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<th>Series</th>
<th>Secondary</th>
<th>RM</th>
<th>Current</th>
<th>Price</th>
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<tr>
<td>15 VA</td>
<td>1x100</td>
<td>6+6</td>
<td>1.25</td>
<td>50 + P.V.A. 7.58 £5.12</td>
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<tr>
<td>30 VA</td>
<td>1x100</td>
<td>6+6</td>
<td>1.25</td>
<td>50 + P.V.A. 7.58 £5.12</td>
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<tr>
<td>60 VA</td>
<td>1x100</td>
<td>6+6</td>
<td>1.25</td>
<td>50 + P.V.A. 7.58 £5.12</td>
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<thead>
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<th>Address</th>
<th>Telephone</th>
<th>Telex</th>
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<tr>
<td>Black Star Ltd.</td>
<td>9A, Crown Street</td>
<td>(0490) 62440</td>
<td>32339</td>
</tr>
<tr>
<td>Bell Elec</td>
<td>9A, Crown Street</td>
<td>(0490) 62440</td>
<td>32339</td>
</tr>
<tr>
<td>Sabtronics</td>
<td>9A, Crown Street</td>
<td>(0490) 62440</td>
<td>32339</td>
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<tr>
<td>Elec</td>
<td>9A, Crown Street</td>
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<td>Elico</td>
<td>9A, Crown Street</td>
<td>(0490) 62440</td>
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<table>
<thead>
<tr>
<th>Module Number</th>
<th>Output Power Watts rms</th>
<th>Load Impedance</th>
<th>DISTORTION T.H.D in %</th>
<th>Supply Voltage Typ</th>
<th>Size (mm)</th>
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**MOSFET MODULES**

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**PWR AMP SYSTEMS**

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<td>Power amp</td>
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Know-how: resource or property?

When the committee of the UK's Independent Review of the Radio Spectrum sent out a letter last year inviting people to contribute evidence, it put forward some new and interesting questions for consideration. One was whether decisions on spectrum allocations and frequency assignments should be influenced by value judgements of the "worth" of the services and transmissions in question. This obviously implied a need for assessing the different claims within society for spectrum space. Another question was whether frequency assignments should be determined or influenced by market forces — for example, by treating spectrum space as an economic quantity and charging rent for it or auctioning it off to the highest bidder.

These two possible approaches to the disposal of frequencies are obviously ideologically opposed. As such, they could almost have been laid out as part of the agenda for the ideological battle of the UK's coming General Election, for much of this battle will be between different value judgements on the right way to apportion scarce resources. They belong, respectively, to the opposing principles of political power and economic power.

But the radio spectrum is only one example of how these different attitudes reach into the whole body of electronics and communications technology. Electronics manufacturing, in contrast to making shoes or breakfast cereals, is a perpetual race to get ahead in specialized technical knowledge — or that amalgam of applied physics and empirical practices we like to call know-how. In business you must keep up with your competitors in know-how or you will do badly and perhaps fail. In international diplomacy you must keep up with your adversary in the ability to deploy such know-how as a military threat.

All political parties in Britain declare that electronics know-how is important to the economic future of the country and that it should be disseminated as rapidly as possible. But the Right and Left extremes differ fundamentally on the best way of using it for the good of the people, because they see it in different ways.

The Right, believing in the essential beneficence of the free market, think that know-how should be acquired under the stimulus of commercial competition. The process of demand in a free market ensures that people get from the technology what they really want from it. Meanwhile, the know-how is a property, rightfully belonging to the entrepreneur because he made the effort to possess it in the first place. Then, after a period of commercial exploitation, it eventually becomes common knowledge, to be consigned to the text-books, and so ceases to be a property with valuable ownership rights.

The Left, believing in government intervention rather than market forces, think of know-how as a resource that should be applied directly to the collective benefit, not through the selective processes of the market. They dispute the Right's view that everyone gets what he wants in a free-market system simply through demand. They argue that demand is artificially generated by entrepreneurs, by using advertising, for example, to create wants that will blot out awareness of real needs. This artificially created demand is actually what the entrepreneur finds convenient and profitable to sell, and the know-how behind the products follows the same selective pattern.

Experience has shown that know-how produced under the stimulus of competition in free-market economies is more advanced than that obtained under state control in centralized economies. The issue, however, is not about absolute levels of know-how in different systems but about alternative ways of distributing this resource or property to the benefit of society. The problem applies equally in the less developed countries of the Third World. It is too serious to be left to the outcome of party political contests and deserves more concentrated attention than it gets at present from just academic studies and technology assessment organizations.
Tracking satellites with a microcomputer

This fully-automatic system will track amateur or weather satellites continuously using a PET microcomputer to control antenna azimuth and elevation.

by I. P. Jefferson B.Sc., G4IXT

Where B is the latitude of the sub-satellite point, a is the latitude of the receiving station and C is the bearing to North (in this case 0 degrees).

3. Finally, the corresponding longitude of the sub-satellite point is calculated:

\[
\sin L = \frac{\sin C \sin D}{\cos B}
\]  

where L is the difference in longitude between the sub-satellite point and the receiving station.

Thus the latitude and longitude of a point corresponding to a particular elevation have been calculated, on a heading of due North (0 degrees). It is now necessary to calculate points on other headings at the same elevation angle. (Note that it is only necessary to calculate points for headings 0-180 degrees since the chart is symmetrical). The whole procedure is then repeated for different elevation angles up to 90 degrees.

Having drawn the charts it is necessary to know the sub-satellite point in order to use them. This can be found as follows:

\[
\sin b = \sin(360t/T) \sin U
\]  

where b is the latitude of the sub-satellite point, t is the length of time in minutes since the satellite crossed the equator travelling North (the EQX time) and T is the satellite orbit period at inclination angle U to the equatorial plane.

The corresponding longitude is given by

\[
I = \cos^{-1} \left( \frac{\cos(360t/T) \cdot \cos b}{\pm [t/4]} \right)
\]  

The factor t/4 is due to the rotation of the Earth: the Earth rotates ¼ degree every minute. When the orbit is retrograde, i.e. U greater than 90 degrees, t/4 is added.

To complete the charts, it is now necessary to take values of t from say, 1 minute to 115 minutes (a complete orbit) and substitute in (4) and (5) to find the orbital path.

The graphs plotted will give the antenna azimuth and elevation for the satellite concerned. For any other satellite,
The calculated tracking

The requirement is to produce values of azimuth and elevation for a given satellite at a specific time, as quickly and accurately as is possible. In order to do this, some basic information is needed:

(a) The satellite's orbital period.
(b) The longitude increment at the equator per orbit.
(c) The inclination of the orbit to the equatorial plane.
(d) The apoee and peri gee of the orbit.
(e) A reference orbit, i.e. the time and longitude of an equator crossing, travelling in a particular direction (generally North).
(f) The latitude and longitude of the receiving station.
(g) The time in GMT.

All of the above from (a) to (d) inclusive are fixed and can be built into the program. The remaining data must be supplied by the user when the program is run. For amateur radio and weather satellites, the apoee and perigee differ by about 1% or less, so the orbits can be assumed to be circular and an average height used in calculations.

Using modifications to formulas (4) and (5) we can calculate the latitude and longitude of the sub-satellite point. Replacing symbols with the variable names used in the program, from (4),

\[ \text{PHI} = \sin^{-1} \left[ \sin(\text{CLIN}) \times \sin \left( \frac{2 \pi \text{MI}}{\text{PE}} \right) \right] \]

where \( \text{PHI} \) = latitude in radians of the sub-satellite point
\( \text{CLIN} \) = orbital inclination
\( \text{MI} \) = number of minutes since \( \text{EQX} \)
\( \text{PE} \) = orbital period in minutes

From (5), \( \text{THETA} \) equals

\[ \cos^{-1} \left( \frac{\cos \left( \frac{2 \pi \text{MI}}{\text{PE}} \right)}{\cos \text{PHI}} \right) + \frac{2 \pi \text{MI}}{1440} \]

where \( \text{THETA} \) = longitude in radians of the sub-satellite point.

Now consider a system of vectors in three dimensions. Taking the vectors from the centre of the Earth to the receiving station and to the satellite (Fig. 2), the vector difference between these two gives the vector from the receiving station to the satellite (displaced to the centre of the Earth). If we use spherical polar coordinates, we can draw this on a cartesian system with the centre of the Earth as origin (Fig. 3).

The conventional way of specifying longitude is to use degrees West of the Greenwich meridian. However, we are using values of \( \text{THETA} \) in the opposite direction, so they must be modified as below. Similarly, degrees latitude conventionally increase from the Equator outwards, but the PHI angles above are opposite and must be modified suitably.

Modified values:

\[ PD = (\pi/2) - \text{PHI} \]
\[ TD = (2 \pi) - \text{THETA} \]
\[ FI = (\pi/2) - \text{LAT} \]
\[ TE = (2 \pi) - \text{LONG} \]

where

\[ PD = \phi' \]
\[ TD = \theta' \]
\[ FI = \phi \]
\[ TE = \theta \]

LAT = receiving station latitude.
LONG = receiving station longitude.

Notation:

\( r \) is the vector to the receiving station from the centre of the Earth.
\( r' \) is the vector to the satellite from the centre of the Earth.
\( p \) is the vector from the receiving station to the satellite.

Now the components of the vector \( r \) are

\[ X = r \cos(TE) \sin(FI) \]
\[ Y = r \sin(TE) \sin(FI) \]
\[ Z = r \cos(FI) \]

and similarly for \( r' \)

\[ X' = r' \cos(TD) \sin(PD) \]
\[ Y' = r' \sin(TD) \sin(PD) \]
\[ Z' = r' \cos(PD) \]

If the components of the vector \( p \) are

\[ X_p, Y_p, Z_p \] then:

\[ X_p = X - X' \]
\[ Y_p = Y - Y' \]
\[ Z_p = Z - Z' \]

Theoretically, this vector is all that is necessary to track the satellite since it is easy to work out the spherical polar coordinate angles, and these could be fed directly to the antenna rotators. However, in practice it is difficult to define these angles at the receiving station, since they relate to the cartesian coordinate system previously shown, based at the centre of the Earth. At the receiving station it is convenient to refer to angles of elevation from the horizontal and azimuth angles from due North, so these must be supplied by the program.

Since we are using vector notation, it is simple to find the angle between the vector \( r \) and the vector \( p \) using the dot product:

\[ r \cdot p = |r| |p| \cos E \]

Therefore

\[ \cos E = \frac{XX_p + YY_p + ZZ_p}{\sqrt{X^2 + Y^2 + Z^2} \sqrt{X_p^2 + Y_p^2 + Z_p^2}} \]

This gives the angle \( E \) between the two vectors. Since the horizontal plane at the receiving station is perpendicular to the vector \( r \), by taking \((\pi/2) - E \) we can get the angle of elevation required for the antennae (Fig. 4).

It is more difficult to extract the azimuth angle from due North using any similar method, but it is relatively simple to apply equation (2) if the great circle angle \( D \) can be found. This is an easy matter, since it is the angle between vectors \( r \) and \( r' \). It can be found using the dot product as follows:

\[ \cos D = (X X' + Y Y' + Z Z') / r r' \]

where \( r = \text{ERTH} \) (Earth radius) and \( r' = \text{ERTH} + \text{HT} \) (Earth radius + orbital height). See Fig. 3.

Simple manipulation of equation (2) will give the azimuth bearing angle if all the information which is now known is substituted in.

Using the method described, we now would have all of the information required to track the satellite accurately without having to draw any graphs. All that remains to be done is to present this information in suitable form to the antenna rotators.
Rotator driving

Two rotators are necessary to track the satellite, one to elevate the antenna and one to rotate them to the correct bearing. In the prototype system these rotators were not of the same manufacture, and operated on different principles, so separate methods of interfacing were required for each.

The type SU2000 azimuth rotator. This rotator is controlled electronically, and uses a potentiometer mechanically coupled to the rotating shaft to provide feedback to the control box. When a switch (not shown) is closed for a short period, the circuitry is activated, and the voltage on the control potentiometer is compared with that on the feedback potentiometer. The rotator then turns one way or the other until the difference is reduced to zero.

The voltage range on the control potentiometer is about 0-6V d.c. and operation is linear, with 0V corresponding to 0 degrees and 6V to 360 degrees. To control the rotator the computer must therefore apply a voltage between 0 and 6V (corresponding to the desired position) to the control potentiometer connections, and close the activating switch for a short time (typically 1/4 second). Rotation will then stop automatically at the desired position.

The type 2050 elevation rotator. This rotator uses two a.c. motors operating synchronously, one driving the rotator shaft and the other driving a disc in the control box. Operation is as follows. A second disc, with a notch in it, is turned by hand to the required position. This causes a 3-position switch which rubs against the disc's perimeter to move either left or right. The switch connects an appropriate a.c. phase to the two motors, and applies power to them. The two motors rotate synchronously, until the control box driven disc with the switches attached reaches the position of the notch in the manually-turned disc. When this happens, the switch actuator springs into the notch, the switches go "off" and the motors both stop. In this manner, the rotator shaft follows the position of the manual disc.

In order to control this rotator from the computer, a feedback potentiometer was coupled mechanically to the driven disc and the switches disconnected. Phase switching to the motors was achieved with relays.

Computer control consists of:

a) generating a voltage corresponding to the required position and comparing it with the voltage from the feedback potentiometer. Depending upon the result, an appropriate relay activates.

b) applying power to the motors, which will switch off automatically when the feedback voltage corresponds to the required position.

Control interface

The PET output port is bi-directional and can be programmed as inputs or outputs. At power-up the port defaults to inputs and floats "high". This means that the interface must have a "do nothing" function when presented with all ones logic. Also, the port is an 8-bit port, so the accuracy of the output number is limited, especially since two of these bits are needed to specify which rotator the information applies to. Hence six-bit precision data is used for the rotators, giving about 6 degrees accuracy for azimuth and 3 degrees for elevation. This is quite adequate since the antenna -3dB beamwidth is not better than about 30 degrees.

The two "control bits" used were the most-significant bits of the PET's output word, arranged as:

(ADR)(DAV)XXXXXXX

where X indicates remaining bits for data
ADR = address bit
DAV = data valid bit

A simple arrangement of logic is all that is necessary to control the two rotators using the above codes as data, and driving small switching relays as shown in Fig. 5.

For the azimuth control box, a direct voltage must be derived from the PET's output word and applied to the control connections on the control box. Basically, all that is needed is to use a digital-to-analogue (d-to-a) converter to obtain a voltage which corresponds to the output word, adjust its amplitude with a variable-gain amplifier, and apply the result to the appropriate connection points. A suitable circuit is shown in Fig. 6.

The elevation rotator needs a more complex control circuit, since a decision must be made as to which way to connect the a.c. phases to rotate the motors in a particular direction. The voltage from the feedback potentiometer in the control box is compared with a voltage derived from the PET output port via another d-to-a converter. The supply phase to the motors is then switched in a manner such that they rotate to reduce the voltage difference to zero. A problem is to stop the circuit oscillating about the zero position. This is overcome by allowing a "guard band" around zero where both phases are switched off, and the motors do not rotate.

The circuit used is shown in Fig. 7.

The input voltage and feedback voltage difference is amplified by the difference amplifier. If the resultant voltage is above +0.6V then diode D1 conducts, TR1 switches 'on' and RLA3 switches one particular phase to the motors. The motors rotate in a direction such that the feedback voltage decreases, until the difference output falls within the 1.2V guard band provided by the forward voltage drop across diodes D1 and D2. When this happens, neither D1 or D2 conducts and the motors stop, since both phases are switched out. Similarly, for an initial negative output from the amplifier, D2 conducts, TR2 is 'on' and the motors rotate in the opposite direction to before, increasing the feedback voltage until the difference lies within the guard band.

Complete interface

In order that the PET output word can change whilst either of the rotators is turning, it is necessary for both sections of the circuitry to have their particular data word latched as long as it is needed. The PET can individually update the latches as necessary.

A typical output sequence is as follows:

<table>
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<tr>
<td>1</td>
<td>1</td>
<td>STOP</td>
<td>STOP</td>
</tr>
</tbody>
</table>

11000000 Both rotators OFF, data zero on latches.
10000000 Latch zero into elevation rotator latch and activate rotator.
11010000 Both rotators OFF, data 16 on latches, zero latched in elevation latch.
10010000 Latch 16 into elevation latch, and activate rotator.
11010000 Both rotators OFF, data 16 on latches, 16 latched in elevation latch.
11001000 Both rotators OFF, data 8 on latches, 16 latched in elevation latch.
00001000 Latch 8 into azimuth rotator latch, activate rotator, 16 latched in elevation latch.
**Computer program**

A full description of the program would be rather long, since it contains many simple features such as input/output routines. Therefore the following comments are confined to basic outlines and references to particular points where necessary. The subroutines are listed below, with the exception of one or two which are trivial.

**Time output routine** (lines 100-140)
The PET's inbuilt time clock function is utilised, with times converted to decimal (DT) for ease of manipulation. Some string calculations are performed, and the time is 'POKED' directly onto the screen as HH:MM:SS in the top right-hand corner.

**Latitude/longitude conversion subroutine** (lines 150-195)
Latitude and longitude values needed for calculations are input at various points in the program, and this routine takes degrees and minutes as DDDMM in string form, checks that the input is not rubbish, and returns the decimal equivalent of the input in degrees.

**Main program** (lines 200-580)
This section is not a subroutine. It defines some variables, e.g. Earth radius in Mm,

**Satellite data calculation** (lines 640-830)
Contains data used by the main program.

**Lines 1010-4010**
This section starts with some screen graphics, then uses some of the other subroutines to calculate all of the tracking data. It outputs information to the screen and uses the rotator driver subroutine to track the satellite concerned. The program cycles continuously in this section.

**Time since EQX subroutine** (lines 5000-5060)
Uses the decimalised real time (DT) and decimalised equator-crossing time (EXT) to find the time in minutes since the satellite crossed the equator (MI).

**Subsatellite (etc.) subroutine** (lines 5070-5270)
This subroutine uses equations (6) to (12) to calculate spherical coordinates, vectors and finally the satellite elevation angle from the receiving station.

**Acquisition of signal subroutine** (lines 5280-5340)
Finds the time when the satellite elevation angle is positive, i.e. when the satellite is above the radio horizon. It does this by substituting times since equator crossing in the above subroutine, starting with one minute then incrementing by one minute until the correct time is found.

**Equator crossing data subroutines** (lines 5570-5620, 5630-5680)

Figure 8 shows the block diagram of the interface, which includes all the circuits previously described. The latches are controlled by the circuit Fig. 5, taking their latch instruction from the outputs of the AND gates.

**Further reading**


A listing of Mr Jefferson's program can be supplied by the Wireless World editorial office on receipt of a large stamped addressed envelope. Please mark your envelope "Tracking satellites with a microcomputer".

---

**Figure 7**: The control circuit for the elevation rotator. The relays switch a.c. to the motors.

---

**Figure 8**: Outline of the interface connections.

---

Ian Jefferson designed his satellite tracking system as a final-year project for a degree in Applied Physics at the University of Durham. He now works in broadcast engineering.
Instead of measuring the voltage signal from a high-impedance source, it is often more appropriate to measure the short-circuit current with an operational current-to-voltage converter (Fig. 1(a)). For example, the open-circuit voltage from a photodiode is a markedly nonlinear function of the incident illumination; in fact it saturates at 500-600 mV as the junction becomes "real" earth and the virtual earth of a current-to-voltage converter, its junction voltage is fixed at zero and saturation cannot occur. In monitoring very low light levels, saturation is not likely to be a problem, but there is a second advantage of the photogalvanic mode, again arising from the constancy of junction voltage. In the photovoltaic mode the junction capacitance has to be charged or discharged by the photocurrent whenever the light signal changes; the rise time is consequently poor. In the photogalvanic mode the rise time is essentially that of the operational amplifier.

The value of the feedback resistor in Fig. 1(a) is often fixed by consideration of the magnitude of the current signal and the desired voltage output, since $E_{in} = -I_a R_f$. When very small signals are to be measured the noise behaviour of the circuit should dictate the design. An elementary howler is to choose a rather small value of $R_f$ on the grounds that its Johnson voltage noise (proportional to the square root of $R_f$) should be small. Actually it is the Johnson current noise that matters; this is inversely proportional to the square root of $R_f$. From the noise equivalent circuit for Fig. 1(b) the signal to noise ratio can be written down as

$$S/N = I_n^2 / (E_d^2 / R_f + 1/R_f)^2 + I_n^2 + 4kT \Delta f R_f)^{1/2}$$

where the last term in the denominator is the square of the previously mentioned Johnson current noise. Although the balance of the three contributing factors depends on the properties of the amplifier used, it is clear that $S/N$ is an increasing function of $R_f$. In particular, to avoid unduly multiplying the amplifier noise voltage $E_d$, $R_f$ should be at least equal to the resistance $R$ of the signal source. Since $R$ is often not known (except perhaps that it is known to be large) the natural tendency is towards huge values of $R_f$. Neurophysiologists routinely use values of 500-1000 MΩ to measure picoamp currents flowing through molecular pores in cell membranes.

A common modification to the basic current-to-voltage converter is the use of a tee network in the feedback loop (Fig. 3). Here $R_f$ is the largest conveniently available value, say 100 MΩ, but its effect is multiplied by attenuation in the tee. If, as is usual, $R_1$ and $R_2$ are much smaller than $R_f$, then the output signal is $\beta I_1 R_f$, where $\beta$ is the attenuation ratio $(1 + R_1/R_2)$. For example, with $R_1 = 99k$, $R_2 = 1k$ and $R_f = 100$ MΩ, the tee behaves like a 10 GΩ resistor. The signal to noise ratio, unfortunately, is unimpressed by this synthetic resistor and takes the value given by Eq. 1 for the actual value of $R_f$ used. Thus a real resistor is better than a synthesized one of equivalent value. Similar conclusions apply when offset and drift are analysed.

A further pitfall of the tee network relates to loop gain. Extravagant values of attenuation in the tee may leave insufficient gain for proper feedback action, especially since $R$ and $R_f$ form a second attenuator in the feedback path. A typical operational amplifier has an open-loop low frequency gain of about $10^4$. If we choose $\beta = 1000$ and $R_f/R = 9$, the loop gain is only $10^4 |[2(1 + R_1/R_2)| = 10$. This dangerously small loop gain will become even smaller above the amplifier's first corner frequency (10 - 40 Hz), and the circuit

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**by R. D. Purves, Ph.D.**

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Fig. 4 (a) A simple current source. (b), bootstrapped current source with fet operational amplifier.

Fig. 5. Howland current pump.

Nanoampere current sources

To provide a controlled current of the order of 1 nA one might turn to the circuit of Fig. 4(a). For certain purposes this simple strategy might suffice but if the load current has to remain substantially constant in the face of variations in R_L then we would require R_L >> R_f. For example, if R_L ranges from 0 to 100 MΩ, then for a current variation of 1% we must take R_f as 10 GΩ. Such resistors are both expensive and hard to obtain. Furthermore, if we now require currents of 10-100 nA, the voltage source of Fig. 4(a) will have to take inconveniently large values (100-1000 V).

The solution to these problems is often to be found by bootstrapping, shown in its starkest form in the active current pump of Fig. 4(b). In its originator’s well-chosen phrase “this deceptively simple circuit” produces an output current E/R_s independent of the magnitude of R_L. Readers may like to test their wits by analysing the mode of operation.

The most important parameter characterizing a current pump is its output resistance, which should be as high as possible. Conceptually, it may be determined by setting the command signal to zero, replacing R_f by a voltage source E’, and then calculating the current I’ drawn from this source. The output resistance is E’/I’; in Fig. 4(b) it is R_s(1 + A) where A is the open-loop low frequency gain of the amplifier. Another parameter is the output bias current in the absence of a command; for Fig. 4(b) this is V_op/R_f where V_op is the amplifier’s input offset voltage.

