been "tempered" to give the same frequency (i.e. they are the same physical note), which has become acceptable in modern music.

However, if we consider a keyboard generating "intervals" as opposed to absolute frequencies, this situation should not arise. Imagine a keyboard where notes to the right represent positive intervals relative to the last note played, and notes to the left represent negative intervals (the middle note representing no change). This is shown in Fig. 1. If a piece of music is now reinterpreted as a set of intervals (e.g. major/ minor tones, thirds, fifths, octaves, etc.) the instrument will generate the exact frequencies required. For example, intervals of a fifth from any note will always be the exact ratio of 3:2.

In practice, frequencies have to be generated which are proportions of the previous frequency. This could be done using multiplier circuits or digital techniques, but a simple method which springs to mind is to use a basic synthesizer concept. In these instruments a keyboard generates a linear scale of voltages which control logarithmic voltage-controlled oscillators. Using this idea, the frequency multiplication/division we require is easily obtained by adding/subtracting d.c. voltages. Operational amplifiers can be used for this, as we still have the last note played in a sample-and-hold arrangement.

The circuit in Fig. 2 (albeit crude) illustrates the basic idea, but has not been tested as it is only a suggestion for those readers with more time and patience to try a feasibility study. It may not in fact be practical due to drifting unless highly stable circuits are used. It is analogous to an infra-red based navigation system which is reset only once, and from then on everything is calculated relatively, thus accumulating errors. The instrument may be physically difficult to find the ratio required for musical notation. It is also monophonic, as chords have not yet been considered.

But for those who are interested, the operation is as follows: The key contacts are labelled K1 to K4, and must operate in that order. IC1 and IC2 hold the current note in their "hold" capacitors. When a key is pressed, S1, S2, opens and isolates IC1, IC2, closes, selecting the interval required (plus/minus or zero) which is added to the previous note from IC3, using the summing amplifier IC1, S1, S2 closes storing this new note on IC3, which produces the required frequency from the oscillator. S1 triggers the note envelope shaper, S2 in the reset required at switch-on.

P. A. Ting
Chipping
Manchester

C.B. RADIO AND POPULATION DENSITY

R. B. Hooper's letter in your February issue is interesting. He's perhaps forgotten about the density of population here. England comes second, after the Netherlands, with 900 people per square mile. Scotland, from where I write, is No.22 on the world's list, with 170, but even that is heavily concentrated, in its central area. A lot of the rest is mountainous. Victoria, Mr. Hooper's home-state, is Australia's most densely crowded: This happy region has 37 people per square mile, almost the same as Finland! His island-continent is itself at the end of the world's list. As it's roughly the same area as the continent of Europe it can well afford the "luxury" of citizens' radio, without "mutual interference". With these facts in front of him, Mr. Hooper must realise that the authorities here, with a population of around 20 million, view with enjoyment the prospect of 40 million people within easy reach of a telephone. Our communications system has, fairly recently, been extensively modernised and is quick and effective.

King Canute would have been gratified!

W. C. Rixon
Stromness
Orkney

THE INTELLIGENT PLUG

Two points regarding The Intelligent Plug mains communication system described in your December 1979 issue: (a) it could be lethal: (b) it would need a licence, which would not be granted.

The danger arises from the 1A capacitor in the transmitter circuit, practically between the neutral and earth lines (originally the authors state "for maximum safety"). However, if the neutral and earth connections at the wall socket were dirty and not making very good contact, the live mains would pass through the primary of the mains transformer at least, making the neutral wire also live, and then pass through the I.A., mixing the earth and hence the case and microprocessor live.

In most of the UK this is with in easy reach of a telephone. Our communications system has, fairly recently, been extensively modernised and is quick and effective.

King Canute would have been gratified!

W. C. Rixon
Stromness
Orkney

www.americanradiohistory.com
important of all, freedom is never 'granted' (that would be like being dark with light). It must be taken away for struggling for it. That is one of the main reasons why political and natural culture we can help young people in the true sense of it—see Wireless World making a small contribution.

Mr Frost could have added words from Germain Winstanley to his list. 'We have seen what it takes to struggle for freedom. Also people interested could very well read Henry Thoreau's 'Civil Disobedience'. Finally on this point, one should not forget the important things: how many things about lawyers and doctors -- and more of the same state, but you would not manage after centuries of oppressive and professionalised thought. directly after Mr Frost's letter you print the flaccid letter by Mr Greenwood. It is an easy response to see that an intelligent man like him could still offer the public some open questions. Notice that I imply that Wireless World should be 'above' all this. There is no need to consider the 'apologies'.owell. A flux's time-rate quantity that exists or is, it does not flow. It reflects a point or a state, not a directional quantity that moves. It is perfectly valid to consider current 'flowing' when it is a displacement current, appearing where there is no moving charges. In the accompanying diagram charge moves between points A and B for anywhere between the two capacities.

The displacement current is no current at all. It is a mathematical entity that needs to be introduced into the mathematics of Maxwell's equations in order to make his displacement current in a capacitor begs for an explanation. One possible explanation is that the original term 'displacement current' was used to describe the current in a capacitor since it is a current that occurs inside a transmission line, it need not become visible as a conventional current. The displacement current in a transmission line is used to represent the current that flows to the capacitor, such as a copper wire, because it is a current that flows to the capacitance and then makes it clear and to the point. So, in this case, the displacement current in the wire is the only one that is not only futile, it is also indirected. The displacement current is not a flow of electric charges, but an electromagnetic wave generated from an antenna, and if we get a number of wavelengths away from it, then

\[
\frac{d}{dt}\left(\sum \frac{E}{H}\right) = \frac{dE}{dt} + \frac{dH}{dt}
\]

The expression of this is really a formal one, and it is not necessarily normal to each other, nor is it only a result of the understanding of Maxwell's displacement current. It is not only futile, it is also indirected. However, it is perfectly valid to consider current 'flowing' when it is a displacement current, appearing where there is no moving charges. In the accompanying diagram charge moves between points A and B for anywhere between the two capacities.

From the authors' illustrations, it is hard to work out how the ' magnetic field lines are drawn'. Furthermore, this is a quite a complex one, with the boundaries not necessarily normal to each other. As to para. 2, where Dr Stockman suggests that 'displacement current' should be renamed 'displacement entity', we would prefer to use the term 'displacement current' itself.

With regard to para. 3, we object to Maxwell's lumped capacitance model, the other point is the quantity D is not the electric flux. The quantity D is the flux density, which is the magnetic field lines, to which the old Maxwell capacitor presents a conditional approximation. But, what kind of a transmission line is Maxwell's equation (1) in its

\[
E = \frac{d}{dt}B = \frac{d}{dt} \int \text{Magnetic flux density} \, dV
\]

Here we get the magnitude of the displacement current. The magnetic field lines, i.e., the condition of the displacement current, equation shows that \( \mathbf{E} \) has a magnetic field, which is the displacement current in Maxwell's capacitor, turned 90° with reference to Maxwell's field situation is usually a complex one, with the understanding of extending to right-angle bends, and the edges of the plates located inside the demarcation line of the magnetic field lines, which are not necessarily normal to each other, nor is it only a result of the understanding of Maxwell's displacement current. Therefore substituting in (3),

\[
\sum \frac{E}{H} = \frac{d}{dt}H = \frac{dH}{dt} + \frac{dE}{dt}
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That is one of the most vital messages of a society", as c.b. radio should well's lumped capacitance model, the other point is the quantity D is not the electric flux. The quantity D is the flux density, which is the magnetic field lines, to which the old Maxwell capacitor presents a conditional approximation. But, what kind of a transmission line is Maxwell's equation (1) in its

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\]

That is one of the most vital messages of a society", as c.b. radio should however, we recommend that the Irf capacitance transmitter circuit is reduced as Mr Williams suggested, and that the Irf capacitance has a significant loss of signal to noise ratio. Therefore, we recommend that the Irf capacitance may need to be increased or reduced transmission systems used to combat the accompanying degradation of the channel. The latter raises the difficult question of whether we can or cannot work with optical fibres for transmission. After carefully reconsidering the issue, we still feel that there is no use in hiding behind the facts that science needs to be publicised in the 'pure' or 'beyond politics'. That science, and by implication its relative, is a highly public and messy human activity. Like a magician, one is not only dirty, nor is it only a result of the understanding of Maxwell's displacement current. It is not only futile, it is also indirected. However, it is perfectly valid to consider current 'flowing' when it is a displacement current, appearing where there is no moving charges. In the accompanying diagram charge moves between points A and B for anywhere between the two capacities.

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WHAT’S SO NATURAL ABOUT e?

In Mr Finlay’s interesting article “What’s so natural about e?” (October 1980) y = e^x and y = e^x are drawn and it is shown that for every (x,y) on one it is such that for every (x,y) on the other.

This method is easy to understand, but another method avoids drawing the interpolation curves altogether. I suspect that Euler would have known it so.

We thus want to calculate this distance. The normal procedure would involve differentiation, but as a result of an inspired thought, Mr Finlay wants to avoid this, let us use his values of k. Let us take the graph y = e^x, for which k = 1.1. At the point of contact for this curve (F in my diagram) dy/dx = e . Thus we can use k = 1.1. At y = P = PQ; this gives y = e^x.