Despite its charm, the circuit of Fig. 4(b) is rarely used because it needs a floating signal source. The familiar Howland current pump seems more promising at first sight. In Fig. 5 one or more of the resistors is adjusted to give the “balance” condition R_1R_2 = R_3(R_4 + R_L). Then the current I = -E/R_3R_4 independent of the load R_L. However the output resistance of the Howland pump is sharply degraded by small departures from the balanced state, since the output terminal is shunted by R_1 and R_2. The resulting shunt current must be very accurately compensated by additional drive to R_4. Again, the balance condition depends on five resistors which usually span a wide range of values. Differential aging and temperature effects on resistance are therefore difficult to control, and the Howland circuit needs frequent rebalancing to maintain a high output resistance.

A much better circuit (Fig. 6) is one found in most commercial current pumps for neurophysiological use. It is derived from the Howland design by interposing a fet voltage follower at point X of Fig. 5, to remove the shunting effect of R_1 and R_2. The balance condition is now R_1R_2 = R_3R_L. Three of these resistors can be of the same value and type (e.g. 10k metal oxide), the fourth being the next lower preferred value in series with a cermet trimmer. Resistor R_4 is generally 10 – 100 MΩ, the exact value being immaterial to the balance condition. An extra advantage of his circuit over the Howland pump is that the follower allows the voltage applied to the load to be monitored at the terminal labelled E_out.

In Figs. 5 and 6 the source resistance of the command signal is in series with one of the gain-determining resistors. Both circuits would in practice need an input buffer stage to isolate the “working part” from changes in source resistance. An alternative three-amplifier configuration in Fig. 7 has a spare input terminal for the command signal. This circuit may be understood by recognizing that A_3 is a differential amplifier whose output is a low-impedance replica of the voltage across R_s and thus a direct measure of the output current. This signal is compared with the command by A_3 which forces the output current to take the command value.

References

Fig. 6. Improved Howland current pump.

Fig. 7. A three-amplifier current pump. The resistance of the signal source does not affect the output resistance.
Eprom single-chip microcomputers

Using microcontrollers which have program in eprom, enabling program development by means of an emulator.

by M. D. Bacon, M.A.

Far too many constructional articles involve building a small central processing unit and a bit of extra hardware, and then plugging in a preprogrammed eprom, or alternatively the use of a device which is in fact a preprogrammed microcontroller acting as a digital clock, printer controller or whatever. I suspect that, even if slightly greater expense is involved, many people would like to be able to build things like this for themselves and then start tinkering. What follows is an attempt to indicate how, given certain not-too-expensive hardware, the 'tinker factor' can be put back into home electronics.

Microcontrollers have tended to be very low-key products, despite their wide use in industry for low-grade computing. There are two principal reasons for this. First, most of them are programmed during manufacture, at the mask level, and while this is economic if one is contemplating making 50,000 washing machines, it is of less than no interest to the one-off user. Second, microcontrollers have very little ram, typically 64 or 128 bytes and, unlike microprocessors, cannot normally store a program in this ram and then execute it — which is how general-purpose computers work. This tends to make development of programs a job for a specialized development system, which is expensive.

Recently microcontrollers have become available which contain their program as eprom. They are currently about £13 each and up (as speed and memory size increase) and are becoming widely available. This article confines itself to the baseline machine, the Intel/NEC 8748.

The 8748 is a 40-pin package with an impressive die visible through the ultra-violet erasure window. It runs on a 5V supply and contains 1 kilobyte of eprom, 64 bytes of ram (which has particularly convenient addressing modes), an 8-bit timer with interrupt, 2 testable inputs, 1 interrupt input, single-step capability, 2 8-line input/output ports, a bidirectional bus port which can be latched, a clock generator, and various useful special functions. The device can be made to do almost all the essential functions of a controller, using in addition only seven passive components and about three square inches of vero-board.

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Fig. 1. Emulator section of programmer 8035 is type of 8748 without eprom
Fig. 2. Programmer control circuit.

As readers of Ivor Catt will know, microcomputing is a slow process in electronic terms. However, most microcontroller applications are also very slow; clocks require a resolution of seconds; printer mechanisms require time slots of hundreds of microseconds. If one considers the following list of microcontroller jobs, it will be quickly seen that the external hardware is the limiting factor on speed: burglar alarms; central and solar heating controllers; cassette deck controllers with parallel to serial interface; temperature measurement using thermocouples, with software linearization; special function calculators (such as the Picotutor); interfacing of keyboards and displays to general-purpose microcomputers.

It need hardly be said that the limitations on the one hand of a maximum of 128 bytes of ram and, on the other, of a maximum practical signal handling capacity of about 25kHz, defines where the microcontroller gives way to the microprocessor or to a discrete logic. Within these limits, however, system design becomes largely a matter of obtaining all the input signals at t.r.l. level, buffering the outputs where necessary, connecting all inputs and outputs to appropriate pins of the 8748 and then sitting down to write the program.

To write the program... and there is the difficulty. Programs require development, that is, testing and modifying until they work. As mentioned earlier, this presents problems with a microcontroller.

The major thrust of this article is to present a small circuit, shown in Fig. 1, which enables microcontroller program development to be carried out using an eprom emulator such as that recently described as Wireless World*. It uses a version of the 8748 which lacks the eprom memory and uses an external memory for its program, the 8035. Used in conjunction with the eprom emulator, it provides a model of the 8748 which has only two limitations; the bus port is used to fetch

*Eprom emulator, by Peter Nicholls, September, 1982.

The problem then arises, once a successful program has been developed, of programming the actual 8748 to be used. This is not easy, because address and data lines are multiplexed and the program pulse is rather complex. The solution adopted, once the hardware complexity of adapting a normal programmer was program and cannot be latched, and 4 pins of port 2 are also used for program address. This is not in practice as serious as it may appear, since the bus port is usually used with memory-mapped devices (of which two are shown in the applications) and this use is not affected; the four pins of port 2 are usually used to drive a special p.i.o. device, the 8243. This is provided in the development circuit, and is particularly convenient because it requires only five lines to connect to the 8035/8748 and provides four 4-bit ports, each of which can be used as input or output and each line of which has 4 mA drive—except for port 7 which can source 20mA. The 8243 is operated by special 8748 instructions and, unlike a normal p.i.o., requires no base address or control register settings.

To use the development board, the emulator is used as usual to hold, and alter as required, the development program. Connections are then made between the 8035/8243 and the equipment which it is intended to control. There are many possible ways of doing this, such as using a 40-way dual-in-line plug to which all the 8035 leads except the crystal (pins 2 and 3) are connected. This is a simple in-circuit emulator. Another approach, favoured by the author, is to fit the development board with an edge connector to which all useful lines are brought out. This enables prototype equipment to be built on ordinary Veroband and plugged straight in.

Fig. 3. Programming is carried out one page of four a time. Thumbwheel switch selects page.
realised, was to build a programmer as a peripheral driven by the development board. By doing this as, as shown in Figs 2 and 3, a minimum of extra hardware is required. The most expensive part is a zero-insertion-force socket, and under normal circumstances the careful hobbyist, who will not be doing much programming, can dispense with this in favour of a much cheaper quick-eject socket.

In use the 8748 is programmed one page (1 page = 256 bytes) at a time; this arises out of the modest data handling of the instruction set, which dislikes mixing program and data. The 8748 has four pages of erom, number 0 to 3, and the page to be programmed is set up by a thumbwheel switch or dipswitch as shown.

The programming algorithm (see listing) is then placed in the emulator page 0, i.e. from 000 up. This listing gives a very simple programming routine; it is not claimed to be ideal, but it gives the beginner something to work from — in fact, a chance to tinker.

The page of data to be programmed, regardless of what page it is to appear in, in the 8748, is then loaded into page 3 of the emulator, where it takes advantage of a quirk of the instruction set. The emulator is connected to the development and programming board, and the system powered up. The programming board requires 25V at approximately 50 mA. A switching supply is not advised due to possible interference: if a suitable supply is not otherwise available, dry batteries to a total of 24 nominal volts provide an alternative. Whatever the supply, it should not exceed 26 volts under any circumstances, not fall below 24 during programming.

On power up, the Fail led should come on and all others stay out. As a test, the Interrupt switch which starts programming should be operated. The Fail led should go out while the switch is closed, and come on immediately when it is released while the EA led glows dimly. After thirteen seconds the EA led goes out and the Fail led blinks. Now the Fail led should go out, the EA and Program led comes on, and the Program led should vary in brightness as the value of the data being programmed varies. At the end of the cycle the other leds go out and the Fail led blinks. The page number may them be changed, new data placed in Page 3, and the program cycle repeated. If the Fail led lights during the cycle one or more addresses have mis-programmed.

Fig. 4. Adding 8-bit a-to-d converter.

All the time the 8748 is socketed and power applied the circuit applied to pins 2 and 3 should be oscillating at around 3 MHz, and a square wave should be emitted from Pin 11: if these are missing, there is a fault. A 2.5-3 MHz crystal may be substituted for the inductor if available. Programming requires a slower clock than normal running, and this has been taken into account in the oscillator and the programming algorithm.

Expansion of the 8748 is dealt with very thoroughly in the Intel manual, which is essential reading in any case, but some specific examples are given here. There are two types of expansion; direct, in which microcontroller pins are used as inputs or outputs and retain output values until they are changed, and memory-mapped.

In memory-mapping, the bus port is used with a 74LS373 (for t.t.l.) and/or a 74CS73 (for c.m.o.s.). This octal latch is used to latch an address during a MOVX instruction. In the simplest case, setting one address bit to 1 (i.e. addresses 010, 012, 040 ... 80) is used as a chip select for a particular device, and a Nand gate may be used as shown in Fig. 4 in conjunction with RD-N and an address line to read from a unique device. In the case of the alphanumeric displays dealt with later, the lowest two address lines select a digit within a display, and the next six lines are used to select a particular display. The

<table>
<thead>
<tr>
<th>STATE</th>
<th>PS</th>
<th>P6</th>
<th>P1</th>
<th>DURATION</th>
<th>OTHER OUTPUTS</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>F</td>
<td></td>
<td></td>
<td>If NOT VERIFY</td>
<td>initial state</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>initial state</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>RST-N goes high</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>\text{PROG light goes low}</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>\text{PROG light goes low}</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td>\text{PROG light goes low}</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>\text{PROG light goes low}</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>\text{PROG light goes low}</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td>\text{PROG light goes low}</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>\text{PROG light goes low}</td>
</tr>
<tr>
<td>11</td>
<td>C</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>\text{PROG light goes low}</td>
</tr>
<tr>
<td>12</td>
<td>C</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>\text{PROG light goes low}</td>
</tr>
<tr>
<td>13</td>
<td>0</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td>\text{PROG light goes low}</td>
</tr>
</tbody>
</table>

Total program time 13 seconds per page
scheme can be extended to address up to 256 devices using decoders.

In this way, using the bus port, one or more a-to-d converters can be added to a system and used to measure temperature (using a thermistor bridge or a device such as the AD590), position (using linear rotary potentiometers) or electrical quantities. The recently introduced Ferranti ZN447, 448, 449 series interface very simply; if only one is required and the bus is otherwise unused, as in the first diagram; if other devices share the bus, or more than one a-to-d is required, as in the second. If several channels require to be scanned fairly slowly, then another port can be used with an analogue multiplexer to select a channel prior to conversion. A conversion then requires about 50 microseconds total, so even if quite a lot of channels are being scanned and data is being transmitted to tape or printer each channel can be looked at several times a second. Indeed, as mentioned earlier, the speed of printer or tape recorder is what slows down the system.

If a high throughput is required or it is necessary to read data on several channels simultaneously, the arrangement of Fig. 5 can be used. Here, all the converters start converting together and can then be read out as required. This technique, used in conjunction with a parallel data link and, perhaps, the faster 8749 processor, can achieve total rates in excess of 50 000 samples per second.

Such an arrangement can be used to improve the performance of a general-purpose microprocessor based machine by freeing it from the low-grade tasks involved in operating a a-to-d converters and channel selectors.

Memory-mapping can be applied to the driving of the recent generation of intelligent alphanumerics displays, which are driven like ram and accept ASCII coding. Figure 6 shows an interface for one such display, based on the same principle as the multiple a-to-d technique but Nanding a positive write strobe with an address line to give the chip select function. These devices are not cheap — they cost around £4 per digit all in — but can display the alphabet: in capitals as well as punctuation marks, which 7-segment displays are unable to do. If a prototype board using these devices is detachable from the rest of the system, pull-up resistors should be fitted on all lines, since they use high-output c.m.o.s. devices, which are prone to self-destruct if static appears on a pin while the device is powered up.

At the other end of the scale, the novice user is urged to return to the early ages of computing and drive a line of eight leds via a suitable buffer from port 1. Then, in developing a program, at any point where it is desired to check the value of the accumulator or a register, code may be inserted to cause the value of the byte in question to be output to the led line, followed by a software halt (a jump back to the same line.) Once this part of the program is known to be satisfactory the output and halt may be moved to the next convenient stopping point, and so on. Alternatively, each part of the program can be made to output a specific code and halt for a second or so before continuing, so that execution can be watched at slow speed. Single-stepping is covered in the manual.

Finally, a simple interface to 240V line is shown in Fig. 7, using the MOC3020 opto-isolated triac, which has 7.5kV isolation. It is recommended that the line circuitry be remote from the processor board and linked only by the two lines from 8243 to optocoupler. If zero-crossing switching is desired, this can be arranged by applying a negative pulse to the processor input to interrupt at each zero crossing, and using this to synchronize the turning on of the triacs. Alternatively, by introducing a delay using the timer, phase-angle control may be used in software, with approximately 1° resolution.

Fig. 7. Solid-state relay using optoelectronic triac. Switches up to 8A at 240V a.c.

The fundamental and essential manual for the 8748 is the MCS-48 User’s Manual, Intel Part No. 98-270, available from Rapid Recall, Rapid House, Denmark St., High Wycombe, Bucks, most recently for £15.22 including p.&p. The 8748, 8035 and 8243 in numerous performance versions are also available from this source.

The NEC second-source is available from MultiComponent, formerly ITT, and at the same address, viz. Edinburgh Way, Harlow, Essex. ITT inform me that they are perfectly happy to deal with the general public even for small quantities, and can supply almost everything mentioned in this article; any deficiencies can easily be made up from the advertising section of Wireless World.

Notes

The circuitry mentioned in the text has been built with little trouble on Vero-board, but an artwork for a p.c.b. for development board and programmer can be supplied reasonably quickly if required. An 8748 assembler to run on ZX81 is under development.
Viewdata display module

This display module allows a home computer to shed some of its display processing load and display colour text and graphics in teletext format. Red, green, blue and sync video outputs are provided and the display is controlled by either a serial or parallel link from the host computer. With the addition of a modem, the module can be programmed to display data directly from a viewdata computer.

This module performs all the necessary display functions for a viewdata terminal. Video and tv sync outputs are generated for direct connection to a colour monitor or via a PAL encoder and u.h.f. modulator to an ordinary colour tv set. Data input to the module can be either serial or parallel and consists of characters for display or control commands to the module. The module was originally designed to be connected to a host computer to relieve it of some of the burdens of display processing; it could easily be used with a home computer to provide viewdata and/or display capability.

by Dennis N. Pim

The display module is controlled by an 8048 microcomputer (8748 eprom version). Changes in the software for this processor allow much flexibility in the operation of the module. For example, in my prototype the module receives serial data at 4800baud and any word whose most significant bit is set to logic 1 is decoded as a command rather than a character for display. Simple software changes could be incorporated so that the module directly displays the serial data (with parity) at 1200baud arriving from a viewdata computer.

In the present version, the module can also perform simple editing functions such as scrolling up or down, clear to end of line, and clear to end of page. All or part of the display can also be read by the host computer as can the current cursor location on the screen. Once again the software allows other special functions to be programmed for specific applications thus freeing the host computer from time-consuming display operations.

The module has four page stores, and any of these can be selected for display and/or updating. It is possible therefore to write a new page whilst another page is being displayed and only display the new page when it is complete.

Used in serial input mode, the module has available a general-purpose input/output port. Serial commands enable this port to be read or written; individual bits can be selected as input or output.

Before considering the full circuit of the module, look at the operation of the video generator integrated circuit.

Video generator

The display module uses the GIM AY39735 interlace/non-interlace video generator to generate the tv signals. This i.c. provides the necessary circuitry to generate a full composite tv sync and the red, green and blue video outputs. It contains a character rom and can address up to eight pages of ram store, although in this application only four pages can be used. The i.c. generates the usual viewdata format of 24 rows and 40 columns, and implements all the BT Prestel terminal specification display facilities. It is driven by a 6MHz clock and has a set of tristate address and data lines to connect to the display rams.

![Diagram](https://www.americanradiohistory.com)
R/W signal drives the page store selected by three binary tristate store select lines. Within each video frame there are four time slots that are indicated by the state of two outputs from the chip. These are

TS00 — reading from ram. This occurs under control of the video generator between lines 48 and 288 and is when the display is active.

TS01 — writing to ram when teletext lines are written to the page store during frame flyback. Not used in this application.

TS10 — spare.

TS11 — data interchange period. During this period the video generator can receive commands from the control processor (lines 23 to 47).

During lines 289-6 the video generator is inactive. In addition, the video generator data and address lines are tristate during every line flyback period. This occurs approximately 56μs from the start of the line sync pulse to approximately 16μs after the start of the next pulse, a total time of about 24μs each line. Because the video generator frees the address and data lines during line flyback the 8048 processor can have access to the display rams during this time for updating/reading. The 24μs window gives enough time to read/write one character to the display store.

During time slot TS11, the display chip is enabled to receive commands from the controlling microprocessor by placing 1111XX0XXX on the address lines (X = either logic state). The required command code is then set up on the data bus when the bus is used to strobe the command into the display chip.

Some of the functions that can be controlled in this way are

- clear screen
- half-screen expansion
- select displayed page
- display tv picture or text
- select teletext/viewdata mode
- select mix mode
- cursor on/off (the cursor — a flashing underline — is displayed at any ram location whose most significant bit is set to 1; only seven bits are required for each character display).

The figure shows the video generator in a conventional configuration addressing one 1K × 8 display ram.

Circuit description

The circuit has to cater for the following operations:

- Reading and writing from one 1K block of one of the two 2K rams forming the four page stores by the video generator. (Writing is required for page clear.)
- Reading and writing from one 1K block of one of the two 2K rams by the microcomputer.
- Selection of one 1K block of ram for display by the video generator.
- Selection one 1K block of ram by the microcomputer (not necessarily the same block as that being displayed).
- Sending commands directly to the video generator from the microcomputer during time slot TS11.
- Receiving serial or parallel data or commands from the host computer.
- Sending serial data to host computer.

The video generator data bus is connected to the data buses of two 2K rams, (cmos in the prototype) and the 8048 data bus. The address bus of the display chip is connected to the ram address lines A0 to A9. (Address line A3 is fed via a tristate buffer whose function is explained later). The 8048 supplies address information for the display rams from its multiplexed bus using an eight-bit latch. Address information is latched into this chip by the 8048 ALE line and presented to the address bus when required by a low signal on bit 4 of port 2. Bits 0 and 1 of port 2 provide the required two remaining higher-order ram address lines A8 and A9.

The two 2K rams provide four pages of display. Page selection for display is achieved by the SS0 and SS1 binary tristate outputs of the video generator. SS0 selects the lower or upper half of each ram via the A10 input and SS1 selects one of the two chips via their CS inputs. Reading or writing to each page by the microcomputer is achieved by bits 2 and 3 of port 2 connected to the ram A10 and CS inputs respectively.

The video generator provides a tristate R/W line that can be directly connected to the ram write strobe (the video generator needs to write to the rams for the clear screen function). Unfortunately the WR strobe of the 8048 is not tristate, hence this output cannot also be connected directly to the ram WE inputs. It is therefore connected to the enable input of a tristate non-inverting buffer whose input is connected to the output-enable signal of the address latch (8048 port 2 bit 4) so that the WR strobe is applied to the rams only when they are accessed by the processor. This, as well as providing the required tristate write strobe, prevents the write strobes produced whilst the processor is sending a command to the video generator from corrupting the contents of the rams.

Also, so that the 8048 can send commands to the video generator, the ram outputs must be tristate during the slot TS11. Hence it is possible to permanently ground the ram OE inputs and a read strobe has to be supplied to them. The video generator does not have a read strobe output, but the SS2 page-select line creates one. This tristate line is only held low during the display period (assuming one of pages 0 to 3 are being displayed). The SS2 line therefore provides the required read strobe and is connected to the ram OE inputs. This is why only four pages of ram can be used in this application. The 8048 does have a read strobe (RD) but this like the write strobe is not tristate and hence another buffer is used to provide a tristate strobe in the same way as for the WR line.

Sync pulses from the video generator are fed via a non-monostable to the test zero (T0) input of the processor. This input receives positive-going pulses at the start of line flyback, arranged to be about 10μs wide by the 27kΩ 100μF monostable timing components. The processor therefore knows that it can have access to the display rams from 56μs to 80μs after the leading edge of this pulse. (The next line pulse does of course appear on the T0 input during this time window).

Video generator commands

The time slot outputs of the video generator (TS1 and TS2) are and-ed together using a spare inverter and a spare tristate buffer to provide a signal on the processor's test-one input (T1), which is logic high during time slot TS11, when the video generator is enabled to receive commands.

Because the processor might access the display rams during any line flyback, including those occurring during time slot TS11 when the video generator is enabled to receive commands, it is important to prevent the video chip from responding to data on the data bus intended for the rams. (It is possible to select a ram address which activates the video generator during this time slot). This situation is prevented by effectively breaking the display's A3 address line during a processor read or write using a tristate buffer which is disabled by bit 4 of the processors port 2. If the processor is required to send a command to the video generator, the required enabling address of 1111XX0XXX is set up on the address bus by the four 22kΩ pull-up resistors on address lines A6 to A9, and by setting bit 5 of port 2 to zero thus providing the required logic 0 on address line A3. During time slot TS11 the ram outputs are tristate and the processor can then send a command to the video generator via the data bus, using data bit 7 as a strobe.

Inputs

Two ways to input characters or commands are provided. Port 1 of the 8048 can be used as an eight-bit parallel input. In
Alternatively, the interrupt input can be used as a serial input, and the processor programmed to accept a variety of bit rates between 600 and 4800 baud (although the module cannot actually process characters at the full rate of 480 per second).

In the prototype, serial/parallel operation is selected by setting bit 6 of port 2 to logic 1 or 0 respectively, switch S1 provides this function. Alternative software versions could of course be provided for either serial or parallel input, thus freeing bit 6 of port 2 for other functions.

**Outputs**

Signals to the TV monitor are the three colour outputs, red, green and blue, composite sync and the video generator's picture/text (P/T) output which provides monochrome video when the video generator is set to "mix" mode (this can be used as a printer output). The logic outputs are protected by series resistors. Interlaced or non-interlaced sync can be provided: S2 connected to the phase/comp input of the video generator selects the sync type required. If serial input is used, port 1 can be used as a general purpose eight-bit port (either input or output or a combination). The bits of this port can be read or set by commands from the serial input.

A serial output line is provided on bit 7 of port 2 which performs two functions. Firstly, it can output data from the display module. This data can include status information, displayed characters stored in the rams or data on the general-purpose i/o port. Data rates are selectable by different software versions, and the output rate can be made different from the serial input rate. Secondly, this output indicates that the 8048 is busy. A logic 0 on this line indicates that the processor input buffer is full and no further characters can be accepted until this output returns to logic 1. Confusion as to whether a logic 0 on this output is a buffer-full indication or the start bit of serial output data should not arise if the host computer always waits for returned data after a command that requires data to be returned before sending a further command. The Viewdata display module never sends data down the serial line unless instructed to do so.

To be continued with software description.

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Display module requires power supplies of +5V at 200mA and +12V at 80mA. Both processor and video generator are driven by same 6MHz clock. Deaconhouse Ltd, of 57 Guildford Street, Chertsey, Surrey (tel. 09328 66015) will supply 85 +155mm double-sided boards to the pattern given in the final article.
Cooling electronic equipment

Heat is an enemy of electronic circuits. This article discusses the various methods for removing heat from equipment including heat sinks, convection, cooling fans and air conditioning.

It has long been known that one of the biggest enemies of electronic equipment is heat. It is surprising that heat dissipation, or the removal of heat from circuits, is normally a secondary consideration or even an annoying necessity during the final stages of housing the electronics. It is hoped that this article will highlight some of the points to be considered in the area of ventilation in electronic packagings, as well as to show how ventilation requirements can be calculated to ensure a benign environment for electronics.

Possibly the easiest to understand and the most practicable method of cooling is the use of a heat sink. Large slabs of metal or even the equipment enclosure itself can be put in direct contact with the heat source. The amount of heat transferred in this way can be calculated by using Fourier's Law:

\[ Q = \frac{K A \Delta T}{L} \]

where \( Q \) = heat transferred per unit time
\( A \) = area perpendicular to the heat flow through which the heat is passing
\( L \) = thickness of body of matter through which the heat is passing
\( \Delta T \) = the temperature difference between the hot and cold sides of the substance through which the heat is being transferred.
\( K \) = specific co-efficient of conductivity.

It can be seen that \( L \) should be as small as possible, and \( A \) as large; hence the thin cross-section and the fins of heat sinks.

There are many kinds of heat sinks on the market today, for just as many applications, ranging from 'clip-on' models for single transistors to models weighing many tons for large transformers.

The majority of electronics equipment manufactured today is cooled by the action of convection. If the heat source is too great for convected air to remove sufficient heat, resulting in an unacceptable temperature rise of the electronics, the designer should consider using a forced draft unit, probably in the form of an axial fan.

Let us consider Graph 1. The vertical axis represents heat losses within the system. In many cases it is often sufficient to approximate this to the total electrical consumption of the equipment to be cooled. Determine the acceptable temperature rise of the air flow. This is measured in degrees Kelvin above ambient. A good guide is that 10K is almost always appropriate. The required air flow can be read from the graph. As an example, let us suppose we have a piece of equipment running on 240 volts and consuming 6.25 amps. The total energy consumption and heat dissipation will be 240 \times 6.25 = 1500 watts. Anticipating an acceptable temperature rise of 10K, the air flow required to achieve the desired criteria will be approximately 230 cubic feet per minute (cfm, 1 cubic ft. = 28.3 litres). Consider a fan unit, standing in free air (represented by point A on Graph 2). At this point, the fan is working hardest and is passing as much air as possible, in this case above 100cfm. The resistance to air flow or back pressure is almost negligible. If the same fan is placed horizontally on a surface (represented by point B in Graph 2), air flow, in theory, is zero. In practice however, a slight air flow will be experienced from the vortex created by air displacement of the fan blades on the upper surface. Back pressure is the minimum required for zero air flow, and our example shows that this will be in the region of 0.3 inches of water. In the laboratory, back pressure can be measured using a manometer. Points C and D on the graph give the upper and lower points of back pressure relating to the optimum operating range, and the air flow from any fan can be deduced by the measurement of pressure rise and reference to its characteristic curve.

Multiple fans may be used if a single fan cannot cope with the required airflow. However a second fan will only assist the first by about 20%, and additional fans by proportionally less. One further calculation of the required airflow should take into account the amount of free space in the housing. If half the space is occupied by the circuitry then the airflow should be doubled; if three-quarters then the requirement should be multiplied by three. this is a rule-of-thumb which works well in practice.

When maximum cleanliness and additional cooling is desired, the use of a blower unit fitted to the enclosure is recommended. This will ensure that clean, filtered air passes into the rack, efficiently maintaining a positive pressure against the ingress of dust.

For hot, humid or otherwise hostile environments, air conditioning a sealed enclosure is a solution. Units are available to fit specific racking systems such as the 19-inch. Their heat transfer is usually measured in British thermal units per hour (Btu/Hr) and can be calculated by multiplying the wattage of the equipment by a factor of 3.4. (The conversion factor to \( \text{kJ} \) is 3.6 as \( 1\text{Btu} = 1,055\text{kJ} \).)

It is hoped that this article has given the reader some understanding of the behaviour of heat and its dissipation in electronic equipment cooled either by simple heat sinks, natural convection in basic instrument housings or forced draft units and air conditioners. Simple calculations will determine the amount of heat that requires removal to achieve the desired working temperature and thus a long working life of each component.
Meteor-trail bouncers

Back in the 1950s, a good deal of interest was aroused by the Janet project of the Canadian Defence Research Board which showed that the highly ionized trails left by meteors entering the earth's upper atmosphere can sustain two-way communication at high or very high frequencies for periods lasting sometimes for several seconds, but more usually for a matter of milliseconds. Because of the vast number of meteors that enter the atmosphere each day, with the number peaking during the regular meteor shower periods — the Canadians showed that by using 600 words per minute "burst" transmissions, triggered by a path opening, it was possible to handle teleprinter traffic at roughly normal speed. This early work used carrier powers of about 100 watts at 50 MHz with 5-element Yagi aerial arrays.

Because the meteor trail reflections occur roughly 85 to 115 km (70 miles) above the earth at about the same height as Sporadic E, the maximum range of both modes of reflection is about 2000 km but meteor scatter is far more consistently available. It is claimed that burst meteor scatter traffic is extremely difficult to intercept, to the degree where even encrypted traffic is virtually secure.

Although in the 1960s and 1970s little was published about the developing use of meteor-trail communications, other than by amateurs snatching brief contacts, sometimes at high speed but without computerized or "teletyping" facilities, it became evident a few years ago that NATO has been using meteor-burst military systems (Comet) since the late 1960s. More recently there has been increasing use of these techniques for specialized applications, for example by the US Department of Agriculture. In 1981 Telecom Inc marketed a computer-controlled system using a data rate of 4800 bits/s and a 1 kW transmitter. Scientific Radio Systems Inc have also now developed an SRM-500 series of terminals operating in the 40-50 MHz band using 1 kW at the base stations, 300W at the remote terminals. A 5-element Yagi is used at the master station but smaller aerials down to a dipole at the remote terminal. The more powerful the set-up, the less the "waiting time" between bursts and the higher the average rate of transmission. Computer technology is used for packet formatting, buffering and error correction. Typically, ionized trails have a length of about 25 km and act as "directional aerials" to give a footprint for a given path roughly about 25 miles long and 5 miles wide, making it extremely difficult to intercept or jam the system.

Waiting time between bursts seldom exceeds a few minutes even in the non-shower periods. Some 50,000 high-energy meteors fall into the upper atmosphere each second, of which one may open a particular path.

Terman's legacy

Few men can have so influenced the study of radio communications, broadcasting and electronics as Frederick Emmons Terman, who died in December aged 82. His work as Professor of Electrical Engineering at Stanford University, California, led to the pre-eminence of Silicon Valley as the centre of so much advanced electronics, dominated by his former students. But it is as author of "Radio Engineering" — first published (in the U.K.) in 1934 — that his fame spread quickly throughout the world as the 688-page book became the "bible of the profession.

The merits of the first edition were recognized from the outset; "a book of outstanding merit ... a book which will have instant appeal to engineers, amateur or professional ... it rarely that a book of such merit appears" are some of the phrases in just one typical review. Further titles "Fundamentals of Radio", "Measurements in Radio Engineering" appeared later but it was the successive editions of "Terman's Radio Engineering" that dominated the world scene for many years. Professor Terman maintained his early links with amateur radio, advising on the old "Jones Radio Handbook" that still survives some 20 editions later as "The Radio Handbook".

Cuban transmissions are due to be examined from the early days. Professor Terman maintained his early links with amateur radio, advising on the old "Jones Radio Handbook" that still survives some 20 editions later as "The Radio Handbook". Stanford University, similarly, remains an educational centre with an unusual record of practical development, including, for example, the first s.s.b. without pilot carrier experiments in 1946 by Villard. As Electronics has written: "Few men can be said to have left a living and growing legacy of such impressive magnitude. The industry has good reasons to remember and cherish the name of Frederick E. Terman".

World broadcasting

There is a paradox about radio broadcasting across frontiers: many people in the UK thoroughly enjoy listening at night to BBC World Service and resent the transfer of the service last year to the more directional aerials at the FCO site at Oxfordness; on the other hand the prevalence of super-power external broadcasting transmitters, including Orfordness, is a prime cause for the chaotic and unsatisfactory state of m.f. broadcasting in Europe. The USA with its "clear channels", daytime-only, stations, highly-directional

...erials and maximum of 50 kW provides listeners with far more interference-free choice and so underlines the importance of good frequency-spectrum management. In the very early days of broadcasting America learned the hard way that there must be firm regulation of transmitting facilities no matter how de-regulated the programmes may be. But for well over a year a real threat to North American night-time a.m. broadcasting has been evident in the Cuban response to the proposal, strongly backed by the White House, to set up a powerful Radio Marti m.f. service directed at Cuba. In turn Cuba threatened to build a total of 187 m.f. transmitters, including some of 500 kW. Last August, Cuban transmissions showed up temporarily on some of most cherished American "clear channels", confirming an earlier NAB conclusion that many American stations would experience a dramatic loss of night-time coverage if the Marti plan went ahead.

Nevertheless the White House continued to assign high priority to Radio Marti and sought authorization from Congress to spend $7.5 million for this purpose, against growing opposition on the part of some Congressmen. The 1982 bill however has been pushed aside — and it will now need a new bill in 1983 if the project is to go ahead. Most American broadcasters fervently hope it won't.

External broadcasting can be an expensive business. The Grant-in-Aid cost of the BBC Overseas Service, excluding expenditure on relay stations operated by the FCO, but including the cost of the monitoring service at Caversham, has been given as: 1977-79 £32.2 million; 1978-79 £37.2 million; 1979-80 £42.9 million; 1980-81 £55 million; 1981-82 £62.8 million; 1982-83 (estimated) £71 million. And these figures may not cover all of the substantial cost of electrical power.

Many aspects of frequency planning for h.f. broadcasting are due to be examined in a two-part World Administrative Radio Conference in January 1984 and autumn 1986. The problem of international jamming seems certain to be raised once again — but unlikely to be solved. Communications engineers as well as broadcasters may well be affected by this WARC.

Interference from CB

The introduction of legal Citizen's Band operation on 27 MHz f.m. in November 1981 did not at first have any great effect on the rising number of complaints, made by viewers and listeners, of interference to television and radio reception. The dramatic increase in 1981: from about 200 per month in January 1981 to 2200 per month
Those examinations!

Despite criticisms over the past few years of the Radio Amateurs' Examination there appears to be surprisingly little pressure for reform on the part of the RSGB. The society ascribes the agitation largely to "misleading comments" in various technical journals. It is claimed that with three members of the RSGB nominated by the Society's Education Committee on the advisory committee of the City and Guilds "the Society is able to keep a watching brief on the conduct of the examination and to ensure that the syllabus reflects changes taking place in amateur radio techniques . . . great care is taken in the preparation of the examination questions, and the Society's representatives assist and advise on this at every stage."

It is not my wish to pick a quarrel with the RSGB's education committee but, until CGI are prepared to show that none of the current questions are as ambiguous or as patently unanswerable as those that have been quoted previously in this column, many people are likely to remain unconvinced that all is well with the RAF.

There is, for instance, still no comment on the question of why there should be a relatively low "pass" mark coupled with the award of "credit" and "distinction" grades in what is intended as a qualifying test. Indeed CGI has gone farther down this path by instituting annual "Bronze Medal wards" to the most outstanding candidate or candidates in the examinations! For the May 1982 RAE, Christopher Dracup, Richard Keith Freeston and William George Winteridge have been named as recipients of the award. Congratulations to all three — but surely this is a strange way of conducting a test intended to discover whether candidates are competent to operate a transmitter without affecting other services, in order to participate in a hobby intended to provide self-training.

A problem that will face Class A candidates is the unmanning of so many British Telecom coast stations where it has been possible to take Morse tests throughout the year. This will presumably still be possible at the ten Marine Radio Surveyor's offices but one wonders for how long. Yet, as some countries show, it is possible to use tape recorders to carry out supervised examinations without the examiner being a qualified operator. In the USA, the ARRL has petitioned the FCC to permit the use of volunteers in the amateur licence examinations, made possible under the provisions of the recent Public Law 97-259.

The Guernsey amateur radio society are proud of the results being achieved by their young RAE course tutor, John Morris, G/U6BG1. Still under 18 years old, he has already tutored 14 members of the society to success. All nine of his pupils for the December examination, aged 14 upwards, passed, bringing the number of Guernsey schoolboy-amateurs to seven. His pupils, however, are not all young; they have included a retired doctor.

50 MHz operation

Since February 1, 40 British Class A amateurs have been permitted to operate between 50 and 52 MHz outside of television broadcasting hours. These include three stations in Northern Ireland, three in the Channel Islands, ten in Scotland, five in Wales and nineteen in England. The Home Office has disappointed Class B (144 MHz and above) licensees by ruling that "cross-band" operation with the 50 MHz stations must be confined to those holding Class A licences.

The GB3SIX 50 MHz beacon on Anglesey began transmitting on a 24-hour basis at the end of December and has been reported in Nova Scotia, Canada and Connecticut, USA despite the marked decline of sunspot activity this season. Long-distance paths in a southerly direction continue to open quite frequently and the beacons in France, Brazil and South Africa have been well received, and many long-distance two-way contacts achieved.

Old-timers depart

Douglas Johnson, G6DW, died in January a few months before he reached the 60th anniversary of obtaining his licence in 1923. A former adviser to the RSGB on legal matters, he had been an ardent long-distance operator for many years and had contacted over 500 different Australian amateurs.

Bill Browning, G2AOX, who in 1924 was the only manufacturer of radio receivers in the City of London, died in December. As a result of a spinal injury in a power boat race, he became very active in the Radio Amateur Invalid and Blind Club of which he was president for many years. In the early days of Oscar he developed a very simple tracking system for low-orbit satellites.

In brief

More repeaters on v.h.f. and u.h.f. bands are expected to be licensed shortly (Phase 5 and 6) . . . When the STS-9 Space Shuttle launch takes place next September one of those on board is expected to be Dr Owen Garriott, W5LFL who has been seeking permission to take with him a 144 MHz handheld transceiver. Plans are going ahead to organize amateur radio contacts on an orderly basis . . . The FCC is now authorizing the operation of automatic beacons of up to 100 watts without a control operator being on duty, a previous requirement . . . A Californian cable company has been fined $2000 for "signal leakage in excess of that permitted by the rules" and $4000 for "failing to correct harmful interference to amateur radio operators". This follows the company's failure to reduce interference following complaints . . . A Hollywood amateur has had his licence revoked for violating FCC rules on transmission of "obscene, indecent or profane words, language or meaning". His defence that the language was not obscene by Los Angeles community standards, and was the kind of language that had for a long time been used by amateur operators, was rejected . . . The White Rose mobile rally at the University of Leeds is being held on March 27 . . . the Swansea rally at the Patti Pavilion (next to St Helens Cricket Ground) is on April 10 . . . RSGB VHF Convention at Sandown Park Racecourse, Esher is on March 26 . . . Former members of the RAF's Civilian Wireless Reserve, formed in 1938, are invited to join s.a.b. nets on the first Monday in each month (3760 kHz, 2200 local time) or second Monday in each month (7050 kHz).

PAT HAWKER, G3YA
**LETTERS**

**SEMICONDUCTOR MUSEUM**

I wonder how many subscribers to your excellent magazine have noticed the sad disappearance of the British germanium transistor? I am sure that many of your readers can remember the days when the transistor was but a young upstart trying to steal some of the market from the venerable valve.

In those days, Britain possessed her own transistors, and weird and wonderful they were. Named for their appearance, the red and white spots, and the "top hats," they were uniquely British. Alas, such eccentrics marvels are virtually unobtainable nowadays, superseded by drab devices with standardized American nomenclature and packaging.

Perhaps few of your readers mourn the disappearance of those colourful early types, and perhaps few have even noticed that they are gone. A quick scan of the advertisements in this issue will soon reveal that only a few AC and AD types survive in this market. If any of your readers has some such early germanium types, or data books or sheets which describe them, I would be very grateful if they would write to me.

Andrew Wyllie
18, Rue de Lausanne
1201 Geneva
Switzerland

**HERETICS' GUIDE TO MODERN PHYSICS**

I have thoroughly enjoyed Dr Scott Murray's heretical Guide to Modern Physics for it has reawakened my earlier misunderstandings of undergraduate physics.

My thoughts, however, were jolted by the statement that "If you believe in ghosts and miracles you have missed your vocation; you should have been a theologian not a physicist."

Until now I had no idea that Schroedinger and his colleagues were leading me down the slippery metaphysical path to an acceptance of these phenomena. But surely, theology and physics are not intended to be mutually exclusive but may be combined under a single philosophy. I can content myself with a somewhat hazy explanation of both areas.

Perhaps physical particles are made up from more basic thought or information particles put together in a certain way. This is just as our concept of area is created from the orthogonal addition of two lines, each of some length but of no width or area.

It is not surprising, therefore, that physical measuring instruments which are set up to measure two-dimensional "area" are unable to provide readings of invisible lines of single dimension. Furthermore the thought or information particle building block hypothesis makes phenomena such as trans-kinetics quite easy to explain.

Perhaps physical material can be dismantled into its thought-particle components and reassembled elsewhere at will, although will is presumably made of thought particles too.

We clearly now require a framework for thinking about thought. An analogous technique has been developed for interpretive language control of modern computers; program commands, addresses and data are all arranged to flow through the same wires in an ordered way.

We may extend the computer analogy another step. Perhaps we are permitted to interact with the daily world only through a high-level computer program, called, if you like, "Newton's Laws" whereas others (God or prayer perhaps) can use a more powerful assembler language that produces apparent miracles with ease. This is simply because the high level program controls the physical dimension whereas the low level program controls the thought dimension.

Just a thought.
Dr Brian T. Evans
Watford
Herts

**RS232/CURRENT LOOP**

The following comment on the useful article by L. Macari, February 1983 might be of help.

I designed and constructed a similar interface for communication between two computer systems where the emphasis was a requirement of isolation. The link showed every sign of successful operation though with infrequent, but serious, loss of data. This was eventually traced to the fact that the residual "zero" current of the loop still generated sufficient opto-coupling to create occasional errors, despite the fact that all components of both drivers and isolators, were proprietary brands.

The solution was to add a 1 k resistor across the optical diode to ensure that the "zero current" voltage generated at that diode was less than its conduction threshold. As an additional precaution, I also included a reversed diode across the opto isolator diode to protect against inadvertent reversed connection.

B. Fisher, Dista Products Ltd, Speke, Liverpool

**DEATH OF ELECTRIC CURRENT**

I have progress to report.

D. W. Bell, who is not given to wasting words, said in his letter (October 1982) that the role of mathematics in physics is "essentially predictive" and concluded his letter "But if one accepts the logic of mathematics, one can accept the logic of mathematical models."

It is clear from the introduction to his paper that Hertz would have agreed with Professor Bell; in fact Bell has explained the motive for every experiment performed by Hertz between 1886 and the time of his untimely death on the first day of 1894 at the age 36.

By accepting the logic of Maxwell's mathematical model of an ether, Heaviside and Poynting were the first scientists to realise that Maxwell's equations predict that the source of a current in a wire was located in the surrounding field. Hertz agreed with the mathematical reasoning of the Heaviside-Poynting theory "as the correct interpretation of Maxwell's equations."

Catt's critics, although not accepting the logic of Maxwell's mathematical model, have all based their criticism on the fact that Maxwell's equations predict the phenomenon of displacement current. Maxwell's own definition of his displacement current is in Art. 111 of his Treatise, dealing with the phenomenon of induction of electricity through non-conductors.

"Electric Displacement. When induction is transmitted through a dielectric, there is in the first place a displacement of electricity in the direction of the induction. For instance, in a Leyden jar, of which the inner coating is charged positively, and the outer coating negatively, the direction of the displacement of positive electricity in the substance of the glass is from within outward.

Any increase of this displacement is equivalent, during an increase, to a current of positive electricity from within outward, and any diminution of the displacement is equivalent to a current in the opposite direction."

In other words, only during an acceleration or deceleration of the velocity of electric displacement does Maxwell's displacement current manifest itself. Maxwell said in Art. 62 that all electric currents flow in closed circuits, and in Art. 305 that as all currents of conduction must flow from a high to a low potential, conduction currents cannot flow in closed loops. I have suspected that all current loops are closed, and more importantly caused by, a displacement current, for instance in the induction of electricity from the secondary winding of a transformer.

Hertz's paper seems to confirm this is so. The present confusion in electromagnetic theory lies in our failure to differentiate between electric displacement and displacement current; the latter only manifests itself when the momentum of the former either accelerates or decelerates.

Ivor Catt's Heaviside Signal or Poynting Vector travels through space at the constant velocity of light, and is therefore by Newton's first law of motion, inert. It is a form of perpetual motion, and will travel through space at its constant velocity forever, unless acted upon by a polarized force. Newton defined inertia as a 'latent' or potential force. If a body at rest or travelling at a constant velocity is either accelerated or decelerated, its equal and opposite reaction to a polarized force causes its latent force to be transformed into an active force, because a force is the product of a mass and an acceleration or deceleration. Maxwell's electric displacement also travels through his ether at the constant velocity of light in free space in the form of a wave of displacement or strain of his ether, and like the Heaviside Signal, will do so forever unless a polarized force, such as a first day of 1894 at the age 36. By accepting the logic of Maxwell's mathematical model of an ether, Heaviside and Poynting were the first scientists to realise that Maxwell's equations predict that the source of a current in a wire was located in the surrounding field. Hertz agreed with the mathematical reasoning of the Heaviside-Poynting theory "as the correct interpretation of Maxwell's equations."

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tion. When a wave of electric displacement of the intensity of the ether's potential energy suffers a deceleration after its flight through space at a constant velocity, the electric displacement's kinetic energy is transformed into an electromagnetic force which produces a displacement current. The e.m.f. causes a displacement current to penetrate the surface of a conductor of electricity, say an aerial.

In the case of very-low-temperature superconductivity, I believe Maxwell's equations and his mathematical model predict that the wire presents an impenetrable barrier and perfectly frictionless surface of slip to the electric displacement in the neighbourhood of the wire, and the current is inert and flowing in a closed loop at a constant velocity in the surrounding field only. As the temperature of the wire increases, the wire's surface loses its properties, and the reactive centripetal force of the surrounding ether aimed at the centre of the wire, decelerates the momentum of the electric displacement by forcing it to penetrate the wire only. As the temperature of the displacement current in the wire. The permittivity, or modulus of electric elasticity of the ether surrounding the individual atoms of the mass of the wire must decrease as the wire's temperature increases. The flow of heat is a form of displacement current.

Hertz's paper raises many questions which are sure candidates for the immediate application of Dr. Murray's Doctrine of the Improper Question. If a current of conduction is caused by the penetration into the wire by displacement current, is the current when steady, travelling at a constant velocity longitudinally through the length of the wire, or, as Maxwell's equations predict, acting vertically through the surface of the wire only?