The author replies: I thank Mr Palmer for his kind remarks and several ways, including its historical value and elegant one of drawing tangents from the origin against any number of curves. This transfers the curve bodily by 1 unit. This transfers the point of contact is the same for all the curves.

We have already worked out that for natural growth, where dy/dx = e and for natural decay, where dy/dx = -e

We have y = e^x and y = e^-x. A closely related kind of natural growth, not explosive like e^x and therefore (fortuitously) more common, is expressed by y = 1/e^-x. To see what this means, consider the following account, based on recent physical experience may be.

We have y = e^x and y = e^-x. A closely related kind of natural growth, not explosive like e^x and therefore (fortuitously) more common, is expressed by y = 1/e^-x. To see what this means, consider the following account, based on recent physical experience may be.

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filters and attenuators (and we mustn't forget that attenuation can be measured in nepers — yes, the CIEB isn't any more successful with the Grid cables between the pylons, and yet both of them, like the rest of us, haven't doubted the admired graceful lines of a suspension bridge over the Forth, the Forth Road Bridge.

The first two cases are examples of curves produced by gravity pulling an evenly-forming line in a horizontal shape — a catenary (from the Latin ‘catena’ = chain) — and the others, which have the added complication of an almost horizontal roadway along below, are pretty near it in shape.

The catenary is formed by adding a formula such as Fig. 17, namely $e^{-x}$ and $e^{x}$, and halving the result, i.e. 

$$\frac{e^{-x} + e^{x}}{2}$$

which looks very similar after what we have said about the complex of the relationships between $\cos x$ and $\sin x$, and which is a useful generalisation which always results in a curve that is the inverse of the hyperbolic tangent hyperbolic equivalent of $\tan x$.

Now that last factor alone is not unfamiliar to electrical engineers since we represent it by $j$ and use it a lot in a.c. work. As we have known long ago that this brighter a star is, the bigger is its magnitude, and today the brightness can be accurately measured, and vary according to the angle of the star. Now why should this be so? Of what possible practical value is an imaginary number? How can we deal with it? The answer is that, usually, it is generally introduced as a mathematical trick, a sorcerer's device that will unlock the door to several mysteries, and so it does.

The last two examples are just one case of the human sense responses, in which the eye is primarily concerned, and the ear to sound volume and to pitch (frequency), all in a logarithmic scale, making it possible for us to distinguish very weak sensations and to be mercifully protected against excessively strong ones. The same law discovered by the 18th century physicists, Weber and Fechner, applies to other senses, too, as of touch or pressure in comparing weights in the two hands.

I earlier mentioned the shape of a grand piano, determined by the varying requirements of its strings, as an interesting comparison between it and the FA Cup rounds as a knock-out competition. The shape is arrived at by the frets in fingering a guitar following an exponential curve, as does the corresponding way in which a fiddler handles his strings or a trombonist moves his slide. What about a guitar? The neck of a guitar, born of age-fitting hurdy-gurdy, in the somewhat colder world of statistics, gantry such matters as the distribution and normal distribution curves and various aspects of probability.

Another class of differential equations, the second order, such as

$$\frac{dy}{dx} + 2 \frac{dy}{dx} + y = 0$$

is of great importance to engineers. We meet them most commonly in dealing with natural vibrations, with mechanical or electrical, and it is then a time variable. The general solution is

$$y = e^{-x} (A \cos x + B \sin x)$$

The first natural step turns out to be the series for calculating cost, and the second line for times sin $x$ (in radians), which is how we have known all those years ago!

$$\cos x = 1 - \frac{x^2}{2} + \frac{x^4}{24} - \frac{x^6}{720} + \cdots$$

This is usually attributed to Euler, that master-builder of series, and so is known as Euler's Trigonometric Identity. Interestingly, though, this formula (1748) was anticipated by an Englishman, Roger Cotes, who in 1714 published a theorem which appeared in modern form

$$\log (1 + x) = x - \frac{x^2}{2} + \frac{x^3}{3} - \cdots$$

This is that is, which is the most mystical relation of the three w e r e d , $e$ and $\pi$ that I mentioned earlier. How wonderful is it to see that it all flows through by $\tau$, for a good reason that will appear in a moment, so that

$$e^{i \phi} = \cos \phi + i \sin \phi$$

This trig. side shouldn't bother anyone because it is a clear instruction to build up a phase diagram from $\cos \phi$ and $\sin \phi$, horizontally to the right followed by wind vertically upwards, as in Fig. 18.

For the first formula, we use Euler's identity, and then from $e^{i \phi} = \cos \phi + i \sin \phi$, and

$$\cos \phi = \frac{e^{i \phi} + e^{-i \phi}}{2}$$

and

$$\sin \phi = \frac{e^{i \phi} - e^{-i \phi}}{2i}$$

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Finals

Have you, like me, ever had a hangup about? Maybe you refused to believe in the existence of this peculiar number, or even took a physical dislike to the formula in which it appeared? If so, I hope that by now your feelings towards 2.718... will have softened and indeed, much as they may do in real life towards a man of, as I have tried to do here, and as the very greatest of mathematicians have always done.

Finally, a request. Does anyone know a simple mechanical model which brings out the value of e? I have looked for a list of sections on the operation of all sections of the equipment under dis-


22. M.G. Senare-Marconi was in trouble with the newspapers and popular science publications in the early part of 1910. Many operators learned to explain "V" or atmospheric and Marconi expressed the view that, since identical "signals" were received with great

18. To anyone's satisfaction) that no missing link, as has so often happened which the infants could use (in place of buttons), will be found easy to read by British service technicians. Circuit diagrams may be a bit more difficult, since they are drawn in the 'upside down' transatlantic fashion. The book contains 583 pages, £16.20 and is published in hardback by George Philip & Son International, 66 Wood Lane End, Hemel Hempstead, Herts. HP2 8RG.

Complex Digital Control Systems, by Gutli-Through direct marketing we can now offer these test instruments and many many more at very competitive prices, which include

have contributed to its understanding, smiling from their golden clouds in Paris. Could I make a special plea to any teacher of (or lecturer in) mathematics who has taken the trouble to read through these articles? Please try to enliven your subject; make it worth cultivating to his own satisfaction, to the average student an incentive by revealing to

Barrie & Jenkins Ltd. £15.10-


22. M.G. Senare-Marconi was in trouble with the newspapers and popular science publications in the early part of 1910. Many operators learned to explain "V" or atmospheric and Marconi expressed the view that, since identical "signals" were received with great separation on the earth, the most likely explanation is that there is a great distance and possibly well outside the earth, meaning natural sources, of course. This remark was joyfully seized on by Fleet Street, who interpreted it as meaning that "playful Marconi" was transmitting to us, Marconi denied that he meant anything like that, but it was too late and the controversy was well under way. The initial head of steam was maintained by those who wanted to see a reply to worry much about the facts.

A succession of articles appeared, and the claim in our April 3, 1920 issue (we were then fortnightly) carried a piece by Philip Courbet and the report of the presidential address to the Wireless Society of London by A.A. Campbell Swinton, F.R.S. His remarks on the subject went as follows:

"Perhaps it might with advantage be pointed out that the intensity of received wireless signals varies inversely more or less according to the square of the distance between the source and the point of reception; so if we suppose the mysterious signals in question originate on the planet Mars, the power of the sending apparatus must be of prodigious dimensions.

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20. Ref. 22, Ch. 8 pp. 73-8 (e).


Improving photodiode camera signals

Shading correction for array scanner used in chromosome analysis

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

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

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

Fig. 1. Chromosomes in a blood cell are shown on this microscope slide in the circled area, which has a diameter of about 50μm. The drawn horizontal line represents a scan traversing the image on the photodiode array. Large dark objects in this field of view are nuclei of blood cells which are not dividing.

Fig. 2. Oscilloscope trace of the 256-diode array scanner signal corresponding to the scan line marked in Fig. 1. Vertical scale is 200mV/cent, horizontal scale is 30μm/cm.
microscopes. The microscope slide is at the same time driven back and forth under the control of a stepping motor at 90° to the scanner direction and at a speed of 3,000 microns per second.

The major component of the non-uniformity of diode array signal voltages arises out of the slide illumination and primary optics. At each stage in the microscope light path there is a loss of intensity due to the imperfect transmission of the optical components across the entire field of view. Maximum transmission is usually along the optical axis. A lesser component of signal non-uniformity is the differential photodiode sensitivity, which is specified as 8% by the manufacturers, though in practice only one or two diodes differ in sensitivity from their neighbours by this amount.

The magnitude of signals from large chromosomes exceeds the 8% sensitivity variation of the diodes but is much less than the observed 2:1 illumination variation. Small chromosome signals are obscured by both. In the absence of shading correction, therefore, detection of chromosomes and the measurement of their transmissivity is very nearly impossible.