Should we call the electric current in a conductor the Catt Effect? M. G. Wellard

Kenley, Surrey

I refer to the letter from Mr. Ivo Catt in the WW for February 1983. He asked me to look at his diagram on p.80 WW December 1980. I have now been able to do this, courtesy of the WW reprint service.

It has taken me several days (and sleepless nights) to see what was in his mind, and do not mind admitting I got off to what I think was a false start in what I intended to say by reply, because I think he has made a mistake in what he invites me to do. So he does not mind I am not going to do two things my way.

Firstly, that 50ohm bit that he wants to put in the upper plate, I am going to do so loosely, so that it can be removed without touching it, by means of a sudden surge of gravity, or a puff of wind, or an angel on wings, so that whatever portion of the total charge is residing on it goes with it, leaving a gap in the surface. What was one charged capacitor is now two smaller ones, each carrying less than half the original charge.

Secondly I am not, in the interests of simplicity, going to use a length of coax., but rather to employ two parallel conductors of a spacing which entitles them to the nominal qualification of 50ohms, erected in the way he asks me to do now? No more or less than two terminal posts, one for each capacitor, each of the same sign and potential.

We can do as we please in the way of rearranging these charges from external sources.

What we have not got is a pair of conductors so placed and utilized that they can be said to be exhibiting a 2 ohm resistors to any external influence. So they are not by my reckoning an accurate substitute for the 50ohm resistor we got the angels to take away.

What I will join in and say, is that of course in charging and discharging these two capacitors, or the original one for that matter, at the velocity of light or theréabouts we do have a time lapse from terminal to the most remote part of the conducting surfaces concerned, which does not help me to consider the behaviour of frictionally induced charges on insulators.

O. Dogg

Huntingdon, Huntingdon

West Sussex

I noted with pleasure the letter in your February issue about the forthcoming course in Information Systems Engineering at the University of Bradford. Professor D. P. Howson was one of the first students in a postgraduate course which I introduced in the University of Birmingham in, I think, 1959. I am not sure that this says anything about the speed of response in Academe, but at least it shows that we lay sound foundations.

D. A. Bell

Professor Emeritus of Electronic Engineering, University of Hull

FACTORIES OF THE FUTURE

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Professor Emeritus of Electronic Engineering, University of Hull

SCIENCE AND POETIC IMAGINATION

I wish to take issue with the over-simplistic view of scientific innovation versus academic qualifications proposed by S. Frost (WW Letters, Feb, 1983, p.60).

The factors of inventiveness and scholarly attainment are too independent to hold a simple inverse relationship. The realms of the academically qualified contain many people who are immensely inventive and many who are not. Amongst those who lack qualifications there are some who are very inventive and a vast majority of those who are not.

Scientific and technical innovation are generally achieved by groups of workers comprising a mixture of abilities (both academic and technical). Furthermore, most developments at the forefront of technology can only be made by those who understand their fields in depth, a requirement that is rarely met without advanced education. I observe that the development of vertically aligned magnetic particles in tape and disk storage media — an idea much praised by S. Frost — was attributed to a Professor Iwasaki of Tohoku University (WW Feb, 1983, p.35).

This is hardly the unqualified, poetically-inclined, home inventor that S. Frost would regard as most likely to make such a discovery.

Finally, with regard to Lucretius, it should be pointed out that of this philosopher's more significant blunders were not the result of inability to test his conclusions, but rather a consequence of mere faulty logic.

P. A. Stockwell

London

DEUS EX MACHINA

I read with interest your February editorial, entitled "Deus ex machina", in which the argument ran:

— the idea of a living existing is horrific
— therefore x cannot exist.

In the editorial x was the thinking, artistic, humorous computer but the general structure of the argument is very comforting and since reading the editorial I have been able to show conclusively that nuclear weapons and the Sun newspaper do not exist.

I would, however, like to take you to task on the question of the appreciation of humour. It is very possible that my children are particularly thick, but I have noticed that they have had to be taught how to appreciate a pun or joke (as distinct from slapstick). I don't think that at the age of five they would properly appreciate a nonsensical poem without the proper facial grimaces of the reader. I think I could program a computer to recognise a nonsensical poem and respond accordingly, given the same manpower that has gone into programming (teaching) my children.

C. W. Hobbs

Sussex

Wireless World of February, 1983 raises some interesting points, some philosophical, rather than technical. Here's my two-penn'orth, although I can't hope to be as philosophical as A. C. Batchelor was in his letter.

Your editorial interests me, first of all. The one piece of classic English fiction which expounds, better than any other, the idea of artificial 'human life' is Mary Shelley's Frankenstein. In this, the brilliant scientist creates a living being, from spare parts, but cannot endow his creation with a soul. Thoughts, emotions, yes; an immortal soul — no. Perhaps with this began the 'commonplace conceit' of which you speak in your editorial.

Beware, however, of categorically declaring something to be an impossibility, as you do when you exclude the possibility of a thinking, feeling computer. Admittedly it appears highly unlikely, but then so would everyday twentieth-century technology to a mediaeval peasant. The trouble with the Doctrine of the Improper Question, is that it's OK until an unexpected Improper Answer clouts you round the back of the neck, as did Galileo's answers clout the Roman Catholic Church.

Which brings me to your charge of sacrilege. That is a purely subjective idea. To some sects, a simple, life-saving blood transfusion is sacrilegious. Possible closer to what most of us could call sacrilege, is the current trend towards worshipping The Computer, but you don't need me to tell you this, when you have Ivo Catt!

However, on to other matters. It saddens me when I see people at each other's throats, in the way that Peter Gregory seems to be at the CBers (Letters column). His letter seems to be yet another example of the merry-go-round of mud slinging which seems to go on within our so-called ' fraternity' of radio amateurs, sparked off, no doubt, by the attitude of professionals to
us (see Pat Hawkers' commentary on Prof. Beynon's opinion of UOSAT). Everyone has to have someone to kick; G3s have G6s; new boys have old buffers; f.m. mobile operators on 2m have the guys who use S20 for more; everyone has the CBers, and the CBers presumably go home and kick the cat!

The CB lobby, by its failure to campaign for what it really wanted, i.e. at least the FCC specifications (40 channels, 4W, a.m./s.s.b., no antenna restrictions, etc.), campaigned for, got, and was split in two by "a CB service on 27MHz", which happened to be just about incompatible with anything else under the sun. To give the appearance of being forward-looking and responsive to public pressure, the Government rushed in a system which ignored one of the basic aspects of two-way radio efficiency -- the receiver, as a result of which we now have cheap, imported transceivers flooding the market at less than £20 a throw, which get sworn at as the merest suggestion of a strong signal.

I cannot approve of misuse of the radio spectrum, but I think two points should be borne in mind: everything ever invented has been misused at some point, and the current Government would commit collective harakiri sooner than legalize something that people were already doing illegally. Sadly the existence of pirates on 27MHz, 6.6MHz, or as intruders on our amateur bands, indicates that the Government may well be totally out of touch with what people want from two-way radio. M. E. J. Wright's scrambled-egg of a letter seems to have more than a grain of truth in it.

Long may your excellent magazine flourish, including the forum of your letters page, but please, by the way, spare me the inaccurate use of the term deus ex machina. It was a device for getting us out of rather than into trouble.

Paul Thompson
Southport
Merseyside

It is very fine what was written in your Editorial in WW of January 1983, but unfortunately you do nothing else but express an idea, a thought, a conjecture which comes from the extrapolation made about the future by what is known now in our present status. The chromosomes, which hang on our human features from generation to generation, are of finite number and composition, and the brain that comes from them is a biological machine which, with its ten thousand million neurons, is clearly too complex to understand now without the aid of computers.

It is as if several thousands of years ago, at the time that the wheel was invented, someone had extrapolated the idea that never in the future anyone could be able to build an automobile using it.

The computer -- and the Von Neumann-cycle computer is only one of the infinite number of possible structures (the structure and the brain is another) -- is the "wheel" of our brain.

Please, don't extrapolate so much from it, now.

Dante Viallett
Castellanza
Italy

If, as your February editorial asserts, a willingness to perform actions for the sole benefit of others distinguishes men from beasts, then computers are more human than bestial. Everything they do is for the benefit of others -- ourselves!

It can, of course, be objected that this doesn't make a computer human, because willingness implies consciousness, but computers are not conscious. In theory, however, a computer can easily be made conscious, that is, to distinguish between 'self' and 'not-self'. There is every reason to believe that this will eventually be done, for practical purposes. At present we have to make our computers. How much easier if they could be programmed to replicate themselves. Already a computer can be made to control the machinery which makes other computers, in a blind, mechanical way. However, as von Neumann explained, it is perfectly straightforward, in theory, to educate a computer so that it knows how to replicate itself and is motivated to do so.

To effect this, the computer is given a technical description of a machine just like itself, but with a built-in instruction to make identical machines. All these "offsprings" will arrive into the world with a knowledge of what they are and a motive to reproduce. They would need operating mechanisms and much information about the world. The mechanisms are being developed by robotics engineers and the knowledge, though vast, is just straightforward technical stuff.

In principle, then, a conscious, self-replicating machine is quite feasible. Of course, such a machine still isn't human. It doesn't fail in love, respond to poetry, and so on. Arguably the only reason why humans have acquired these emotional abilities is that they help to ensure the continuation of the race. A self-replicating machine wouldn't need them.

Whether a machine could be programmed to feel emotion at present be a theological question rather than a technical one. Some inklings of the answer can be obtained by asking another theological question: Could God make such a machine? Being omniscient, presumably He could. If so, then human beings, too, can reasonably be regarded as programmed self-replicating mechanisms. This emotion has been rendered more plausible by the discovery of the human body's "program" in the form of the genetic code. This apparently contains the basic information needed to allow a one-celled embryo to develop into a being with emotions, a given environment in which to grow up and learn.

An intelligent machine, equipped with a knowledge of the world about it and a motivation to replicate itself would doubtless utilize human resources of the world as well as the inanimate ones. Present trends show that it would have no difficulty in bribing mankind to work for it by providing the wherewithal to make human life pleasant. Eventually, the machines would just take over. Whether they allowed human life to continue is an open question. They would have little difficulty in eliminating it since humans have already created the weapons needed to destroy the planet.

One explanation of the absence of contact with alien life forms is that this is what happens to all advanced civilizations. After all, the probability that somewhere around three billions of suns of the Galaxy life evolved long before it did here. So where are they? Even with the limited machinery for space travel at present envisaged here the Galaxy would be colonised in a single generation. If they are not here, they must have succumbed to the machines.

Why, then, are the machines themselves not here? Perhaps they, too, evolve, and decide that a program of blind replication needs changing. Or perhaps they have decided, being being no object, the most efficient method of colonization is to spread the seeds of primitive life about the universe, knowing that these will give rise to intelligent organisms which will design self-replicating computers, which will take over.

For deus ex machina read deus in machina.

G. W. Short
Croydon

MEMORY WRITE PROTECTION

I would like to suggest that, due to substantial overloading, the circuit described by A.C. Dickens (Circuit Ideas, December 1982) fails spectacularly to achieve its desired aim.

Firstly, the Z-80 machine cycle, in common with that of most computers, does not perform the operation for an interrupt (be it NMI or INT) until completion of the execution of the current instruction. In the light of this fact, it can be seen that (with the circuit as outlined) a potentially destructive Memory Write will have been effected before the system can respond.

Secondly, should a Write be made to the system memory area (by, for example, a PUSH to the "protected" system stack during the interrupt service routine), then a further non-maskable interrupt will occur. This will, of course, cause another call to the interrupt service routine, necessitating a further System-Memory-Write, and a non-maskable interrupt will yet again ensue. The system will become, in effect, nothing but an expensive oscillator.

Finally, since the circuit responds to any write cycle, then a spurious activation of the interrupt will occur during an OUT instruction if the upper address lines (i.e. the contents of the A or B registers) appear to be the appropriate addresses.

In conclusion, this circuit will require much modification if it is to perform its designated task satisfactorily.

P. Hart
Computer Centre
South Cheshire College,
Crewe
Cheshire.

LOGIC MAPS

As one who has long objected to the confusion between Venn and Euler diagrams, so assiduously encouraged by schools' examination boards, I must express my delight on reading the article, Logic Maps -- from Lull to Kar naugh (Wireless World, Dec. 1982), by N. Dar wood. This brief resume of the historical de velopment of such diagrams has great educational value. However, there are several inaccuracies in the article which mar the good intent of the work.

Of minor concern, his bibliography is in error on two points. Firstly, I believe that Euler's circles were first used in his Lettres a une Princesse d'Allemagne, which were written in 1761 (not 1760) and published in 1768. Secondly, Boole's The Laws of Thought, was published in 1854 (not 1884), and reprinted by Dover Publications in 1958. In any case, the ideas elaborated
in that book were first put forward in his Mathematical Analysis of Logic, (Cambridge 1847), reprinted Oxford 1948), a work published before he was appointed to the Chair of Mathematics (not Probability Theory) in Queen's College, Cork. An account of Boole's life can be found in W. Keenan, "Boole and the revival of Logic" Mind, liv (1948), pp.149-75. Whilst setting the chronology to rights, I might also point out that Leibniz was not born until 1646, and so, in 1600, was dreaming neither of his arts combinatores, nor of his calculus de continuis et discontinuis.

More serious is Darwood's misreading of Venn and Boole. Despite the comments of Lewis Carroll (C.L. Dodgson), Venn does not insist on circles (or eclipses) for his diagrams, nor does he ignore situations involving more than six classes.

"With employment of more intricate figures we might go on forever. All that is requisite is to draw some continuous figure which shall intersect, once, and only, every subdivision. The new outline thus drawn is to cut every one of the previous compartments in two, and so just double their number. There is clearly no reason against conceiving indefinitely..." (Symbolic Logic, London 1881, p.106)

He goes further in a footnote on pp108-9,

"I will be found that when we adhere to continuous figures, instead of the discontinuous five-term figure... there is a tendency for the resultant outlines thus successively drawn to attain a comb-like shape after the first four or five... Thus the fifth term of the figure will have two teeth... and so on, till the (4+x)th has 2x. There is no trouble in drawing such diagrams as a group of terms which our paper will find room for."

It is not the geometry of his diagrams that cannot cope with large numbers of classes, rather it is the perception of the human eye and the human brain.

"the visual aid for which mainly such diagrams exist is soon lost on such a path." What is more, Venn's diagrams, unlike those of Carroll, are not like the chessboard or Karnaugh grids, and maintain the contiguity of all areas belonging to any one class.

Regarding Boole, there are several mistakes. In The Laws of Thought, the variables are introduced as "primary propositions", regarding them as statements about the truth values of propositions, or rather "primary propositions", which were about things (i.e. classes). He introduces secondary propositions as a model of his algebra, although he interprets them in terms of classes, regarding his symbol "x" as denoting the class of things at which some proposition, X, is true. Later in the book he offers, as another model, an interpretation of the variables as measure of the probability of events.

As to the "mystery" of why Boole uses "+" for disjunction, Boole himself writes (regarding classes).

"... we have expressed the operation aggregated by the sign +, ..." (p.33).

What would be more natural for a mathematician than the use of the sign of addition for aggregation? Earlier, Leibniz, in his Non Inelgans Specimen Demonstrandi in Abstractis uses the sign "O" for something like the union of sets.

Lastly, in his exposition of Boole's algebra, Darwood seems to confuse the modern mathematical conception of a Boolean Algebra with the algebra of Boole. The former uses "+" in a way which can be interpreted as inclusive alternative, i.e. "A + B" means "A or B or both A and B".

On this basis, he is correct when, having derived

\[ A + B \bar{A} = A + B \]

from

\[ A + BC = (A + B)(A + C) \]

he refuses to subtract A from both sides to obtain the incorrect

\[ B = \bar{A} \]

Boole, however, takes disjunction in an exclusive sense.

"The expression, "Either y's or z's," would generally be understood to include things that are y's and not z's, and z's and not y's, as well as things that come under one of the two not the other. Remembering, however, that the symbol + does not possess the separating power... we must resolve any disjunctive expression which may come before us into a number of conjunctions separated in thought, and then connect their respective expressions by the symbol +." (p.56)

In other words, "A + B" is only a well-formed expression in Boole's system if we have already assumed the truth of B = \bar{A}. Then of course, it is not surprising that we can deduce the true statement B = \bar{A}. On Boole's interpretation, subtraction will work in his system as it does in ordinary algebra.

As a final point, it is possible to fill the gap between Lulli's use of linked circles, for in De Censura Veri (1555), Ludovicus Vives uses a diagram to indicate that if all B is A, and all C is B, then all C is A. If one compares this with an Eulerian diagram of the same proposition, then the link is clear.

H. Tennant

Holbeck

Lincolnshire

MICHELSON – MORLEY

The saga of the M.M. experiment must surely be one of the strangest tales in the history of science. It is a story of such monstrous oversights and omissions that when those defects are repaired the experiment is found to prove exactly the opposite of that which is taught.

In the 1887 paper1 M.M. admit to an earlier experimental omission, the effect of the aborvation of light in the transverse axis, which was pointed out by M.A. Potter. They also admit that it was an analysis by H.A. Lorentz which led to the idea that the transverse axis would reduce the originally anticipated result by half. At the present time we are not taught that it was Lorentz who did half of the calculations for M.M. and we must remember that at the time Lorentz wanted a particular amount of length contraction, the reason being that he would repair the equations of J.C. Maxwell.

Did Lorentz secretly predict a null result to himself: If he did, and on the evidence he surely must have, then he certainly did not divulge his ideas to M.M. Otherwise they would have claimed a comfortable experimental confirmation instead of the nebulous uncertainty that science has tried to sweep under the carpet ever since.

Let us pretend that there was in fact a null result, let us further pretend that Lorentz did not fully appreciate the implication of Fig. 1 in the supplement of the paper which describes graphically just how aberration of light occurs.

The mathematic of the experiment was designed to reveal the difference in time taken by both rays of light in their respective paths. The error made by M.M. was that they did not measure, directly, the difference in arrival time of the light wavefronts. They chose instead to interpret a phase difference in light waves as being the same thing as a measure of a difference in time.

A phase difference is a proportion of a wavelength expressed either as a spatial displacement or alternatively as an angular displacement which in itself is a form of spatial displacement. The introduction of time into the notion of phase difference is clearly ridiculous for it would allow phase difference the dimensions of velocity.

So, we now have a situation where we have slid, with magnificent ease, from the mathematical comparison of time into the experimental comparison of distance and there is no bridge joining the two things. It is not even a paradigm shift.

Now we must consider the experiment in the terms in which it was conducted, those of wave theory and practice.

First let us do the experiment with the transverse axis. There are two points of view to be considered.

To an observer moving with the experiment the light is seen to travel straight out and back to its origin but to an observer at rest in space the light follows a triangular path as a result of the aberration which occurs when light is reflected into a sideways path by a moving mirror.

Now, the important thing to remember is that both observers are looking at the same ray of light and that they both see the same number of waves. The phenomenon of aberration extends the wavelength on the triangular path by an amount which conforms to the Lorentz transform. Regardless of the velocity of the experiment it is quite impossible for the number of waves in this axis to vary.

In the longitudinal axis we have again two observers looking at the same thing, one sees two equal paths and the other two unequal length paths but they both see the same number of waves. There is no mystery here because it is well known that with the Doppler effect there is, whether light be blue or red shifted, an additional element of red shift which accords with the Lorentz transform. Because the wavelengths are extended and because that fact has been overlooked it became popularly accepted that the length of the experiment itself varies with velocity.

So, we see that by using interferometry and invariant length the experiment must always yield a null result.

Had length in fact varied as supposed by Lorentz then the result would have been both obvious and spectacular.

What will the scientific establishment do to rectify their errors and the illusion that light is light and hope that reason will continue to be driven away from the explanation of Nature?

A. Jones

Swanage

Dorset.

1. Philosophical Magazine December 1887.

2. Einstein's Universe, N. Calder.
Op-amp tester gives good/bad indication

Full op-amp parameter tests are complex and in most cases only an indication of whether or not the device is good or bad is required. Malfunctioning is mainly due to misuse which results in one of three conditions:

- constant output at either supply rail
- offset voltage ($V_{OS}$) too high
- offset current ($I_{OS}$) too high.

In general an input overload will result in both $V_{OS}$ and $I_{OS}$ being excessive but if the second-stage differential pair is affected, an excessive $V_{OS}$ with normal $I_{OS}$ is possible. Defects such as abnormal offset drift or input noise are due to manufacturing or aging and are more difficult to determine.

A good/bad indication of the three conditions listed above is given by the circuit shown, which consists of a 1kHz Wien-bridge oscillator designed around a 741 op-amp. Diodes are used to stabilize the output at about 2V pk-pk as distortion is unimportant, and attenuators feed around 85mV to the device under test (d.u.t.). Operating with a gain of 100 in inverting mode, the d.u.t. gives an output of 100 times the sum of $V_{OS}$ and the oscillator signal. Two resistors in series with the d.u.t. input transform the input offset current into an equivalent $V_{OS}$ so the output consists of an 8.5V-amplitude signal while a d.c. shift of 100$V_{OS}$ or 100($V_{OS} + R I_{OS}$) occurs depending on the switch position.

Two 311 comparators convert the d.u.t. output into pulses driving LEDs which have equal intensity when the d.c. shift is zero. Comparator values are chosen so that one LED is extinguished when d.c. shift is greater than 15mV or the d.u.t. output remains at either supply rail. Comparator levels may be increased to test older jfet op-amps with offset voltages around 15mV.

After testing the op-amp with the switch closed, open the switch and one of the LEDs will extinguish if $I_{OS} > V_{OS} + 15 \times 10^{-3}/R$. Limitations of the tester are the use of fixed 12V supply rails and that offset current detection is not sensitive enough for jfet op-amps unless R is made very large, say 10MΩ.

Small plug-in p.c.b.s shown suit different i.c.s. In practice only a few boards are necessary since a number of op-amps have identical connections (741, 301, 309, CA3130, CA3140, LF356, LF357). For dual and quad op-amps, p.c.b.s with terminal rows representing each op-amp element may be used as shown; individual elements are tested by turning the board.

Sampling synchronous demodulator

This circuit offers a superior signal-to-noise ratio to that provided by the usual arrangement of a single op-amp switched between the inverting and non-inverting modes. Signals are demodulated by sampling positive peaks with $S_1$ and negative ones with $S_2$, averaging these voltages and subtracting them with a differential amplifier. The output voltage is thus equal to the pk-pk input voltage, i.e. twice that of a conventional circuit. Sampling pulse width can be adjusted to minimise output ripple at the switching frequency, which is often a source of noise when demodulating slow rise-time signals. Spike injection from the switches is integrated by the filters and appears as a simple offset voltage which is easily nulled.

The circuit was developed for use with a photo multiplier in a chopped-beam photometry system. Linearity of the prototype was within 1% of readings in the range 30μV to 3V r.m.s. using a DG200 for $S_1, 2$ and TL081C amplifiers. Low-drift devices such as OP-05s are required to maintain this performance over a useful temperature range and for demanding applications an instrumentation amplifier should be used.

D. J. Faulkner & P. West
Institute of Ophthalmology
London

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Sampling synchronous demodulator
Low battery indicator

Many battery operated instruments make use of a simple zener regulated supply to maintain performance during the life of the battery. If the zener current is monitored as shown warning will be given when the battery voltage falls below $V_z + V_{be}$. In some cases the addition of $V_{be}$ may be significant and $V_z$ should be reduced accordingly.

R. D. Homerstone
Daventry

Preamplifier using discrete op-amps

Today's audio designs with six figure gains are a bit of transistor over-kill. The two stage-gain block compromises first-stage linearity in order to obtain a virtual ground output. Hence, the need for large amounts of purifying feedback. Now may just be the time for that last look at a simple design before i.c.s and their excessive gain/feedback dull our receptors for fine music. Here is a single-stage differential-gain block which optimizes gain and linearity and that eliminates the need for feedback. Output provided will drive most power amplifiers, being around two thirds of that obtained with simple two-stage designs.

Open-loop gain for the 'n-p-n' configuration is 278 with a bandpass limit of 50kHz. With a dual 24V supply, clipping is above 12V and open-loop distortion less than 0.5% at line level. Virtual-ground output is obtained using an inverting amplifier in an h-configuration. In a dual-h configuration, second-order harmonics are cancelled in the output stage and remaining distortion products are largely even-order.

No turn-on thumps occur if all diodes are "kept alive" by a $\pm 2.5V$ supply. I discovered a "de-thumper" action for the power supply but it will not perform with regulator i.c.s. An oversize click suppressor capacitor around 0.02µF across the turn-on switch will pass sufficient current to give a $\pm 2.5V$ volt power supply output. Any voltage change above that value will find a balanced demand and no audible output.

Point of clarification:

A balanced circuit, such as the single-h, is inherently non-thumping at turn-on, when powered by a non-regulated power supply. There are turn-on clicks, however, that are problems to some. The oversize capacitor will give maximum protection against them with the added advantage of a low level warm-up.

George C. Hill
Richmond
Indiana
Quadrature clock generator

Usual circuits for generating quadrature signals quarter the frequency of the input signal – this circuit generates true quadrature signals at half the input-signal frequency using an equal mark-to-space ratio source. Latches shown are edge triggered.

S. Sondersgaard
Edinburgh

Cycle protection

With this device fitted, turning the wheels of a bicycle or tampering with the lights will trigger an alarm which may only be turned off by a BNC connector. A rise in the base voltage of Tr1 triggers the alarm timer and enables the output modulator. This is normally prevented by a ground path at D2 cathode through the dynamo and LP1,2 (the bridge rectifier isolates the dynamo when stationary).

Capacitor C1 is included to stop the batteries being switched from charge to supply each half cycle when the lights are on. Resistor 1 limits the charging current and D1 switches the batteries off when the dynamo reaches normal speed. Resistors R2,3 and C2 prevent the alarm being switched off by S2 once initiated (unless the 'key' is used).

The complete circuit and batteries are mounted in the frame tube under the saddle. Switch 2 protrudes from the tube under the saddle – the alarm buzzer is mounted under the seat – and switch 3 sounds the horn when the BNC connector is in position. Under normal conditions the 'key' may be removed after turning the alarm off.

Experience of failures due to light-duty wiring and connector problems leads me to stress the importance of a robust construction.

J. Ashby
Cottingham
North Humberside

Monitor for ZX81

Video signals from the ZX81 can be used to drive monitors without a video buffer amplifier provided that connecting leads are shorter than a metre. Short cables have around 50pF capacitance and may be driven directly by the computer u.l.a. if the monitor's 75Ω terminating resistance is switched out. Damage to the u.l.a. and ringing are prevented by the 68Ω series resistor. Cable lengths within the computer should be taken into account.

P. Gascoyne
Wantage
Oxfordshire

WIRELESS WORLD APRIL 1983
Electronic mains switching

Switching peripherals on and off while a microcomputer system is running is precarious in that transients produced can cause changes in memory. Initially, the cost of a transformer makes this zero-voltage switching circuit for driving up to eight mains outlets seem expensive, but further sets of eight outlets only need one latch, eight switches, transistors and triacs and a handful of resistors each. With minor modifications, cost could be reduced by replacing the isolating transformer with an auto-transformer or potential divider.

Transformer provides 5V to drive t.t.l. circuits and 16V to drive high-power triacs with insensitive gates; lower voltages may be used with more sensitive triacs down to about 7.5V when the voltage regulator's function will be affected. A squarewave driving the first transistor is derived from the mains positive half-cycle using either a zener or three ordinary diodes with a high-value resistor and transistor buffer stage (the base resistor may not be needed). On the squarewave negative transition, the first two i.c.s form a short pulse which latches logic levels in the 74373 depending on the switch positions. Outputs of this i.c. drive the triacs through buffer transistors; values of resistors in the buffers will depend on the sensitivity of the triacs used. The squarewave negative transition is used as latching will occur nearer to zero volts than when the positive edge is used. All elements of the circuit are connected to the mains.

M. Selce
Sutton

Simulating iron-cored components

Designed to simulate iron-cored components on an analogue computer, this variable circuit models square-loop hysteresis using Schmitt triggers and a summing amplifier. Output amplitude and hysteresis of each cmos trigger are variable, with negative feedback controlling the hysteresis loop.

Setting is best done by trial and error using an XY oscilloscope and a piece of tracing paper with the required loop drawn on it.

D. H. Rice
Bishop's Stortford
Herts

Power-amplifier testing

Cheap half-watt loudspeakers can be connected to power amplifiers up to 30 watts for testing purposes using a series bulb. If this power is exceeded or the amplifier fault gives a d.c. output, the lamp blows leaving the speaker intact. At low power the lamp has little audible effect.

C. Richardson
University of Hull

Zero dot for bar graph

Possible ambiguities in bar-graph readings caused by all elements being extinguished when the input is zero can be prevented by adding a zero light-emitting diode. The transistor extinguishes the zero led when any other diode is lit, its collector resistor being chosen to suit the required zero-led current. This circuit was used with the LM3914.

P. Gascoyne
Wantage
Oxfordshire
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Three-terminal superconductor

A superconducting device that operates in a similar way to a high-speed switching transistor but in a much smaller space and at 1/100 of the power was experimentally demonstrated at the IBM Thomas J. Watson Research Centre, New York, in January. Dubbed the quiteron, the invention is the first device to make use of the non-equilibrium superconductivity phenomenon known as heavy quasi-particle injection tunneling. It is also the first device of its kind that can both amplify and switch, giving it the potential for applications in digital and analogue circuits.

Still in the experimental stage, the quiteron consists of two tunnel junctions formed by three thin films of superconducting material separated by two thinner films of insulating material. Electrical energy through one tunnel junction drives the central conducting layer into a non-equilibrium state and the second junction represents the central conducting layer's state.

Switching speeds of less than 300ps and small and large-signal gains of ten and three respectively are not astounding but taking into account projections that the device could be scaled down to lateral dimensions of 0.1μm with a power consumption of 1/100 that of current high-speed semiconductors, the quiteron could represent a breakthrough. Non-latching operation and insensitivity to stray magnetic fields are inherent.

A short-term strong point of quiterons - provided that they can be economically manufactured - is that they can be used to form the equivalent of a current v.l.s.i. circuit since they have three terminals and invert the input signal. Superconducting devices such as the two-terminal Josephson junction might require an i.c. technology that has to be developed from the ground up. The quiteron was described at the Applied Superconductivity Conference held at Knoxville, Tennessee, in December of 1982. Authors of the paper were S. Faris, S. I. Raider, W. J. Gallagher and R. E. Drake.

Another million for Sinclair

Sinclair Research, said to be worth £136m, recently declared itself as the first company in the world to sell a million home computers. Excluding 600 000 computers manufactured under licence by Timex in the USA, this figure has been reached in three years and the company says that this may only be the beginning since even Britain — with more computers per head than any country in the world — has only one computer for each 20 homes.

Whether this optimism is justified remains to be seen. A report issued by Mindtel claims that by the end of 1985, 10% of British households will have a home computer. Virtually every month sees the introduction of a new home computer and the situation is now far more volatile than it was when Sinclair's ZX80 was introduced in 1980. But the Henry Ford of the home computer world is reported to be selling off around £13m of his industry, part of which will help finance a personal interest — an electric car.

- Following a decline in watch sales and the loss of a deal involving Nimslo 3D cameras, the future of the Timex plant in Dundee, where the Sinclair Spectrum is manufactured is in doubt. Timex intend to move work in Dundee to France, with a consequent loss of jobs in Scotland. The European Communities Commission issued a statement saying that it plans to investigate French government grants to the Timex company in Besancon.

Computer data via satellite — a demonstration

Project universe — devised by the Government, universities and industry to demonstrate the viability of high-speed communication between computers by satellite — received its inauguration on 22 February at Info 83. Combining ground-based Cambridge rings and other types of local-area network with OTS satellite links, the project involves the use of six UK Earth stations operating at above 10GHz to send and receive data between remote computers at 1Mb/s.

Each computer can communicate with other computers through the local-area network, or with remote computers through the satellite link, at a rate 100 times faster than is possible using current telephone lines. The system is likely to run for two years, when OTS is expected to cease functioning. The six Earth-station sites are at the Universities of Cambridge and Loughborough, University College London, the Marconi Research Centre (Chelmsford), Essex, BT's Martlesham Heath, Suffolk and at SERC's Rutherford Appleton Laboratory in Chilton. Funders of the operation are BT, Dol, GEC-Marconi Research, SERC and Logica.
Proposals for non-ionizing radiation limits

New UK limits for exposure to e.i.f., r.f. and microwave radiation are proposed in a consultative document from the National Radiological Protection Board. Written in response to a request from the Health and Safety Executive for advice on non-ionizing radiation, the publication proposes a mean specific energy absorption rate in the whole body of 0.4W kg⁻¹ for microwave and r.f. radiation. The current UK limit of 1W kg⁻¹, recommended by the Home Office and Medical Research Council, has stood for around 20 years and presumably the Health and Safety Executive will use the document in its final form as the basis for new regulations.

Hand-held radio transmitters, intruder alarms and proximity devices emitting less than 7W "may be regarded as harmless" says the board, but they should be designed so that they cannot deliver more than 4W kg⁻¹ to the eye for long periods. R.f. and microwave hazards to people with pacemakers are unlikely provided that the limits shown in the table are observed. "Higher levels of exposure may cause some types of pacemaker to revert to a 'fixed' mode of operation" say the board. People with pacemakers working in power-line frequency fields greater than 2kV m⁻¹ or in any field that is likely to exceed the limits in Table 2 should seek medical advice – some makes of pacemaker are affected more than others.

Estimating exposure hazards in the near field remains a problem. Here it is advised that "Under reactive near-field conditions, limits on power density are difficult to interpret and r.m.s. electric and magnetic field strength limits should be used. Until more information is available neither of these limits should be exceeded."

The Board suggests that for r.f. and microwaves, measurements of power density should be made with equipment capable of averaging values over a period of less than 1s and at less than 5cm from the radiation source. In periods of less than six minutes, the energy density to which a person is exposed should not exceed 360 times the prescribed power density levels. How to deal with moving antennas and mixed frequencies are outlined and the board advises that any exposure producing a sensation of warmth or auditory sensation such as that which can result from intense pulses of microwave radiation should be avoided.

In circumstances where the mean specific energy absorption rate in the whole body does not exceed 0.4W kg⁻¹ and a peak of 4W kg⁻¹ in a volume smaller than 1cm³ averaged over less than six minutes, exposures to higher power densities or field strengths are permissible. "This relaxation" says the board "is likely to apply in the frequency range 3kHZ to 300MHz under near or restricted field conditions, but the incident power density on any part of the body should not exceed ten times the prescribed limits, and field strengths should not exceed 3.16 times these values."

Exposure to power-frequency fields (50Hz) of less than 10kV m⁻¹ is regarded by the board to be acceptable and exposure to fields of up to 30kV m⁻¹ is considered unlikely to be harmful. "Apart from the 50Hz power frequency" says the board "there are very few applications in the e.i.f. range and there is little information that can be used as a basis for limiting exposure."

According to the foreword, "In general, the Board bases its advice on a scientific consensus of opinion about established facts. In the case of the biological effects of non-ionizing electromagnetic radiations many observations that might appear significant are proving difficult to confirm."

Some of these observations are argued summarily in the document and some are listed as references. Of course persons seriously considering offering comments on the document will also do their own research. The Board invites comments on the proposals before 1 July 1983, but due to "scientific uncertainties", it intends to keep the position under review. Copies of Proposals for the Health Protection of Workers and Members of the Public against the Dangers of Extra-Low Frequency, Radiofrequency and Microwave Radiations: A Consultative Document are available from HMSO for £2.

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**Proposed limits for continuous exposure to radio frequency and microwave radiations as proposed by the NRPP.** For "general populations", levels are almost identical to those of the recently approved America National Standards Institute safety guidelines (C9). The curve dips at between 30 and 300MHz because of body resonances.

**Proposed limits for continuous exposure to r.f. and microwaves for adults (top) and the general population including children (bottom).**

<table>
<thead>
<tr>
<th>Frequency range (Hz)</th>
<th>Power density (W m⁻²)</th>
<th>R.m.s. electric field strength (V m⁻¹)</th>
<th>R.m.s. magnetic field strength (A m⁻¹)</th>
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<td>3k-3M</td>
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<tr>
<td>3M-30M</td>
<td>9000/√²</td>
<td>600</td>
<td>5/µt</td>
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<tr>
<td>30M-100M</td>
<td>10</td>
<td>60</td>
<td>0.16</td>
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<tr>
<td>300M-1.5G</td>
<td>1/30</td>
<td>3.5 V/µt</td>
<td>9.4.10⁻³ V/µt</td>
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<tr>
<td>1.5G-300G</td>
<td>50</td>
<td>140</td>
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<td>100M-1G</td>
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<td>6 V/µt</td>
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<tr>
<td>1G-300G</td>
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<td>200</td>
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A voice from above

The digital speech synthesizer aboard Uosat is now fully operational and the project team expect to get long-awaited pictures from the spacecraft c.c.d. camera during March. The speech synthesizer, the first device of its kind to have been used in space, is a National Semiconductor Digitaltalker. Operating under the control of Uosat's primary computer, the synthesizer has been carrying operational telemetry and experimental data. With the help of the published calibration equations, the strings of spoken figures from Uosat can be decoded to give (for example) the amount of solar particle radiation, the current being supplied by the solar cells, or the temperature in the spacecraft batteries. The project team hope that the availability of data in this readily accessible format will help to stimulate interest in space science among schools and colleges as well as individual amateurs.

Speech transmissions were at first being made at weekends using Uosats general data beacon on 144.825MHz. Three-minute periods of speech could be heard alternating with data transmissions and a bulletin of satellite news in teleprinter codes. The beacon should be receivable anywhere on unmodified v.h.f. amateur radio equipment with no more than a fixed pair of crossed dipoles. On some passes even a hand-held v.h.f. receiver may be adequate, according to the Surrey team. The other significant transmitter, the engineering data beacon on 435.025MHz, can also carry speech, but a much more sensitive receiving installation is needed to pick it up.

Other systems aboard Uosat now in operation include the microwave beacons on 2.401 and 10.47GHz, intended for propagation experiments when the spacecraft is finally stabilized. This was expected to take place in early March, much later than originally intended, but a five-month gap in the programme occurred last year when the ground-station at Guildford lost control of the satellite (News, Wireless World, November 1982).

For attitude control and stabilization, Uosat has another novel device in the spacecraft. The magnetorquer is a coil which, when pulsed electrically, makes the craft swing like a compass needle to align with the Earth's magnetic field. Having attained the correct attitude, Uosat can fix it by extending a boom that acts as a pendulum to ensure that the base of the spacecraft always points towards Earth. At this stage, the project team plan to switch on some of their remaining experiments, which include four h.f. beacons, a magnetometer and the c.c.d. television camera.

Uosat's orbit passes over the poles, and in Britain it is above the horizon three or four times each afternoon and early morning at 96 minute intervals for periods of up to 12 minutes. A recorded bulletin gives up-to-date information about the satellite, including current orbital data, is available by telephone from the University 0483 61202.

Government backs AMPS

An 'advanced' version of the American AMPS cellular-radio system is given the Government's seal of approval. In answer to a Parliamentary question, Mr Kenneth Baker MP, Minister for Information Technology, said "It is with world markets in mind that the Government decided to endorse the system choice made by BT, Racal Millicom and Sectel and the development of an advanced version of the AMPS system to be known as Total Access Communication System (TACS)."

Racal Millicom put forward a technical description of an improved version of AMPS in their successful bid to be chosen as providers of the second national cellular radio network (see News, February). The system is used in the US and therefore classed as a known quantity, unlike its main contender MATS-E which seems to be technically superior. BT say that there is little difference between the systems evaluated and that they are delighted with the decision. TACS has the advantage that it will allow cellular radio to get off the ground quickly.

In brief

Finland plans to have a two-way cable tv system operational by early 1985. Scandinavia's largest tv manufacturer Salora announced that they are to supply a two-way pay tv system, including the head-end electronics and set-top decoders, for a network expected to serve about 22,000 homes in Tampere city. The deal to supply equipment for the coaxial network is worth

Wolverhampton Polytechnic has chosen equipment computer graphics equipment conforming to Canada's Telidon standard to help students become familiar with high-resolution computer graphics and viewdata. In doing so, it has become the first UK polytechnic or university to install equipment of this kind. Their system is being used to create animated graphics, 35mm slides, overhead projection films and video-tape material. Information for an in-house viewdata service is also being produced on the system.

Change of company name

The name of our parent company has been changed from IPC Business Press Ltd to Business Press International Ltd. This change has been made, say our proprietors, to reflect the wide range of markets covered by the 100 publications of the company, and to identify its position as the world leader of business publishing.

WIRELESS WORLD APRIL 1983
A digital tape clock

An electronic replacement for the mechanical counters used in many tape recorders.

The lack of precision of ordinary mechanical tape-counters and a need for something more than numbers relating to locations on the tape were among the motives behind the present design. It is basically a digital clock measuring tape running-time in minutes and seconds. Although it was devised for a ReVox A77, it could be used with almost any reel-to-reel tape recorder, with few modifications. The accuracy of the counter is close to one part per thousand, measured on a 10½ inch reel with a 3600ft tape. This means a deviation of only six seconds from one end of the tape to the other at 19.05cm/s.

Two optical sensors are used in the unit. One measures the length of tape passing and the other directs the counters to count up or down according to whether the tape is moving forwards or rewinding. A third sensor may be added to detect clear leader for an automatic reset and start of the clock.

by Per C. Andersen

![Fig. 1. The length-of-tape transducer.](image1)

![Fig. 2. Timing disc for length-of-tape transducer.](image2)

![Fig. 3. Method of detecting tape motion.](image3)

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WIRELESS WORLD APRIL 1983

58

www.americanradiohistory.com
The length-of-tape transducer is assembled from three parts: a rubber-coated brass roller with ball-bearings, a plastics timing-disc and the optical sensor itself. The physical dimensions are shown in Fig. 1. The brass roller was turned to a circumference of 32mm and then coated with rubber to a circumference of 33.9mm. The rubber is necessary to ensure good tape contact and to prevent slipping and skewing. If liquid rubber is not available, strips of a suitable adhesive tape could be used; but care should be taken that the ends do not overlap and that the adhesive is strong enough to keep the ends from peeling after continued on page 62.

Fig. 4. Timing disc for tape motion sensor.

Fig. 5. Pin connections for the 75189 (top view).

Fig. 6. This circuitry links the optical tape sensors and the function switches of the tape recorder with the counter/display section shown in Fig. 7.

This section is optional for automatic reset only.

Fig. 7. The counter/display section. The dotted connections may be included to prevent count-downs below zero when rewinding.

WIRELESS WORLD APRIL 1983
Haziness and its applications

How belief in the wave theory of matter and the indeterminacy of Nature — coupled with a third (gross) philosophical error, the wilful confusion of measurement with fact — so undermined the discipline of experimental and logical thought that the chaos in modern physics became complete.

It is often said that the indeterminacy of a physical measurement arises as a natural consequence of the postulated wave-like properties of matter itself and that it affords proof of those properties, but that is not so. Heisenberg himself was ambivalent about it: his preferred derivation of the Indeterminacy Principle was on wave-theory lines that took an electron to be a "wave packet" of de Broglie-type matter waves, whereas his arguments in demonstration took a light quantum to be a wave system but envisaged an electron to be a particle. In fact it is not necessary even for the light to consist of waves, because the Compton effect (which provided the basis of Heisenberg's own illustrations of the Principle) does not require waves for its physical explanation, as already discussed. The indeterminacy does not follow from any postulated wave-like properties of matter or light, but simply from the essential granularity or "quantization" (type one) of microphysical Nature — that is, from the fact that one's most fundamental measuring instruments, electrons and photons, behave like discrete, indivisible, self-consistent particles, of small but finite mass.

The wave theory actually entered the philosophical lists by means of a characteristically specious argument in the following manner. If, despite all the contrary evidence, an electron were to consist of a wave packet of matter waves, then the shape of that wave packet might perhaps be arbitrary. (After all, nobody has ever seen an electron.) Axiomatically a wave packet is distributed in space, so that one cannot really define its position — that is, where its exact centre is — especially if it is a long wave-packet. On the other hand if it is a short one its position will be better defined, but in the nature of things it can then contain only very few waves. This means that its wavelength must be ill-defined, and according to the duality doctrine an electron's apparent wavelength as

a wave system is to be associated inversely with its mechanical momentum as a particle. (The premise I refer to here is p=h/λ). So this concept seemed to fit Heisenberg's indeterminacy formula like a glove: if an electron were a wave packet, then its position and momentum would be mutually indeterminate for natural reasons. The indeterminacy would lie not with our measurements but within the structure of the electron itself. In that case, note well, our human failure to make precise predictions of its behaviour would arise simply because the electron's behaviour was itself imprecise or "indeterminate".

The attractiveness of this idea lies in the way in which it places the reason for our difficulties so firmly elsewhere; if Nature herself is indeterminate, how shall the physicists be blamed? It would provide a balm for nettled professional pride and a sop to human vanity if it were true, but of course it isn't. We cannot allow that an electron must become long and thin or short and fat according to the way in which we may choose to perform an experiment; that proposal conflicts with the general and consistent experimental evidence that electrons are indistinguishable. Nor do electrons dissipate like wave packets, any more than photons do. And between ourselves we have already rejected the doctrine of the indeterminacy of Nature on the logical ground of the unlimited precision of retrospective measurement. Appealing though it may have seemed to some people, that scheme just isn't on.

Nevertheless the concept of an electron as a wave packet persists. It leads directly to the established "doctrine of haziness" — the erroneous doctrine that fundamental physical particles are essentially and necessarily structureless, amorphous, and of indeterminate size and shape. The philosophical error which allowed that doctrine to flourish was the blindly false identification of the true, physical extent of the structure of a particle with the vague, probabilistic boundaries of our knowledge of its position. The error was made possible by the continued association of the statistics of position measurement with the mythical probability waves of the wave theory of matter — the mistake that has already been exposed in the "Reduction of the wave packet".

How can I be so sure that the identification was wrong? I offer two proofs, both independent of wave theory. One is that the form of a particle is a physical matter while our knowledge of its location is a metaphorical matter, and as before we may not identify chalk with cheese. The other is that the imprecision of a measurement (Δx) is not to be identified with imprecision in the quantity measured (x) — more especially when, as in this case, the measuring instrument is granular or "quantized" and in that sense imperfect. It is like claiming that a precision-ground ball bearing is nonspherical and faulty because one can't measure its diameter very accurately with a domestic rule!