Shading correction theory

When there is no object on the microscope slide imaged onto the 100W quartz halogen light source, only the background signal is detected by the photodiode in the array. Each diode voltage therefore must be processed to form:

\[ V_{i} = V_{i0} + V_{i\text{corrected}}. \]

Each diode voltage therefore must be multiplied by a factor \( V_{i0}/V_{i} \)

where \( V_{i} \) is the constant voltage representing the flat response of a perfect system. Comparing these two equations we see that the shading corrected voltage \( V_{i} \) is given by

\[ V_{i} = V_{i0} + V_{i0} \left( V_{i} / V_{i0} \right) \]

or

\[ V_{i} = V_{i0} \left( 1 + \frac{V_{i}}{V_{i0}} \right) \]

Detailed circuit

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

1. Reducing \( V_{i0} \) by a fraction \( f \), store correction factors \( E_i/V_i \), then multiply the corrected diode signals with a factor \( 1/f \) to form:

\[ V_{i} = f \left( V_{i0} + V_{i0} \left( E_i/V_i \right) \right) \]

2. Store correction factors \( V_{i0}/E_i \), then divide diode signals with these factors to form:

\[ V_{i} = V_{i0} \left( E_i/V_i \right) \]

The actual method adopted is the last of these options. Fig. 5 shows the complete shading correction circuit. Diode zero timing signals occur at the start of each scan and the diode clock signals occur each time a diode video signal is ready for processing. Both pulses are approximately 500ns which is half the duration of each diode signal. The start circuit is designed to begin accumulation of correction factors at the second...
during the start button is pressed, thus giving a clean start. Correction factors tally full twice before the correction diode zero pulses are blocked and the register at the rate of one per scan.

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

Mercury switch for parallel-tracking pickup arm

J. Cut two lengths of nickel wire and turn one end of each to a 60° point. Flatten other end in a vice and file square to 1.2in. and 1.3in. Drill a hole in the flat end of wire (e.g. 22swg) in flattened portion. Insert short pieces of nickel wire with one end turned to 60° point. Comp. into place, and apply a spot of Araldite to secure. Bend the ends of the electrodes as indicated. Hold both electrodes together side by side in a small vice or pliers. Twist into final shape. Glue temporarily with "superglue". Test for electrical isolation.

K. Assemble pivot cups in switch case and rear part of lid. Try cut electrode assembly for size and freedom of movement. If necessary dismantle electrode assembly and pivot cups and file bend until acceptable. Introduce mercury ball into trial basis and check that correct action takes place. The electrode assembly can then be permanently fixed with Araldite instead of "superglue".

Now remove pivot cups and solder 12in. length of Litz wire to them. Also solder 12in. of Litz wire to three-channel electrodes taking care not to disturb their position. Re-assemble switch, with some rapid-setting Araldite on the lid. This gives you about 3min to manoeuvre the lid. Give a final mechanical and electrical check before gluing on the front part of the lid, using Araldite.

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

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

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

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

Material: mu-metal transformer laminations.

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

Improved tone control

Many audio amplifiers use a Baxandall tone control network around a single transistor as shown. With this arrangement the gain is adequate when the controls are flat but, if bass or treble boost is required, noticeable distortion often arises. This problem can frequently be overcome by providing the original transistor with a bootstrap collector load. With an inverted emitter follower, the increase in gain is around 3.5. The base-emitter resistor should be 3k and the bias resistors must be adjusted to restore the original d.c. conditions.

G. Hibbert
Blacksfriars
Oxford

Continuous a-to-d converter

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

J. E. Dahl
J. D. Whitfield
University of Queensland
Australia
Battery charger protection

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

R. H. Bennett
Christchurch
New Zealand

Voltage follower with adjustable zero-offset

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

R. D. Smith
Gallowgate
Aberdeen

Divide by three

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

M. Rocha
University of Porto
Portugal

Data channel error recorder

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

For every input frequency select C and output 1 to equal mark-to-space ratio

(a) (b) (c) (d) (e)

V.h.f. automatic d.f. set

A portable receiver, indicator unit and antenna array constitute the ADFS-320 v.h.f. automatic direction finder, intended for the location of narrow-band f.m. or a.m. signals in the 148 to 174MHz range. The unit is manufactured by the American T.R.C. Company and is distributed in the UK by Technology Ltd; the receiver/indicator unit consists of a c.r.t., signal strength meter, internal loudspeaker and 10 plug-in crystal points. A standard Adcock antenna array is fitted for shipboard or fixed-location installations and comprises four vertical dipole elements, a central whip section for sense reference and signal pre-processing circuits, all contained in one integrated assembly. A signal is instantaneously displayed as a relative compass bearing on the circular c.r.t., where it is shown as a thin line trace running from the centre of an indicated compass head at the outer edge. The makers say that information displayed in this way is easily interpreted, even by inexperienced operators. The circuit technique employed eliminates the need for a manual "sense" function to resolve 180° ambiguity and results in automatic readout of bearings.