That last misidentification (of measurement with fact, Δx=0x) is such an obvious error that it should not be accepted from a sixth-form student; yet here we have found apparently-responsible physicists and teachers of physics not only perpetrating it, but perpetuating it for fifty years! From their contemporary writings there are grounds for suspecting that it, and the corresponding misidentifications in the case of momentum (Δp), energy (ΔE), and time (Δt), may have been made willfully by the Copenhagen School in the 1930s, rather than through ignorance of

by W. A. Scott Murray
B.Sc., Ph.D.
the philosophical issues involved. This is not to impute to those concerned any motives other than the highest: they were genuinely seekers after fundamental truth. But it does seem that they may have been carried away by the sheer excitement of this new idea that was being developed in natural philosophy, and entranced by the mysticism into which these ideas were so inexorably leading them. They wanted the world of electrons and photons to be mystical and mysterious. Their picture of that world could be summed up fairly accurately as follows:

- Everything in microphysics is indeterminate (or hazy).
- Everything in microphysics is “quantized” (or precise).

Unless care is taken over the definition of terms these two statements are mutually contradictory. (An example of their conflict was developed in the, WW June 1982 article, page 81). I have argued that the first is untrue and I could argue similarly about the second, but instead I will tell you a fairy story and leave the judgement to you.

Once upon a time a young man was measuring the speeds at which beta particle (fast-moving electrons) were being ejected from radioactive atomic nuclei. He found that their energies varied smoothly over at least a ten-to-one range, which surprised him because he had expected to find instead a series of sharp energy values like a line spectrum in light. On the other hand, gamma rays (photons) that left the nuclei at approximately the same time did show a line spectrum, which was interpreted as evidence that the internal structure of the nucleus is “quantized” (type two) into definite energy levels — like a Rutherford/Bohr planetary atom, only more so.

I think everyone would agree that atomic nuclei are quantized (type one), in that every nucleus is constructed out of a definite number of discrete particles, protons and neutrons that can be recognized and stated by their consistent properties and behaviour. But according to the new ideas the mechanics of everything small is also quantized (type two), and because the atomic nucleus is very much smaller than the complete atom, a proton should the mechanical energy and momentum within the nucleus be quantized. Yet the beta radiation, which is associated with the radioactive decay of one neutron into a proton inside the nucleus, apparently is not quantized. It was an article of the new faith that it should be quantized.

“Therefore”, said the quantum-theorists, “the conservation of energy must have failed (Niels Bohr); or, alternatively, the experimental evidence of the beta decay must be wrong.”

Wolfgang Pauli saved the day, by postulating the existence of a completely unexpected neutrino or “small neutral particle” which had about the same mass as an electron but no electric charge. Such a particle, he suggested, would not show up in any ordinary particle counter or photograph. So: if one neutrino were to be emitted along with every radioactive beta electron, nobody would ever be able to detect the fact; but the invisible neutrino would carry away energy too, so that it and the beta electron, between them, could possess the quantized line spectrum of energy that the theory demanded although the visible beta electron did not. (The failure to quantize the sharing of this energy between the neutrino and the beta electron in fixed proportions was not explained).

Now if you feel this to be a somewhat implausible, ad hoc suggestion, designed to make the theoretical facts agree with the theory and not far removed from a confidence trick, be sure I share your suspicions. The question before us is: Do we believe in neutrinos? We would not be alone if we didn’t. Neutrinos are essential to the modern quantum theory, however, and their existence is assumed as a matter of course when describing nuclear reactions, yet not even their owners seem to be very sure about them. When first invented by Pauli they had about the same mass as an electron (so as to share the missing energy equitably, on average); then suddenly it was proved that they could have no rest mass, but must be like some kind of non-radiating, indestructible photon. However, it stood up for that they must be spinning — “but not mechanically, of course, since there is no structure there to spin”. More recently it has been declared that they probably do have rest mass but very, very little (actual amount unspecified), and that there must be at least four different kinds of them. It does not add up to a very convincing story.

From the theorists’ viewpoint the delightful thing about neutrinos is that they are virtually indestructible. Being so light, and electrically neutral, it is said that most of them fly right through the planet Earth, touching neither nucleus nor electron and leaving no trace of their passage. (There is another kind of “evidence” here too, but we needn’t labour every one!). Very occasionally a particle counter registers inside a 12-ft-thick steel box near the target area of the big CERN accelerator at Geneva, and this effect, like some others, is attributed to a neutrino collision because “it couldn’t be anything else”. Then one day the astrophysicists discovered that, according to current theory, the Sun should be pouring out neutrinos at a calculable, fabulous rate; and accordingly an enormous neutrino detector was built in the United States especially to look for them, deep below ground in a diamond mine where unidentified particles would be unlikely to be mistaken for neutrinos and confuse the results.

That experiment was reported in 1976. It detected fewer than one-tenth of the neutrinos of solar origin that it was expected to detect if it existed at all; there is no assurance that the very few nuclear reactions that it did detect were actually due to neutrinos. The astrophysicists have been sent away to do all their sums again. But why should the poor astro-physicists take the blame for this negative result? What if Pauli’s adventurous speculation should have been wrong, and his postulated neutrino never existed after all? To the theorists such a thought really is unthinkable: for if, after weighing the evidence, we were to determine that on balance of probabilities we did not believe in neutrinos, then we would be suggesting that the atomic nucleus might not be “quantized” (into discrete energy levels, type two). And that thought in its turn would strike at the roots of every modern theory about the physics of elementary particles.

Now I said at the beginning that little was to be gained by attacking established theories and thereby trying all their devotees into uncompromising battle in their defence. That is in practice an end to all modern parley, “counter-productive”. It is much better to examine miracles — physical phenomena that we do not in truth understand, although our various theories may be willing to offer glib but scarcely plausible “explanations” of them at the drop of a hat. Surveying modern physics, it is in the territory of the elementary particles that miracles are thickest on the ground. Vast sums of money and immense efforts of mind have been spent on particle physics over the past fifty years. Each new atom smash, when eventually it is made to run, generates a host of new problems but solves no old ones. There has been no credible outcome from all this outlay. Instead, we find all manner of hypothetical entities cluttering the contemporary letterpress — “as charmed quarks, evincing isospin”, for example — concepts which are supported by no physical evidence, untested and in principle untestable experimentally. (Pauli postulate of the neutrino. The wilful misinterpretation of the meaning of the Indeterminacy Principle then heralded a new rejection of physical discipline, leading to the invention of “virtual processes” which violate the conservation laws whenever convenient, as exemplified by the “predictability” of the meson. Having got away to such an inauspicious start the study of elementary particles had little chance of recovery; the rather obvious failure of theoretical physics in this area, due to its domination by “quantum” metaphysics and mysticism, is scarcely surprising.)
li's neutrino gave only a first glimpse into this modern fantasy world.) Particle physics today is in an almost impenetrable mess, infinitely more confused and less coherent now than it was when Chadwick discovered the neutron in 1932. I wonder why?

It seems to me possible that the lamentable state of this area of physics may reflect, and indeed be the consequence of, its domination by the metaphysical ideas of the "quantum theory" of the Copenhagen School. A quotation from a popular modern textbook (no names, no pack-drill!) may provide a convenient example for analysis:-

"Because of the Heisenberg uncertainty principle in quantum mechanics, a particle cannot have a definite position in space-time and a definite energy and momentum. The more localised the particle is in space-time, the larger the uncertainty in its energy and momentum. So that, virtual processes which do not conserve energy and momentum can occur over very small intervals in space and time by virtue of the Heisenberg uncertainty principle, provided they are followed by processes which ensure conservation of energy and momentum for the whole process."  

There, good friends, you have it all. The student is being told, ex cathedra, that it is legitimate for him to postulate any "virtual process" in his theories (by which is invariably meant a process that violates the conservation laws) provided he is not found out! Perhaps, philosophically, we have asked for this: we live in an indisciplined, lawless age, where logical consistency and honesty are no longer demanded. The fundamental error in the passage quoted, which is no misprint but a faithful transcription of currently-established doctrine, lies in the statement that a particle "cannot have" a definite position in space-time and a definite energy and momentum; here is the false doctrine of the Indeterminacy of Nature, rather than the legitimate indeterminacy of measurement.

That the misinterpretation was deliberate is well evidenced. In 1935, by an exact application of the "virtual process" argument quoted above, Hideki Yukawa "predicted" the likely existence of a mesotron or meson (medium-sized particle) - a manifestation of nuclear binding energy which might appear externally in the guise of a discrete particle when an atomic nucleus was disrupted. The meson was duly discovered experimentally and its track photographed two years later, an obvious and brilliant success for the doctrine of haziness. Unfortunately some 35 different kinds of meson are now known (by count dated 1973), and the mechanism of the conservation-dodging "virtual process" as it was argued by Yukawa can reasonably account for only one of them.

The unexplained plurality of mesons represents only the tip of the iceberg. The total of recorded elementary particles exceeds 85 (1973 figure)*. I consider myself to be just as radical a thinker as the next man, not at all old-fashioned, and I am quite willing to believe that the 60 or more of the particles currently thought to have immeasurably short life-times - in the trade they are sometimes called "resonances" rather than particles, with good reason - are simply the undifferentiated, non-specific explosion debris of sub-nuclear disintegrations: isolated, fast-flying packages of energy which are of the wrong mass to form themselves into mechanically stable or partially-stable structures (= "particles"), and which are actually dissipating, spreading out into space and effectively vanishing before our very eyes. (This would correspond to a loss of detectable energy from the local system, although the conservation law would not be violated in the universe as a whole). I would not expect such ephemeral, neutrino-like things to be "quantized".

What of the remaining elementary particles, of at least 25 known species, whose lifetimes range from the 10^-16 seconds or so of the principal baryons to the all-time stability of the proton and the electron? (Why are they stable? Why are all the others unstable?) The established dogma of today's "quantum theory" holds that it is improper to ask (or answer) questions about their structures, which can never be observed, but what about their masses, which are very accurately measurable? How, and why, are the masses - or internal energies - of these elementary particles, building-blocks of the physical world, related to each other? Current microphysical theory offers no answers to such fundamental questions, and has made only one memorable prediction (the "omega minus" particle, forecast by extrapolation). It invented a series of qualities for elementary particles which, it held, "must be" quantized plus/minus like spin and therefore "must" be conserved. One of these qualities it called parity. It did not even blush when the first honest experiments showed that parity was not conserved. Instead it went on to devise - via parity theory, if you please! - yet another indetectable particle - a tachyon which always travels faster than light.

In view of the immense efforts that have been expended in its area, current microphysical theory would seem to have been something of a failure. "Microphysical entities are hazy", we are told by eminent men, "and one must not ask old-fashioned questions about them." Surely such haziness is more likely to lie in human minds than in fundamental physics?

* Over 200 now, ten years later. Is this progress?

Mr Andersen, who lives in Denmark, works as a field engineer installing and repairing computer systems. He retains a keen interest in planning and constructing his own designs.
Assembly language programming

Many microprocessors respond to over 100 machine-code instructions – the 6809 responds to 1464 – and remembering these instructions in hexadecimal form is for most impossible. Assembly-language memory aids used to overcome this programming difficulty are the subject of Bob Coates’ second tutorial article.

Hexadecimal-form numbers discussed at the end of last month’s article improve the legibility of binary codes used by the processor but illustrate machine code and not assembly language. The following example demonstrates the progression from machine code to assembly language.

- Load accumulator with data in hexadecimal address 40
- Add accumulator contents to data in address 41
- Store the result in address 42

Binary-form numbers used by the 6805 microprocessor to carry out this program are as follows.

10110110
01000000
10110111
01000001
10110111
01000010

This is the only number form that the processor can understand instructions but the binary instructions may be represented in hexadecimal form as follows.

B6 40 BB 41 B7 42

Hexadecimal numbers are easier to assimilate and make programming mistakes easier to spot. Instructions entered on the Picotutor keypad in hexadecimal form are converted to binary by part of the processor-eprom monitor program before they are stored in memory for subsequent use by the microprocessor. Hexadecimal-form numbers are not the ideal solution to the programming problem though; the 6805 has 205 instructions and the 6809 has 1464 and remembering these in hexadecimal form remains difficult to say the least.

Instruction-code mnemonics

As a memory aid, each instruction is assigned an abbreviation relating to the language familiar to the operator (in this case English). These assembly-language instruction names are called mnemonics and should in some way describe the function of the instruction. All manufacturers provide a set of mnemonics for their microprocessor instruction sets. There is nothing special about the mnemonics chosen and one could invent one’s own but it makes sense to adhere to a standardized set.

Usually the mnemonics chosen are obvious. For instance with the 6805 a load-accumulator instruction is represented by LDA and jump-to-subroutine is represented by JSR. Unfortunately some are not so obvious; with the 8600, transferring the contents of accumulator A to accumulator B is quite logically TAB but transferring the contents of accumulator A to the condition-code register is represented by TAP. With the Z80 microprocessor EXX

by R. F. Coates

meaning exchange alternate registers doesn’t leave one much the wiser either.

Fortunately, 6805 mnemonics are fairly obvious and apply to equivalent instructions on all eight-bit microprocessors from Motorola which helps one apply experience gained with one microprocessor to another; in machine-code terms instructions used with processors in the range may vary but mnemonics used to represent them stay the same. Standard Zilog and Motorola mnemonics will be used in this series. Computer-assemblers usually require a prefix or suffix to denote hexadecimal numbers; these symbols, usually a $ prefix or an S suffix, will only be used where necessary.

Using 6805 mnemonics, the previous example is written in assembly language as

LDA 40
ADD 41
STA 42

with abbreviations LDA, ADD and STA representing load accumulator, add and store accumulator respectively. Like the hexadecimal-to-binary conversion performed by the Picotutor, translation between assembly-language mnemonic programs known as source code and hexadecimal machine-language programs known as object code is a task that can be performed by a microprocessor. Assembly-language programs are usually keyed directly into a microcomputer and translated by an ‘assembler’ program but such translations are involved and outside the scope of Picotutor. Consequently, our source programs are translated manually using a conversion table.

Programming tables

Microprocessor manufacturers produce tables giving all the instruction mnemonics with their machine-code equivalents such as the ones shown for the 6805. These tables, essential for assembly-language programming, are usually included in microprocessor data sheets. With mnemonics added, our simple program is now more understandable but is still not self-explanatory. Comments added to explain the program flow will make its operation clear and ease reference to the program at a later date. To do this, a table is drawn with columns representing various statements or ‘fields’ or the instructions. Column headings from left to right are as follows.

Label field
Operation code or mnemonic field
Operand or address field
Comment field

Labels, like comments, are optional and are used to make the programs easier to read. They indicate points in the mnemonic source file such as the start of a subroutine which is jumped to from a different part of the program. This point will have to be specified in the machine-language object code as an address but as this address is not known before the program is assembled it is substituted by a label. The label indicating the start of the routine is also used in place of the address (in the address field) of the instruction that causes

Instruction tables for the 6805. Most → register/memory instructions use two operands, one for the accumulator or index register and the other obtained from memory. Read-modify-write instructions read a memory location or register, modify or test its contents and send the modified value back to memory or the register. When certain conditions are met, branch instructions divert the program. Bit-manipulation instructions are described in the text and control instructions control the processor during program execution.

WIRELESS WORLD APRIL 1983
### Addressing Modes

<table>
<thead>
<tr>
<th>Function</th>
<th>Addressing Mode</th>
<th>Immediate</th>
<th>Direct</th>
<th>Extended</th>
<th>Indexed (No Offset)</th>
<th>Indexed (B-Offset)</th>
<th>B-Indexed (B-Offset)</th>
<th>Branch to Subroutine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate</td>
<td>Direct</td>
<td>Extended</td>
<td>Indexed</td>
<td>Indexed</td>
<td>B-Indexed</td>
<td>Immediate</td>
<td>B-Indexed</td>
<td>Branch to Subroutine</td>
</tr>
<tr>
<td>Load A from Memory</td>
<td>LDA</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load X from Memory</td>
<td>LDX</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store A from Memory</td>
<td>STA</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store X from Memory</td>
<td>STX</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Add Memory to A</td>
<td>ADD</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch to Subroutine</td>
<td>BSR</td>
<td></td>
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</table>

### Boolean Operations

<table>
<thead>
<tr>
<th>Function</th>
<th>Condition Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load A from Memory</td>
<td>A = A</td>
</tr>
<tr>
<td>Load X from Memory</td>
<td>M = X</td>
</tr>
<tr>
<td>Store A from Memory</td>
<td>A = A</td>
</tr>
<tr>
<td>Store X from Memory</td>
<td>A = A</td>
</tr>
<tr>
<td>Add Memory to A</td>
<td>A = A</td>
</tr>
<tr>
<td>Branch to Subroutine</td>
<td></td>
</tr>
</tbody>
</table>

### Read/modify/write instructions

<table>
<thead>
<tr>
<th>Function</th>
<th>Addressing Mode</th>
<th>Immediate</th>
<th>Direct</th>
<th>Extended</th>
<th>Indexed (No Offset)</th>
<th>Indexed (B-Offset)</th>
<th>B-Indexed (B-Offset)</th>
<th>Branch to Subroutine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increment</td>
<td>INC</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decrement</td>
<td>DEC</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear Carry</td>
<td>CLC</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complement</td>
<td>COM</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negate (A's complement)</td>
<td>NEG</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotate Left thru Carry</td>
<td>ROL</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotate Right thru Carry</td>
<td>ROR</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logical Shift Left</td>
<td>LSL</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logical Shift Right</td>
<td>LSR</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arithmetic Shift Right</td>
<td>ASR</td>
<td>A</td>
<td></td>
<td></td>
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</table>

### Test for Negative or Zero

<table>
<thead>
<tr>
<th>Function</th>
<th>Addressing Mode</th>
<th>Immediate</th>
<th>Direct</th>
<th>Extended</th>
<th>Indexed (No Offset)</th>
<th>Indexed (B-Offset)</th>
<th>B-Indexed (B-Offset)</th>
<th>Branch to Subroutine</th>
</tr>
</thead>
</table>
| Branch instructions

<table>
<thead>
<tr>
<th>Function</th>
<th>Addressing Mode</th>
<th>Relative Addressing Mode</th>
<th>Branch Test</th>
<th>Branch Condition Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branch Always</td>
<td>BPA</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch Never</td>
<td>BBN</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch FF Higher</td>
<td>BHI</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch FF Lower or Same</td>
<td>BLS</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch FF Carry Clear</td>
<td>BCC</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch FF Higher or Same</td>
<td>BHS</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch FF Carry Set</td>
<td>BCS</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch FF Equal</td>
<td>BEQ</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch FF Carry Clear</td>
<td>BHC</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch FF Carry Set</td>
<td>BHS</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch FF Plus</td>
<td>BPL</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch FF minus</td>
<td>BMN</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch FF Interrupt Mask Bit is Clear</td>
<td>BFIC</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch FF Interrupt Mask Bit is Set</td>
<td>BFIS</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch FF Interrupt Line is Low</td>
<td>BFIL</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch FF Interrupt Lines is High</td>
<td>BFIL</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch to Subroutine</td>
<td>BSR</td>
<td>A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Bit manipulation instructions

<table>
<thead>
<tr>
<th>Function</th>
<th>Addressing Mode</th>
<th>Immediate</th>
<th>Direct</th>
<th>Extended</th>
<th>Indexed (No Offset)</th>
<th>Indexed (B-Offset)</th>
<th>B-Indexed (B-Offset)</th>
<th>Branch to Subroutine</th>
</tr>
</thead>
</table>
| Condition code symbols

<table>
<thead>
<tr>
<th>Condition</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>Half Carry from bit 3</td>
</tr>
<tr>
<td>N</td>
<td>Negative (sign bit)</td>
</tr>
<tr>
<td>C</td>
<td>Carry/Borrow</td>
</tr>
<tr>
<td>Z</td>
<td>Zero</td>
</tr>
<tr>
<td>A</td>
<td>Accumulator</td>
</tr>
<tr>
<td>X</td>
<td>Index Register</td>
</tr>
<tr>
<td>I</td>
<td>Indirect</td>
</tr>
<tr>
<td>S</td>
<td>Symbol</td>
</tr>
<tr>
<td>P</td>
<td>Program Memory</td>
</tr>
<tr>
<td>M</td>
<td>Memory</td>
</tr>
<tr>
<td>I</td>
<td>Indirect</td>
</tr>
<tr>
<td>C</td>
<td>Carry/Borrow</td>
</tr>
<tr>
<td>N</td>
<td>Negative (sign bit)</td>
</tr>
<tr>
<td>H</td>
<td>Half Carry from bit 3</td>
</tr>
<tr>
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<td>Zero</td>
</tr>
<tr>
<td>A</td>
<td>Accumulator</td>
</tr>
<tr>
<td>X</td>
<td>Index Register</td>
</tr>
<tr>
<td>I</td>
<td>Indirect</td>
</tr>
<tr>
<td>S</td>
<td>Symbol</td>
</tr>
<tr>
<td>P</td>
<td>Program Memory</td>
</tr>
<tr>
<td>M</td>
<td>Memory</td>
</tr>
</tbody>
</table>

### Boolean operation symbols

<table>
<thead>
<tr>
<th>Boolean operation</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>=</td>
<td>Equal</td>
</tr>
<tr>
<td>&lt; &gt;</td>
<td>Greater or less than</td>
</tr>
<tr>
<td>&lt; =</td>
<td>Less than or equal</td>
</tr>
<tr>
<td>&gt; =</td>
<td>Greater than or equal</td>
</tr>
<tr>
<td>Not</td>
<td>Invert</td>
</tr>
<tr>
<td>AND</td>
<td>Logical AND</td>
</tr>
<tr>
<td>OR</td>
<td>Logical OR</td>
</tr>
<tr>
<td>XOR</td>
<td>Exclusive OR</td>
</tr>
<tr>
<td>NOT</td>
<td>Invert</td>
</tr>
<tr>
<td>XNOR</td>
<td>Exclusive NOR</td>
</tr>
<tr>
<td>XNOR</td>
<td>Logical NOR</td>
</tr>
<tr>
<td>AND</td>
<td>Logical AND</td>
</tr>
<tr>
<td>OR</td>
<td>Logical OR</td>
</tr>
<tr>
<td>XOR</td>
<td>Exclusive OR</td>
</tr>
<tr>
<td>NOT</td>
<td>Invert</td>
</tr>
</tbody>
</table>

### Other symbols

<table>
<thead>
<tr>
<th>Other symbol</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Index Register</td>
</tr>
<tr>
<td>M</td>
<td>Memory</td>
</tr>
<tr>
<td>A</td>
<td>Accumulator</td>
</tr>
<tr>
<td>I</td>
<td>Indirect</td>
</tr>
<tr>
<td>C</td>
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<td>N</td>
<td>Negative (sign bit)</td>
</tr>
<tr>
<td>H</td>
<td>Half Carry from bit 3</td>
</tr>
<tr>
<td>Z</td>
<td>Zero</td>
</tr>
<tr>
<td>A</td>
<td>Accumulator</td>
</tr>
</tbody>
</table>

### Branch instructions

<table>
<thead>
<tr>
<th>Function</th>
<th>Addressing Mode</th>
<th>Immediate</th>
<th>Direct</th>
<th>Extended</th>
<th>Indexed (No Offset)</th>
<th>Indexed (B-Offset)</th>
<th>B-Indexed (B-Offset)</th>
<th>Branch to Subroutine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branch to Subroutine</td>
<td>BSR</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Read/modify/write instructions

<table>
<thead>
<tr>
<th>Function</th>
<th>Addressing Mode</th>
<th>Immediate</th>
<th>Direct</th>
<th>Extended</th>
<th>Indexed (No Offset)</th>
<th>Indexed (B-Offset)</th>
<th>B-Indexed (B-Offset)</th>
<th>Branch to Subroutine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit Test Memory with A (Logical Compare)</td>
<td>BIT</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Test for Negative or Zero

<table>
<thead>
<tr>
<th>Function</th>
<th>Addressing Mode</th>
<th>Immediate</th>
<th>Direct</th>
<th>Extended</th>
<th>Indexed (No Offset)</th>
<th>Indexed (B-Offset)</th>
<th>B-Indexed (B-Offset)</th>
<th>Branch to Subroutine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test for Negative or Zero</td>
<td>TST</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
the program to jump to the subroutine. Labels should be limited to six characters as this is the maximum allowed by most computer assemblers.

The operation-code column (mnemonic field) contains the instruction mnemonic and the operand column (address field) contains any further information required for the instruction to be carried out. In our program all instructions require additional information to specify ram addresses of the data to be acted upon. With instructions such as load accumulator where data is not loaded from an address location, the required data byte is specified immediately after the operation code in the object-code program. Other instructions may require no further information, such as TAB on the 6800 which transfers the contents of accumulators A and B.

Table 1 shows the program in its expanded form.

Numbers shown in this and subsequent tables are in hexadecimal form unless otherwise indicated. Microcomputer assemblers often require a dollar symbol or letter H to identify hexadecimal numbers.

This is a complete assembly-language source program, and the next step is to assemble it. This requires two further columns in the table to list the machine-code equivalent of the instruction and the hexadecimal address at which the program is to be stored in the microcomputer memory. Ram addresses from 24 to 6F (hexadecimal) are available in the Picotutor to store such programs. Addresses 40-42 are used to store data and the program must not overlap these so the obvious place to store the program is at the beginning of the memory, address 24.

But should we enter the program and then run it, the processor will look for another instruction after the last one in the program and find only random data which will make it run out of control (ram locations can settle at any value after switch on). This could corrupt either the program or data and the Picotutor reset button will probably have to be pressed to direct the processor back to the monitor program. A more orderly way of terminating the program is to end it with a jump back to the monitor which will allow the result of the operation to be examined. Such a jump instruction is

JMP START

Jump to monitor start

The start label in the operand/address field represents the monitor restart address which will vary according to the microprocessor and monitor program used. On the Picotutor, this address is 80. With machine-code equivalents included, the program is as shown in Table 2.

Table 2. When assembly is complete, two further columns contain addresses and instructions in hexadecimal form.

<table>
<thead>
<tr>
<th>Address</th>
<th>Machine code</th>
<th>Label</th>
<th>Op-code</th>
<th>Operand</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>B640</td>
<td>ADDTWO</td>
<td>LDA</td>
<td>40</td>
<td>load accumulator from address 40</td>
</tr>
<tr>
<td>26</td>
<td>BB41</td>
<td>ADD</td>
<td>41</td>
<td>add to contents of address 41</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>B742</td>
<td>STA</td>
<td>42</td>
<td>store result in accumulator</td>
<td></td>
</tr>
<tr>
<td>2A</td>
<td>BC80</td>
<td>JMP</td>
<td>START</td>
<td>jump to monitor start</td>
<td></td>
</tr>
</tbody>
</table>

In this example, each instruction requires two bytes, one the operation code (op-code) and the other the data address, so when we fill in the hexadecimal numbers for the program address, each line increments by two (left-hand column). The number of bytes for each instruction varies between one and three according to the numbers of the additional information that the instruction requires.

From now on, all tables shown will be in this form. It is wise to adopt this method of constructing tables not only because it helps one understand the flow of the program, but also because computer assemblers produce such tables. Printed programming forms are available.

Running the program

To run the previous program on the Picotutor, the machine code (object code) must be entered first at the specified addresses. After switch on a dash at the left-hand side of the display indicates that the unit is ready to accept a command, so press the memory-open key (mo) which will result in the seven-segment equivalent of an m appearing on the display, indicating that a three-digit address is awaited. When the first address of the program is entered, 024, irrelevant data will be displayed. The first byte of the program, B6, is now entered and the step-up key (an arrow) pressed to close location 24 and open location 25. Byte 40 is now entered, and the process repeated until the last byte of the program, 80, is entered at memory location 02B. Now the reset button is pressed to terminate the memory-open command.

Keying in mo 024 and pressing the step up key will allow the program to be checked. Providing that new data is not entered, pressing the step up or down keys will not alter the contents of the address locations. Before running the program, data that the routine has to act upon must be entered. For example memory locations 40 and 41 are filled with 04 and 05 respectively. Now, with the dash sign displayed, press the go key and type in the starting address of 024. The dash should now reappear.

When the go key is pressed and the starting address entered, the microprocessor stops running the monitor program and runs the program starting at the specified location. The monitor program, keyboard and display stop functioning during this time until the last instruction is reached when control is returned to the monitor program and the dash reappears. If the program is correct, the location storing the result of the addition (mo 042) will hold the value nine. Try running the program again but with different values in locations 40 and 41, remembering that the numbers added and hence the result are in hexadecimal form.

Other microprocessors. Two accumulators are available on 6800 and 6809 processors, so the program has to specify which one is to be used. Our example uses accumulator A as follows.

<table>
<thead>
<tr>
<th>Address</th>
<th>Machine code</th>
<th>Label</th>
<th>Op-code</th>
<th>Operand</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>B61040</td>
<td>LDAA</td>
<td>1040</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1003</td>
<td>BB1041</td>
<td>ADDA</td>
<td>1041</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1006</td>
<td>B71042</td>
<td>STAA</td>
<td>1042</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1009</td>
<td>7E7D97</td>
<td>JMP</td>
<td>START</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data addresses require two bytes (1040-1042) whereas only one byte was needed in the previous program because high-order address bytes of 00 do not need to be specified for the 6805 (explained later). Monitor start address 7D97 in the monitor of the program code for the Nanycomp (see Wireless World, January and July 1981) and will need to be altered to suit the computer concerned.

For the Z80 the program needs to be altered slightly as it is not possible to add the accumulator contents directly to those of a memory location. Instead a pair of general-purpose 8-bit registers are loaded with the address of the data and the accumulator content is added to data in the memory location whose address is contained in the register pair, Table 3.

Points to note in this version are that load mnemonic LD is used for both loading and storing which requires two operands, the first specifying the destination and the second the source. The first line means load the accumulator with the contents of memory location 2040. Parentheses are used to indicate that the register is to be loaded with data contained at the address location specified. In line two, parentheses are not used so the HL register pair is loaded with address value 2041 for use as a
pointer for the add instruction. The fourth line stores the contents of the accumulator at address location 2042.

Operand addresses are written with the low-order byte first when assembled — a common source of errors when assembling manually. Addresses and the monitor-start location may need altering to suit your system.

Addressing modes

We have already seen that it is necessary to address memory locations to retrieve or store data, but so far only one method for the 6805 has been described. Six basic addressing modes available on Motorola products are:

- Immediate
- Extended
- Direct
- Indirect
- Indexed
- Inherent

Immediate. In this addressing mode the operand of the instruction is present in the byte immediately following the op-code of the instruction in the object code. A hash sign immediately before source-code operand denotes this form of addressing, for example A66F LDA #6F will load the accumulator with value 6F. The operand is always eight bits on the 6805, but on other processors it may be 16 bits. On the Z80 for example 214120 LD HL,2041 loads the HL register pair (two by eight bits) with the 16bit value 2041. Op-code 21 requires two further bytes, 4120, to form a 16bit operand. Sixteen-bit operands are sometimes used with 6800 and 6809 processors.

Extended. Here, two bytes immediately following the opcode represent the address of data to be used as the operand. These bytes form a 16bit address for Z80 or 6809/9 processors or an 11 to 13bit address for various versions of the 6805 (remaining bits are unused). For example B61040 LDAA 1040 will load accumulator A with the contents of address 1040. Absence of a prefix implies extended as opposed to immediate addressing. This mode is known as absolute addressing with the Z80 and brackets differentiate it from the immediate mode, e.g. 3A4020 LDA, (2040).

Direct. This is a version of extended addressing. If the most-significant byte of an extended address is 00 then direct addressing can be used and the most-significant byte need not be specified, resulting in a one byte saving in memory space. Although the range is limited to addresses 0000 to 00FF, this mode can save a considerable amount of memory space on the 6805 since operand addresses are usually in ram or i/o ports within this range. An example of direct addressing for the 6805 is B640 LDA 40.

An extension to this idea on the 6809 is an eight-bit direct register which holds the most-significant address byte. Instead of being fixed at 00, this byte may be altered by the program. There is no equivalent to this mode on the Z80.

Indexed. In direct and extended-addressing modes, the address of data which forms the operand is specified but here the address is contained in an index register called a pointer. A similar concept used with the Z80 appeared earlier — 86 ADD A,(HL) — where the accumulator content is added to data in an address location pointed to by two bytes in the HL-register pair.

But with indexing it is also possible to specify an offset which is added to the contents of the index register to form the effective operand address. This offset is contained in an immediate byte(s) for the 6805 as follows.

\[
\begin{align*}
\text{AE78} & \quad \text{LDX} \#78 \\
\text{E604} & \quad \text{LDA} 4, X
\end{align*}
\]

In the first line, the eight-bit index register is loaded with immediate operand 78 and the second line loads the accumulator with the contents of memory address 7C (78+4) without altering the index register contents. Sixteen-bit offsets may also be used; for example:

\[
\begin{align*}
\text{AE78} & \quad \text{LDX} \#78 \\
\text{D60146} & \quad \text{LDA} 146, X
\end{align*}
\]

will load the accumulator from address 1BE. Operation codes E6 and D6 are used to signify eight and 16bit offsets respectively. A special case exists when the offset is zero in that F6 LDA 0,X replaces E600 LDA 0,X. Operation code F6 for indexed addressing with no offset is peculiar to the 6805.

The 6800 has a 16bit index register but only allows eight-bit offsets. Although the 6809 has only two index registers (X and Y), two stack pointers (S and U) may be used as index registers; indexing modes of this processor are beyond the scope of this article. The Z80 has two 16bit index registers, IX and IY.

Inherent. This type of addressing is used when it is obvious from the nature of the instruction that no further operand or address is required to complete it, as for example with SEI, set interrupt mask, RTS, Return from subroutine, and CLRA which clears the accumulator.

Relative. Branch and conditional-branch instruction use relative addressing. With these instructions program counters and the program branches either forward or backward to another point depending on the value of a displacement byte. The displacement byte is a signed two's complement number which is added to the program counter after it has been incremented to point to the next sequential instruction. This byte allows branches of between 127 and -128 steps from the current program position by modifying the value in the program counter.

With the 6809, displacements represented by 16 bits may be used allowing the program to branch to any position in a 65Kbyte memory.

The six addressing modes above apply to all the processors that I have mentioned (8080 has no relative-addressing mode). In addition, the 6809 has many more addressing modes but for our purposes, the ones covered will suffice. Two further addressing modes are only available on the 6805.

Bit set/clear. This allows a single bit of any byte in address-page zero (0000-00FF) to be set or cleared without affecting any other bit in that byte.

Bit test and branch. A specific bit of any byte in address-page zero may be tested and cause a branch or not, depending on the result of the test.

These two modes are useful in control applications since they allow single i/o lines to be specified. A similar form of bit manipulation is possible using the Z80.

Books

Handbook of Antenna Design, Volume 1, Editors: A. W. Rudge, K. Mline, A. D. Oliver, and P. Knight, 708 pages, Hardback, Peter Pereginus, £42. Written by a multi-national group of antenna experts, this book constitutes volume 1 of the IEEE Electromagnetic Waves Series. It presents the principles and applications of antenna design with particular emphasis on recent developments. Fundamental theory and analytical techniques are explained in detail where appropriate and there is extensive design data with examples of practical application. A wide range of antennas are dealt with from very low frequencies to millimetric waves and from satellite communications to radar and broadcasting.

Complete Guide to Videocassette Recorder Operation and Service, By John D. Lenk, 356 pages, Hardback, Prentice-Hall, £19.50. This book provides a practical approach to servicing and trouble-shooting v.c.r.s with special emphasis on Beta and VHS recorders. Starting from basic principles, the author describes an easy step-by-step method to service the machines including a section on any special tools that may be required and their operation. An American book, it describes NTSC machines, but it is applicable to PAL systems.
Peak-to-peak bar/dot indicator

Depending on the frequency of the input, the instrument provides a led bar or moving-dot display of pk-pk voltage

The circuits presented here are for a 31-led bar/dot meter which indicates the peak-to-peak range of signals with frequency content from 0 to 10 kHz and amplitudes between ±1.5V peak. At frequencies greater than 100Hz the meter gives a bar indication extending over the range of the peak negative to peak positive values of the input signal. At frequencies below 1 Hz the meter gives a moving dot display range.

by A. J. Ewins

Fig. 1. Circuit diagram of led bar/dot meter, to provide a single output voltage.
ing over the peak-to-peak levels of the input signal. The display may be generally likened to that of a signal on the "y" axis of an oscilloscope with no timebase. The display is able to indicate both the a.c. and d.c. content of a signal, the d.c. content of a signal with a high-frequency component merely shifting the displayed bar in the direction of the d.c. offset.

The circuit of Fig. 1, on its own, produces a full-scale display extending over the range of the two input voltages, \( V_1 \) and \( V_2 \), where \( +2.5V > V_2 > V_1 > -2.5V \). When an input voltage is applied simultaneously to \( V_1 \) and \( V_2 \), a single dot is displayed which indicates the amplitude of the applied voltage. The circuit of Fig. 2 produces two output voltages, \( V_{\text{min}} \) \( (V_2) \) and \( V_{\text{max}} \) \( (V_1) \), representing the peak negative and peak positive voltages of the signal applied to its input. The circuit has a gain of 5/3 to amplify input signals of \( \pm 1.5V \) peak to an output level of \( \pm 2.5V \).

**Circuit operation**

The heart of the circuit of Fig. 1 is the d-to-a converter i.c., ZN425E. With a suitable clock oscillator (see Fig. 3) it can be used as a full-wave rectifier. The frequency of the clock is determined by the first op. amp., amplified by a factor of about 2 and offset by the second op. amp., the resulting output is a negative ramp falling from +2.5V to −2.5V. (The 'offset' control can be used to produce a negative ramp of 5V pk-pk anywhere between \( \pm 5V \), enabling the centre zero of the display to be shifted from one end of the scale to the other.) This ramp voltage is mixed with the two input voltages, \( V_1 \) and \( V_2 \), separately, and applied to two comparators. The result of this is that when the instantaneous value of the ramp voltage (inverted) lies outside the range of \( V_1 \) and \( V_2 \), the INH level is at logical '1' and an addressed led will be off. When the instantaneous value of the ramp voltage lies inside the range of \( V_1 \) and \( V_2 \), the INH level is at a logical '0' and an addressed led will be turned ON. Thus only those LEDs which give an indication of an analogue voltage between \( V_1 \) and \( V_2 \) are lit as they are addressed. One comparator is referenced to zero volts and the other to a small negative voltage. This ensures that just one led is lit, giving a dot display, when \( V_2 \) equals \( V_1 \).

The four 2N2905 transistors are connected as emitter followers when addressed and provide a constant current source to the leds. The value of the constant current is determined by the common 20 ohm emitter resistor and the voltage applied to the transistor bases. The 'brilliance' control determines the base voltage and hence controls the value of the constant current, which may be adjusted to any value between 0 and 200 mA. The eight n-p-n transistors act as switches to sink this current through the selected led. The average current that a led sees is \( 1/2 \) of the constant current value. The led's used in the original design were end-stackable types from Farnell Electronic Components, types CQX10-4 (red), CQX11-4 (green) and CQX12-4 (yellow). Although shown as single transistors, for convenience, the T1S151 devices are in fact Darlington pairs from Texas Instruments. An alternative to these transistors would be an array i.c. such as the ULN2801A, which is an 18-pin device containing 8 n-p-n Darlington pairs intended for just such an application.

Only 31 leds are used in the display, though 32 are addressable. The reason for omitting the first led is twofold. Firstly, the first led is always dimly lit due to the finite time of the fly-back of the ramp voltage; secondly, 31 leds give a very convenient display with one used as a zero indication, and fifteen in each positive and negative direction providing an indication in 100mV steps. The resolution of the display is, in fact, better than 100 mV. This results from a graduation in the illumination intensity of adjacent lens as the signal level changes from one 100 mV step to the next. When the signal level lies exactly halfway between 100 mV steps at, say, 350 mV, then the adjacent 300 mV and 400 mV leds will each be half lit. It is possible to estimate when one led is \( 1/4 \) lit and the adjacent led is \( 3/4 \) lit. A resolution of about 25 mV can thus be achieved.

Finally, using the dock oscillator of Fig. 3, the leds are scanned about once every 25ms.

**LITERATURE RECEIVED**

Several volumes have been added to the range of technical literature published by Texas Instruments. Among them are new data books on mos memory devices, microcomputer components and power semiconductors and an educational guide to applications of electronics in motor vehicles. A booklet describing these and other technical publications is available from Texas Instruments Ltd, P.O. Box 50, Market Harborough, Leicester.

A new Sprague Semiconductor Chip catalogue is now available from the company's UK chip distributor, Hy-Comp Ltd, at 7 Shield Road (Ashford Industrial Estate), Ashford, Middlesex, TW15 1AV.

A 12-page catalogue from BICC-Vero describes the range of pluggable telephone connectors designed by the company for British Telecom. The connectors have features which, according to the makers, make them suitable for other applications, such as with sensors, keyboards and handheld controllers. BICC-Vero Connectors, Parr, St Helens, Merseyside.

A directory covering more than 200 product categories is contained in a guide to British manufacturers of electronic capital equipment. The booklet is available free of charge from the Electronic Engineering Association, Leicester House, 8 Leicester Street, London WC2H 7BN.

Microprocessor systems and instruments for energy management are among many new additions to a large catalogue of equipment available for rental from Livingston Hire Ltd, Shirley House, 27 Camden Road, London NW1 9NR.
Two-metre transceiver

Comprising a.f. amplifier and tone generator circuits, this section of the multi-mode transceiver is the tenth and final module. Wiring information completes the hardware description in this penultimate article.

by T. D. Forrester, G8GIW

In addition to providing a tone burst and a.f. preamplification, module 10 generates a 'pip' when the frequency is changed. Dual monostable IC1000 is wired to give outputs of around 2s and 100ms to initiate tone-burst and pip signals respectively. Two-second pulses enable the tone-burst oscillator formed by half of IC1001 through a diode OR gate, the resulting signal appearing at pin 3 of IC1001. Before leaving the module, the tone-burst signal is filtered and attenuated by R1009,1010 and C1005,1006. A potentiometer sets the tone-burst level feeding the f.m. microphone amplifier.

To prevent operation of the tone burst in any mode other than repeater, the 2s monostable is disabled at pin 13 of the i.c. by a low signal from the mode switch. This disable signal comes from the switch wafer used for driving the start transistor of module 3.

The other half of the dual monostable provides a short pip which drives a miniature ear-piece located behind the front panel to indicate frequency changes. Pulses from this half of the monostable also turn the tone-burst oscillator on through the diode-OR gate but now the output is directed through a different NAND gate to the earpiece. When data is sent to the synthesizer by the microprocessor, D1en control line goes high; this line is used to trigger the pip monostable through buffer transistor Tr1001. In scan mode, the buffer transistor is inhibited to avoid the annoyance of continual pips.

Tone-burst frequency is set at 1750Hz by R1008. To set the frequency, pin 12 of IC1000 may be taken high so that the oscillator runs continually. A conventional a.f. preamplifier formed by Tr1002 lifts the level of the audio signal to suit the a.f. power amplifier. Gain of this stage is adjusted using R1011.

Front-panel wiring is detailed in the diagram. The mode switch used has two wafers each with two-pole, six-way

Tone-burst generator block diagram shows how the oscillator is gated to provide both a 1750Hz signal for the repeater and a short audible tone indicating changes in frequency.

Audio preamplifier and tone generator circuits - module 10. Dual c.m.o.s. monostable IC1000 generates pulses of 2s and 100ms for respectively gating the tone-burst oscillator, IC1001, and a short tone fed to an earpiece to indicate changes in frequency. Tr1002 is the a.f. preamplifier.
contacts so a spare pole is available for enhancements.

As can be seen from the photographs, the transceiver is constructed as two halves above and below a centre plate made from 8BA aluminium alloy. On the top left-hand side of this plate is the microprocessor p.c.b. and directly in front of it the display-driver board. To the right of it is the screened transmit-converter module and to the right of that the transmitter final stage, start relay and power regulators, also screened. Teko boxes were used to house the modules.

Four more screening boxes are mounted on the underside of the plate housing from left-to-right the v.c.o. and synthesizer, s.s.b. receive-transmit f.m.—exciter, receive-converter and f.m. i.f. modules. The module on the back of the transceiver houses an inductively-coupled band-pass filter and the antenna change-over relay. As all the r.f. modules are screened separately, there is no reason why the layout described should be adhered to but in terms of access and ease of construction, the module positioning described is believed to be optimum.

Front and rear panels are also made from 8BA aluminium sheet and secured to the tapped centre plate by 8BA screws. Aluminium sheet of 20s.w.g. was used to
Transceiver modules

1 receiver converter, 144MHz to 9MHz
November 1982

2 transmit converter, 9MHz to 144MHz
December 1982

3 transmit power amplifier and power regulators
December 1982/January 1983

4 f.m.-i.f. discriminator, squelch, noise blanker, a.f. power amp
January 1983

5 synthesizer logic January/February 1983

6 synthesizer voltage-controlled oscillator,
power change over February 1983

7 s.s.b. 9MHz transceiver, 9MHz f.m. exciter
February 1983

8 microprocessor control and interfaces
March 1983

9 frequency-display driver March 1983

10 1750Hz tone-burst and receive a.f. preamp
April 1983

make a base plate and three-sided cover.
Letter transfers were used to annotate the front panel which is protected by a tough plastic film.

Software

Flow charts illustrated here break down the main program given last month to help one understand how the transceiver operates. Mnemonics relate to assembly language used for the transceiver program.

Referring to the erase flow chart, if squelch lifts while the transceiver is scanning, the microprocessor checks whether or not the channel concerned is to be ignored (skipped). If so scanning continues but if not, scanning stops for a while. Pressing the skip button during this pause will cause the channel to be skipped over on the next scan.

A subroutine called Erse erases channels from the skip list as follows. During normal operation, i.e. with the set tuned to the desired frequency using the up/down buttons, it is possible to erase a certain frequency by tuning it in and pressing the skip button. This causes the microprocessor to search through its skip list and compare the frequencies in it to the one tuned. When the values match, the frequency in the skip list is overwritten with a zero. On the next scan, the microprocessor stops at this frequency to allow one to listen in.

Two buttons on the microphone allow the set to be tuned up or down in frequency for both normal operation and memory storage. Frequency increments depend on the position of the 100Hz/25kHz switch ganged to the volume potentiometer. In the up/down flow chart, a subroutine called sort tests which direction the frequency is to be stepped in and whether the steps are 100Hz or 25kHz. If either the up or down button is kept pressed, the rate at which the frequency steps up or down increases until the button is released.

To be concluded.
Design an electronic device to aid the disabled

A recent visit to a travelling showcase of aids for the disabled indicated how simple many of the devices were: levers to extend normally difficult-to-operate switches or dials; clamps to grip jars or bottles so that they may be opened more easily; various rods and hooks to aid people to dress themselves. At the other end of the scale, microcomputer hardware and software are being used in imaginative ways to aid severely handicapped people: providing voices to those unable to speak and enabling those unable to move to interface with the world.

Many examples spring to mind; the Possum allows, by the use of simple push switches, the disabled to operate a computer. We have received details of a single-board microcomputer which has been used to operate switches on the reception of whistle tones. The well-known Turtle enables children unable to move to experience spatial dimensions by directing the robot around the floor. And computer graphics can perform a similar function on a television screen. We have reported in the News pages recently the Viewscan system which can scan printed matter and display it on a computer with enlarged characters for the partially-sighted; we also reported on the micro-controlled wheelchair designed by Dan Everard for use by his daughter who suffers from spinal muscular atrophy.