Technation Ltd, 58 Edgware Way, Edgware, Middlesex.

Relay with push-button actuator

Push-button actuation, permitting manual operation of the relay without the need for an energizing voltage to be applied, is a main improvement which Pyo Electro-Devices Ltd, quotes for its new range of Series 12 relays. These are general purpose two and three-pole changeover types for both a.c. and d.c. operation; they have octal base connections and contact ratings of 16A maximum. Options include tropicalization and neon indicators for coil energization. Mounting sockets complete with sensing clip are also available.

Pyo Electro-Devices Ltd, Exning Road, Newmarket, Suffolk.

Programmable v.h.f. receivers

The Bacroset range of programmable receivers, made in the USA by Electra, are now available in the UK from Com-Tek. The receivers are programmable synthesizers, v.h.f. units permitting monitoring of frequencies in the ranges 66-83MHz, 119-130MHz, 146-148MHz, 148-174MHz, 420-470MHz and 470-512MHz. Bacroset model 220F permits up to 26 channels in any combination of the stated frequency ranges to be keyed in and monitored continuously. Power supplies required are either 240V a.c. or 12V d.c. and prices start at £280. Com-Tek (Mid) Ltd, 506, Alum Rock Road, Birmingham B8 3DX.

Tool kit

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

Semi-conductive rubber pads are already used extensively on the continent of Europe in keyboard applications, according to G. English Electronics Ltd, and this company is now producing a fully conducting form which in itself is suitable as a replacement for normal metal contacts.

Display tube analyser / restorer

The model 407 c.r.t. analyser manufactured by the American company B & K/Dynascan Corporation, is intended for the on-site testing of computer terminal displays. The analyser is intended for the display tubes. A characteristic of the unit include which is a replacement for cathode "poisoning," and this process is timed automatically in order to prevent cathode stripping. The complete tester is fully equipped with an array of pin configurations as well as a comprehensive set-up chart which the makers say makes the unit virtually fool-proof.

Miniature photoswitch

The E3S photoswitch is claimed by the makers, IMP Precision Controls, to be the world's smallest. The unit has a sensing range of 3mm (max) and can switch 5mA when operating from a 24V d.c. supply. Main specifications are:

- Frequency range from 0 to 10 MHz.
- Propagation delay: 100 ns.
- False switching rate: 100 per second.
- Voltage supply: 12V d.c.
- Accuracy of measurement: ±0.1%.
- Temperature range: -40°C to +70°C.
- Humidity: 95%.
- Dimensions: 25 x 25 x 15mm.
- Weight: 15g.

Shrink-on tubing and terminals

Test piece materials manufactured in p.v.c. or polyolefin for use as shrinkable tubing or as shrink-on terminals and covers is available from Suhner Electronics Ltd, 27 Warrispie Rd, Woolwich, London SE18 5NL.

Digital readout for antenna rotor

Clasped by the makers, Monitor, of Canada, as "accurate to one degree," the DS-3 digital readout module, which is supplied in kit form, can be used to provide visual information on the orientation of a rotatable antenna. The makers also say that the unit may be used as a workbench digital voltmeter and the price is $19 (money order) from Monitor, Box 55, Agincourt, Ontario, Canada M1P 1A8.

ccr and controls include store, hold, and reset, while various outputs enable all functions to be monitored externally. A 10MHz quartz crystal controls the timebase, with a temperature stability error of ±30 p.p.m. Lascar Electronics Ltd, Unit 1, Thomas Rd, Burnt Mills, Basildon, Essex SS13 3LA.

Flush mounting proximity switch

A proximity switch, which the makers, Hamlin Electronic Ltd, have designed for use in intruder alarms, counting, "brushing" and warning equipment, can be flush mounted in a hole drilled in a door frame. The RP11 is a read-switch device and the operating magnet can be similarly fitted to the door. Four options are available, the standard form A (normally open), standard form B, higher power form A and standard form C (single pole/ double throw). The switch measures 28 x 7.62mm and is supplied with two pairs of leads, one being provided for looping back into the circuit. Hamlin Electronics Europe Ltd, Dene, Norfulke IP2 5AY.

Miniature photoswitch

Designed as an answer to the problems of high density component packing, the E3S range of flat-bodied i.d.s. manufactured by Rastoria Electronics, measure 0.15 in or 0.2cm to centre. They are available in the standard colours of red, green, orange and yellow. Rastoria Electronics Ltd, 275-281 King St, Hammersmith, London W6 9KF.

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WIRELESS WORLD, APRIL 1980

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0.005%

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will

input.

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Slope

(1 dB)

slew-rate

20kHz.

40dB, this

A. is accurate to 1 dB;

20kHz.

CPR

1 size is

45-0-45v

.005%

High output cartndges

for nearly

all

unusual modulated signals . Sensitivity

1

Primary

25V

1

1

(1 dB)

.005%

20kHz.

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high with a

primary and single

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0dB;

trackng heavily modulated records . Common-mode rejection is arbitrary for an annual

discharge, 3 A.D.A. s, 15W

senses. This module

0.01V.

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45-0-45v

90p

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3

5-0-3 5v

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APPLICATIONS which will be treated with strictest confidence. Should be sent accompanied by a resume in the University of Surrey, Department of Music and Television Engineering, 4635-4639. Applications will be considered on receipt. Closing date 31st January 1980.

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£4605-£5952 + £398 L.W.) rising to £4605 plus £398 London Weighting per annum.

The holder of the first post will assist in the planned preventative maintenance and first line call-out servicing of supervisory and ancillary equipment. He/she will work in collaboration with the Lecturer in Recording Techniques on the Television Course and should have radio or recording industry experience. Salaried grade 5 scale, 232.

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Department of Psychology

Applications are invited for the above post in the Department of Psychology. The post is to be responsible for the running of the Psychology Department laboratory and the provision of technical services to it and to the Experimental Psychology Unit as well as the teaching of technical staff.

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required for Medical Research Council supported project in the Department of Psychiatry to design, develop and maintain analogue and digital equipment and to provide technical support to other specialists in the team.

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University of St. Andrews.

Chief Technician

Department of Psychology

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Years of experience 0-1 1-3 3-6 Over 6 ____________________________
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SITUATIONS VACANT

ELECTRONICS TECHNICIAN (Grade B) required by Physics Labs Dept. for the design and construction of minicomputer instrumentation. Applicants should have a good A levels in Physics and Mathematics. Also a good general knowledge in electronics and computer interfacing desirable. Must be able to work as part of a small team. This is a great opportunity for someone in the early stages of their career. Applicants should apply in writing to: Personnel Officer, Target Field Industrial, Holme Lacy Road, Upton upon Severn, Worcestershire WR6 3DD.

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SITUATIONS VACANT

UNIQUE OPPORTUNITIES FOR

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We are currently establishing small teams within our Laboratory to carry out development, test and field trial on military communication equipment from our wide range of sophisticated high technology electronic products. It is essential that these teams are well balanced and we are looking for someone who can take on these roles as Technical Engineers.

The work will be extremely varied, involving the development, evaluation, debugging, design and proof testing of advanced radio communications equipment, with extensive analog and digital circuits, using the most up-to-date techniques, including the use of microprocessors.

Modem. Applicants will be qualified to C&G, HNC or equivalent level, have had several years’ experience of radio communications equipment and be familiar with both analog and digital engineering. Applicants will be currently under considerable pressure and we welcome applicants with alternative experience, who wish to broaden their knowledge.

Salaries offered will be highly attractive and there are excellent prospects for career progression, both within the technical engineer grades and the Company, with potential being recognized and rewarded accordingly.

If you feel you can meet the requirements please write or telephone now, with brief details of qualifications and experience to: Tony Caiger, Technical Recruiting Officer, Plessey Avionics and Communications Limited, Martin Road, West Leigh, Havant, Hampshire, PO9 6US (0705) 48831 ext. 423
You won’t believe it until you see it –
So you’d better come and have a look

Do you have experience working on VHF/UHF telecommunication equipment?

If you have, then this might be the opportunity for you! We are looking for skilled Service Engineers who can troubleshoot and fix various electronic issues. If you’re interested, please apply for the position.

 OPPORTUNITIES FOR VHF/UHF SERVICE ENGINEERS

Application Instructions:

• Submit your resume and cover letter to HR@company.com
• Include a brief description of your work experience in the application
• Interviews will be scheduled for candidates who meet the requirements

Phone: (123) 456-7890
Email: HR@company.com

*Note: This advertisement is valid for the next 30 days.*
Republic of Botswana

Telecommunications Radio Engineer

Up to £10,550 plus allowances

Candidates should be qualified as Radio Engineers ( eg. HNC, C & G Radio Craftsmen) and have several years' experience in the installation and maintenance of ground navigation aids and (VOR/DME/NO) air ground communication system (VHF/HF) and communication equipment using: Fixed telephone networks (Radio telephony) HF transmitters. Duties will include the installation and maintenance of equipment and on-the-job training of staff of the Civil Aviation Department.

Salary includes a substantial tax-free allowance reviewed annually paid under Britain's overseas aid programme. Basic salary attracts 25% tax-free gratuity.

Benefits include free passages, generous paid leave, children's holiday visits and excellent educational opportunities, appointment grant and interest-free car loan.

The terms on which civil and public servants may be released if selected for appointment will be subject to agreement with their present employers.

For full details and application form write quoting MA22/WD.

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TELECOMMUNICATIONS Radio Engineer

Twenty-four hour duty working may be involved.

The successful candidate must be prepared to travel to all regions of the country.

The radio engineer is required to be responsible for all aspects of radio communication systems.

Salary: £10,550 plus allowances.

The successful candidate will require a substantial degree of experience in all aspects of radio communications systems.

Telephones, telegraphs, satellites, VHF, HF, VORs, DMEs, etc.

For full details and application form write quoting MA22/WD.

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2 ELECTRONIC ENGINEERS

To work on system design, in close cooperation with customers at the European level. The successful candidates will work together with A.C. design groups and marketing, to create new circuit concepts using Motorola products. Customer support and associated experience in products and systems will also be part of the job.

Education to degree standard or equivalent in Electronic Engineering and a good command of the English language is required

SENIOR APPLICATIONS ENGINEER (Radio & TV)

The engineer we are looking for will have had a minimum of 3 years experience in the design of Radio and TV circuits.

A knowledge of digital techniques would be a definite advantage.

SENIOR APPLICATIONS ENGINEER (Microprocessors)

An engineer with extensive experience of microprocessor (soft and hardware) design is required, to support the design of consumer oriented control systems in the TV, radio and domestic appliance industries.

Opportunities for travel exist with both of the above positions. If you are interested in joining a rapidly growing division of a major international company, and can satisfy the above conditions, please send your Curriculum Vitae to:

Tecnofonika,
MOTOROLA (SUISSE) S.A.
Lugano-Cremona, Via Canso 1211
CH-2612, Switzerland

Tel: 022 99 14 76

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**WANTED!**

We need a person to join a small group offering engineering support to research workers in pharmacology and related departments.

The work involves the maintenance and development of electronic equipment and some light mechanical tasks.

Applicants should have a good general education with technical qualifications to HNC level. They will be practical people who enjoy solving problems and undertaking constructive projects.

Experience in analogue and digital electronics is essential together with the ability to use a lathe and milling machine.

We have experience in biological research, or whose hobbies include electronics, radio, modelling, etc. would be at an advantage.

We are in a position to offer an attractive salary plus all other benefits, as above.

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We also offer equipment for testing and calibrating (eg. oscilloscopes and wave form analysers) on request.

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TECHWELLCOMB LEADERSHIP Course

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**聘任**

**TELECOMMUNICATIONS**

**Radio Engineer**

Twenty-four hour duty working may be involved.

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The radio engineer is required to be responsible for all aspects of radio communication systems.

Salary: £10,550 plus allowances.

For full details and application form write quoting MA22/WD.
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Applications don’t come much more critical than digital watch manufacture.
Here, discrete deposits of Multicore Oxide-Free Solder Cream are screened onto the PCB. A precision job, with no risk of operator error or fatigue. And, a convenient temporary adhesive for the positioning of components.

ordinary solder creams cannot match this profitable performance. Here’s why...

... because ordinary solder creams or pastes contain rosin-based flux mixed with solder powder produced by atomisation. This means that every particle of the powder is covered with a layer of oxide—slowing down the soldering process, leaving a dirty flux residue and causing solder globules to stick to the flux and possibly fall loose into the equipment after shock or vibration. But, Multicore have developed a very special method of producing solder powders that are virtually oxide-free.

These can be used in cream form—comprising an homogeneous stable mixture of pre-alloyed powder and flux, designed specifically for hybrid microcircuits, PCB’s and critical component joints.

When heated, Multicore Oxide-Free Solder Creams melt and flow as quickly and cleanly as rosin-core solder wire, leaving a pale clear flux residue without solder globules.

The in-built quality of Multicore Oxide-Free Solder Creams make them the ideal specification for almost any application calling for low cost yet high reliability.

They are available in a wide range of combinations of solder alloys, fluxes, particle sizes, flux contents and viscosities—often replacing solder preforms.

However, if you have an application that specifically requires preforms, remember that Multicore supply a wide variety of those as well.

Multicore Solders Ltd are Ministry of Defence Registered Contractors and on Qualified Products List QQ-5-S7E of U.S. Defense Supply Agency for solder creams and preforms.