This last example brings us to an important point. The chair was designed to help a specific person even though it would be of use to many others. Entrants in the Wireless World 'Design an electronic device to help the disabled' competition should be encouraged to contact the people who need the aids, to find out what those needs are and to work in cooperation with the 'end user' so that these objectives are best fulfilled. It would be pointless to re-invent the wheel, so it is well worth checking that the device being designed does not already exist. On the other hand there may be ways of improving the wheel so that it runs more smoothly or is easier to use.

Communication is of course one problem. The autobiography of Joey Deacon needed three people to write it: Joey himself, his friend Harry, who was the only person able to interpret the sounds that Joey made, and a third who could operate a typewriter with one finger. Christy Brown was discovered to be a fine poet after he had learned to communicate by typing with his foot. It must be horrifyingly frustrating to have an intelligent mind trapped inside an incapable body: Joey and his friends were cared for in a mental institution not because of their mental disabilities but chiefly through their inability to communicate.

Physical mobility is always a problem. For example, many disabled people need to wear elastic stockings but there is no device readily available to help them to get them on or off unaided. This is outside the scope of our competition but it does illustrate a simple problem in search of a solution. Reward toys, like the teddy bear whose eyes light up when a deaf child speaks, are in great demand, as are all toys that offer physical or mental exercises to disabled children. Other aids for the deaf include visual feedback systems, which can give a computer display of received sound, especially speech.

It should be noted that most electrical and electronic devices overcome disabilities of 'normal' people. Our voices can only propagate a certain distance. To extend the range we need to amplify it or to carry it through wires. Machines supply the strength we lack or can carry us at speeds we cannot run. Various optical devices enable us to see further or observe things that we cannot see. Calculators are useful when we run out of fingers to count on and computer memories can store vast quantities of data which may be recalled and manipulated in ways beyond the scope of human brains. Aids for the disabled are really just extensions of the same techniques; they enable the handicapped to do things that they otherwise cannot do.

The competition is very straightforward. All you need to do is fill in and send us the entry form which just indicates that you are interested in taking part. The form must be returned before 30th June. The actual design must be submitted to the Editor by 1st October, 1983. An entry must include a statement of the design objectives; an overall description of the device; detailed circuit description and diagrams; a model of the device or that unique part of it which demonstrates its operation and feasibility. The judges will be a group of engineering and doctors and they will be looking for originality and benefit to the handicapped; the potential for production; elegance or engineering design; the electronic content; design reliability and freedom from excessive maintenance; simplicity of operation and the safety of the device. They are also looking for a specifically electronic device so a software package will not be acceptable, although software may be necessary to operate the hardware and should be included if this applies. The competition will be coordinated from the Wireless World editorial office and we are planning to include progress reports on the projects in these columns.

Useful contacts may be found through local council offices or libraries who can put you in touch with disabled people's centres or homes. REMAP, Engineering Help for the Disabled, has 90 branches throughout the UK. Their headquarters are at 25 Mortimer Street, London W1N 8AB. They have a large panel of engineers who are working for the disabled and are willing to offer help and advice.

It should be noted that aids for the handicapped need a fundamental approach to tackling a problem and that devices can be produced which are not only helpful for the disabled but may improve ergonomically facilities for all. Please enter the competition. You may produce a device which is of great help to many people.

A full list of the rules and an application form are included in our advertisement on page 108.
In praise of software

Like the old "nature vs nurture" controversy it is always fun to return to "software vs hardware". Professor Zislos would have us beware of systems swaddled in software (or some such phrase), and whilst it is all too true that the software overhead on many systems is intolerable it does not follow that junking that software will improve matters. In practice this term "software" covers two rather distinct sets of tools, programming languages and operating systems, and it is as well to consider them separately. We'll start with programming languages.

The pristine argument against the use of high-level programming languages is that a skilled machine code programmer using the native instruction set of a computer can write a program that is significantly more efficient (in terms of execution time or storage occupancy or both) than will be generated as object code by a high-level language compiler. The assertion is doubtless true. Unfortunately its utility depends on the availability of "skilled machine code programmers". Such scant evidence as we have suggests that only 25% of those who call themselves so skilled can in fact do better than a compiler. In addition, the demand for programmers is increasing at about 50% annually, whilst the supply is increasing by only 18% annually. That increased supply, is, too, at the novice, unskilled, end of the spectrum of expertise.

So the systems designer and implementor who chooses to rely on machine coding of the applications package just faces the hurdle of hiring adequately skilled programming staff. And then, in a sellers' market, of retaining them.

The immediate advantage of choosing a high level language such as Pascal or Fortran for applications programming is that the implementor has a choice from a much larger pool of skills. It just is a fact of life that the number of good Pascal machine programmers on the market is much greater than that of machine code programmers. And they are not such prima donnas either!

But a number of other advantages accrue from its use of a high level language. If partway through the production run it is economic to replace the microprocessor chip by another then the software does not have to be rewritten but only recompiled. As staff changes it is necessary for newcomers to familiarize themselves with the existing applications programs so as to be able to maintain and modify them. This is much easier and quicker if these programs are written in a high level language, because programs written in a high level language are a little more self-documenting. Also, they neither depend on the local features of a particular chip nor on a particular programmer's quirks in laying out data structures, etc.

The penalty of using a high level language then will be a slower executing program and usually a more extensive object program requiring more room to accommodate it. Should execution time become critical it is usually possible to substitute a faster microprocessor chip, at extra cost.

The relevant question is whether, over the total lifetime of the system, the initial cost of a faster microprocessor and of added ROM exceeds the savings gained from the use of a high level programming language. Remember, programmers expect regular salary increases, chips don't.

Should it be the case that the system under consideration is already employing the fastest technology available then it will be necessary to stick with machine coded programs. It is precisely those users stuck with this need who will be most predatory on the market for skilled machine code programmers and will determine the costs incurred by others. It would therefore be prudent to rely on alternative programming talent.

It is true that you will find some extremely gifted programmers in academic or civil service posts where the salaries are significantly below market norm, so clearly salary is not the only determinant in attracting and holding talent. Further investigation will show that the freedom to experiment in these positions is the attraction, situation that cannot prevail in the successful completion of economic application packages. Under conditions of politically imposed "wages freeze" one can predict that talent will migrate to academic, etc., from the marketplace.

Now to the question of operating systems. As long as a given processor is executing only a single process or task the whole time the presence or absence of an operating system can be a matter of taste. The moment two or more processes share the processor an operating system is mandatory in order to schedule access to processor resources and to protect the processes from mutual interference. The question of whether or not to employ an operating system is then empty, the question becomes whether to use the vendor's standard operating system, or whether to turn to an off-the-shelf product available from some software house for that microprocessor, or whether to write one's own system.

The usual objection to a vendor's operating system is that it is too rich, too extensive, for the needs of the present project. This may be so, but it is usually possible to generate a local version of the system that includes only those facilities needed locally. Indeed, this freedom may be an important factor in choosing a particular microprocessor. Software house operating systems often have the advantage that compatible versions are available for several ranges of microprocessors, making processor substitution easier. The supposed advantage of writing one's own operating system, that it will contain nothing but the bare bones required for the job and so will interpose no unnecessary overhead, is illusory. Six months hence the next upgrade of the microprocessor system will demand a new function of the operating system, and since the private operating system was so specifically designed to eliminate overhead there will be no hooks to hang the new function from.

Implementation and installation decisions in computing are rarely made solely on the basis of technical merit. Computers are tools, and other concerns of the tool users have to be satisfied. There is no doubt that the world's most widely sold computer architecture is not the world's most efficient or powerful or elegant. But its original vendor was deemed financially secure enough to proffer the support needed by customers. In implementing a microprocessor based system it may be that doubling the hardware cost of the basic system may have a negligible effect on the sale price, that software and engineering support costs are far more significant. If this is the case, and if the costs of facilities and actuators are fixed, then minimizing the initial and ongoing software costs may be the most practical way to economize.

Such a turn of events should come as no surprise. The most successful, the most reliable, technological system we have, one we take absolutely for granted most of the time, is the worldwide telephone system. Its success and reliability depend not on local innovativeness but on slavish standardization. We are a bare 32 years beyond the commissioning of the first general purpose electronic digital computers, and it may seem premature to throttle development by adopting standardized tools, such as existing high level languages or operating systems.

H. D. Baeker

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H. D. Baeker is in the dept of computer science, University of Calgury, Canada.
IBM Selectric to TRS80 interface

Along with an assembly language program which is kept in high memory, this interface is all that is needed to have letter-quality printing. As the printer uses typing elements that can easily be changed, what more could a computerist want? Speed? Not so fast, it prints at 60 words a minute, but oh what print, says Tony Scarpelli.

Brian Bateman has already shown how to interface a TRS80 computer to a five-level teletype. His article* inspired me to design and build my own interface that uses relatively inexpensive hardware and even cheaper software to drive an IBM Selectric I/O printer. It is less than $500, which includes the printer, turns you on then read on.

I was in the market for a printer. I had to choose a unit that was either dot matrix or letter-quality. As I was into writing articles, I decided on high quality printing;

1. Originally from a Wang word processor system and ending up as a surplus bargain, this IBM Selectric I/O printer can be used as a letter quality printer in a computer system. Though it can be used as a keyboard as well as a standard typewriter, in this application it is strictly an output device.

2. Character-select solenoids determine which character is to be printed and are held-in as the print solenoid is energized. Function solenoids are on the right. Tab and back space are not used in this application, but could easily be put into service.

3. Not much power is needed to drive the function solenoids, and during initial testing they can be manipulated by hand.

4. Carriage movement detector coil detects pulses from the gear which rotates as long as the carriage moves. Pulses are amplified and integrated to produce a signal used by the computer to detect this movement.

These printers contain the driver solenoids that select the various characters and do the other normal functions such as spacing and printing. The unit was in great shape and probably still had a few more thousands of miles of printing left in it, and only a few minor adjustments got it printing excellently. A call to my local IBM representative got me an account and the ability to get manuals and parts with no hassle; and with great speed. A list at the end of the article gives the numbers of the manual and tools needed to do any type of

by Anthony T. Scarpelli

*Originally from a Wang word processor system and ending up as a surplus bargain, this IBM Selectric I/O printer can be used as a letter quality printer in a computer system. Though it can be used as a keyboard as well as a standard typewriter, in this application it is strictly an output device.
adjustment on these IBM machines. The manual is essential for an understanding of this very complicated mechanism, and for any troubleshooting in case of malfunction.

With the machine working, and with the circuit supplied with the unit, I started on the design of the hardware circuits to drive the solenoids. I am a simple person so I decided to make the circuit as simple as possible so that even I would be able to understand it. I also wanted to make it from parts from my local Radio Shack store so that I wouldn’t have to wait six weeks just to get an IC. If you have the parts on hand, or have a less expensive outlet for the parts, by all means go that route if you wish. I just happen to have a store in town.

The printer has six character-select solenoids, and five other function solenoids that would have to be driven by the computer. I decided that each of the function solenoids would get an output port. The printer also has a carriage-movement detector which would also get a port. I use this detector to speed up the printing by holding up the program during carriage returns. When the carriage returns from a great distance, you don’t want any printing going on, but when it has to return from a short distance, you don’t want to wait for a timing loop to finish.

When you want to have your computer talk to the outside world, the first thing you have to decide is whether you want to use ports or use a memory-mapped system. If you go memory mapped, that is the computer thinks anything external is just part of its memory, you have to deal with 16 address lines. Because this wasn’t necessary and would only add complexity and expense to the system, I decided on ports which only use eight address lines. There are 255 ports available with these eight addresses, and as no. 255 is already used by the TRS80, and no. 254 is used by my speed-up circuit, I used numbers 247 to 253. These are easy to decode as we shall see in a minute.

The next consideration as far as the outside world is concerned is that all address lines and data lines have to be buffered. This does two things: it helps protect the output of the computer, and it gives the output more drive capability. Fig. 1 shows all the buffered lines that are used in my interface. Notice that the designation OUT*, for example, is how Radio Shack indicates an active low signal—it is easier to type than the normal way, you can see. Other than the eight address lines and eight data lines, only OUT*, which indicates something is going out of a port, IN*, which indicates something is coming in, and SYSRES*, which is the system reset, are the only computer-generated signals needed.

Fig. 2 shows the first port I designed and will be used as the example of how all the ports work, and also how you can go about getting your own computer to touch the outside world. First give the port a number, in this case 253, or FD in hexadecimal and 1111 1101 in binary. I called it the space port as it will drive the space solenoid. It is decoded with an eight-input NAND gate: when all its inputs go high the output goes low. As line A1 is the only low line, we can make it high by going through an inverter so that only when the address FD is on the address bus will the output of the gate go low. In the assembly language program, the instruction OUT (C), A causes data in the A register to be put onto the data bus just after the address in the C register is put onto the address bus, while

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Tony Scarpelli is senior biomedical electronics technician at the Maine Medical Center in Portland, Maine, the largest hospital in the largest city in the state. He collaborates with other hospital departments in the design of various electronic projects, such as interfaces that connect computers to various types of medical equipment, and is presently working on a computerized environmental control unit for quadriplegic patients. His electronic career started at the age of three when his father introduced him to a crystal radio. Most of his work has been in medical electronics, repair, and research. He has gone from valves, through transistors and integrated circuits, and has finally landed in the world of computers. He has published computer programs, reviews, and other material in a number of American journals. Fluent in Z80, 8080, and 6502 assembly languages, as well as Basic, Forth, and Mumps, he edits a computer club newsletter, Byte Babble, and spends most of his free time at the keyboard writing programs, articles, and learning new computer languages. He feels that people have only just begun to touch on the computer's potential, and its use as a mind amplifier is still to be fully realized.

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*Using five-level teleprinters with a TRS80; by Brian Bateman, Microcomputing, Jan. 1980.
†Tandy in the U.K.

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Wireless World April 1983

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Fig. 1. Buffer i.c.s interface the expansion port of the TRS80 to the printer driver circuits. They increase the drive output from the computer and help keep any problems occurring in the driver from reaching the computer. Also shown are the bank of capacitors distributed around the board for filtering and de-spiking, a necessity for TTL integrated circuits.
Figs 2-6. Space port decoding, circuit Fig. 2 top left, drives the space solenoid. Eight address lines along with the OUT* signal give a specific port address. Low signal on the single data line is passed to the output when the port is addressed. Carriage return port decoding circuit Fig. 3, bottom left, drives solenoid that produces a carriage return. Index port decoding circuit Fig. 4, top right, drives index or line feed solenoid. Shift port circuit Fig. 5, centre right, is configured to decode signals to drive the shift solenoid for upper case. Print port circuit Fig. 6, right, decodes the signal to drive the print solenoid.
at the same time the OUT* line goes low.
In Fig. 2, a space was given the hex number, FE, which is 1111 1110 in binary, of which bit five is 1. FE is the data in the A register so what happens is this: when that instruction is encountered, first the address FD in the C register goes out on the address bus. So the output of the eight-input gate goes low. Then the data FE in the A register goes out on the data bus, and we pick up D5* (bit 5) which has been inverted by IC4 and present it to the D input of a D flip-flop, as you can see from Fig. 1. (There was no real reason to use bit 5; I just needed a 1 here.) Then the OUT* line goes low, and as this line is connected to one input of an or-gate and the output of the eight-input gate is connected to the other the output of this or-gate goes low. Now the 74LS74 flip-flop transfers any level on its D input to its Q output when its clock input goes from low to high. So after a short time the instruction is finished and the OUT* line goes back high and thus causes the or-gate to go back high and the 0 on the D input gets put onto the input of the inverter just before all the data disappears. So that little bit of data has been saved or latched by the D flip-flop and can now be used to good purpose: to cause the output of the inverter to go high, which turns the motor transistor on and pulls the space solenoid. Of course, if the solenoid stayed pulled in, all we would get would be spaces, so the assem-

**Parts list**
- IC1, 274LS367 hex 3-state buffer
- IC3, 2474LS368 hex 3-input inverter buffer
- IC4, 6, 15 74LS32 quad 2-input or-gate
- IC8, 12, 17 19 23 74LS04 hex inverter
- IC5, 9, 10, 13, 14, 18, 20 74LS30 B-input nand-gate
- IC7, 11, 16 74LS74 dual D-type flip-flop
- IC21, 22 74LS175 quad D flip-flop
- IC25 LM3500 quad Norton op-amp
- T5 to T1: n-p-n transistor (RS2018)
- R1 R11 10kΩ
- R12, 14, 17, 22 10kΩ
- R13 47kΩ
- R16 150kΩ
- R18, 19, 20 1MΩ
- R21 12kΩ
- R15 33kΩ
- R23 100kΩ p.c. b. control
- C1-10 10μF 35V electrolytic
- C11-29 50μF ceramic
- C30, 31.47μF 35V electrolytic
- C32 10μF ceramic
- SO1-19 14-pin wire-wrap sockets
- SO20-27, 16-pin wire-wrap sockets
- SO28 22-pin dual edge-card socket
- Experimental p.c. board
- 16-pin DIP jumper cable
- 4x8½ in. c. perforated board
- TRS80 edge connector

**IBM parts list**
- Selectric I/O typewriter, model 745
- Service manual, no.241-5737-0 ($8.40)
- Adjustment parts manual, no.241-59990-0 ($4.10)
- Parts No./Price list, Form No.S241-51558-4 ($0.50)
- Cycle tool, part no.9900427 ($0.60)
- Gauge, part no.9900575 ($11.50)
- Typing element ANSI-OCR-B, part no.1167185 ($18)

![Fig. 7](image7.png)

**Fig. 7.** Character port circuit accepts more than one data line. The seven address lines are decoded for port number F7H. When this port is addressed, the signals on the six data lines are sent to the character driver solenoids. A six level or correspondence code is used to determine the character to be printed.

![Fig. 8](image8.png)

**Fig. 8.** Carriage movement port is an incoming port as opposed to the other ports. When the address F8H is decoded, the signal present on data line D1, which indicates that the carriage is either moving or not, is detected by the computer.

by language program has some timing to do and also some unlatching, but we'll get to that shortly.

This is about the simplest way for your computer to communicate with the outside world in a structured way. Fig. 3 to 6 are similar except for the address decoding and the input and output connections. Fig. 6 shows the character port and is very similar to the others but has six data inputs and will drive all the character select solenoids at the same time. One of the questions I had about driving transistors was whether these latches could drive a power transistor directly. The fan out for these 74LS175s is the same as an inverter, and I haven't had any drive problems at all. Fig. 8 is the carriage movement port. When this port is addressed, and the output of the carriage movement detector is low, and the IN* line is low, a high is sent out on D1, thus nothing happens. However when the carriage is moving, a low goes out on D1, which is detected by the program, and
Preamplifier Amplifier Integrator Comparator

Fig. 9. Carriage movement detector circuit produces a high or low level depending on whether the carriage is moving or not. See text for explanation of its operation.

Table 1. Computer to interface cable

<table>
<thead>
<tr>
<th>RS-PIN</th>
<th>Signal</th>
<th>44-pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RAS*</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>SYSRES*</td>
<td>A</td>
</tr>
<tr>
<td>3</td>
<td>CAS*</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>A10</td>
<td>B</td>
</tr>
<tr>
<td>5</td>
<td>A12</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>A13</td>
<td>C</td>
</tr>
<tr>
<td>7</td>
<td>A15</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>GND</td>
<td>D</td>
</tr>
<tr>
<td>9</td>
<td>A11</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>A14</td>
<td>E</td>
</tr>
<tr>
<td>11</td>
<td>A9</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>OUT*</td>
<td>F</td>
</tr>
<tr>
<td>13</td>
<td>WR*</td>
<td>7</td>
</tr>
<tr>
<td>14</td>
<td>INTAK*</td>
<td>H</td>
</tr>
<tr>
<td>15</td>
<td>RD*</td>
<td>8</td>
</tr>
<tr>
<td>16</td>
<td>MUX</td>
<td>J</td>
</tr>
<tr>
<td>17</td>
<td>A9</td>
<td>9</td>
</tr>
<tr>
<td>18</td>
<td>D4</td>
<td>K</td>
</tr>
<tr>
<td>19</td>
<td>IN*</td>
<td>10</td>
</tr>
<tr>
<td>20</td>
<td>D7</td>
<td>L</td>
</tr>
<tr>
<td>21</td>
<td>INT*</td>
<td>11</td>
</tr>
<tr>
<td>22</td>
<td>D1</td>
<td>M</td>
</tr>
<tr>
<td>23</td>
<td>TEST*</td>
<td>12</td>
</tr>
<tr>
<td>24</td>
<td>D6</td>
<td>N</td>
</tr>
<tr>
<td>25</td>
<td>A0</td>
<td>13</td>
</tr>
<tr>
<td>26</td>
<td>D3</td>
<td>P</td>
</tr>
<tr>
<td>27</td>
<td>A1</td>
<td>14</td>
</tr>
<tr>
<td>28</td>
<td>D5</td>
<td>R</td>
</tr>
<tr>
<td>29</td>
<td>GND</td>
<td>15</td>
</tr>
<tr>
<td>30</td>
<td>D0</td>
<td>S</td>
</tr>
<tr>
<td>31</td>
<td>A4</td>
<td>16</td>
</tr>
<tr>
<td>32</td>
<td>D2</td>
<td>T</td>
</tr>
<tr>
<td>33</td>
<td>WAIT*</td>
<td>17</td>
</tr>
<tr>
<td>34</td>
<td>A3</td>
<td>U</td>
</tr>
<tr>
<td>35</td>
<td>A5</td>
<td>18</td>
</tr>
<tr>
<td>36</td>
<td>A7</td>
<td>V</td>
</tr>
<tr>
<td>37</td>
<td>GND</td>
<td>19</td>
</tr>
<tr>
<td>38</td>
<td>A6</td>
<td>W</td>
</tr>
<tr>
<td>39</td>
<td>+5V</td>
<td>20</td>
</tr>
<tr>
<td>40</td>
<td>A2</td>
<td>X</td>
</tr>
</tbody>
</table>

5. In the driver transistor board the ribbon cable going off toward the top goes to the diode board in the printer, the other ribbon cable to the interface board. The twisted pair is for power.

6. Diode board inside the printer already had diodes connected across the solenoids, and this saved installing them on the driver board. If this board is missing on your unit, you must install diodes across the solenoids to protect the transistors.
causes a delay loop to hold up the program. We'll get into the program shortly to see how this works exactly.

The carriage movement detector, Fig. 9, is one i.c. long, using a quad LM3900 op-amp. The detector coil is connected to an amplifier that picks up the small sine wave produced by the gear which revolves whenever the carriage is in motion. A second amplifier produces a square wave which then goes into an integrator and gives a d.c. level output. This level is detected by a comparator to produce a t.t.l.-level output to the input of an inverter. A small potentiometer on the negative input of the comparator adjusts the trigger level. If you don't have a small control, two fixed resistors can be used after you have found the right ratio.

The only hardware left to discuss are the driver transistors. Fig. 10 shows what is in the printer, and also how the driver transistor is connected into the system. A 25V transformer, rectifier, and capacitor is all that is needed to power the solenoids. The driver transistor board is simple to construct, and has a connector on it that goes to the interface board. Plus 12 volts goes to this board for the carriage movement detector. The ribbon cable goes out to a connector, which then goes to the diode board in the printer. This diode board, photo 6, has all the wiring that goes to the solenoids, and my ribbon cable goes directly to it. The +25V supply which is more like 35V out of the unloaded power supply, is also connected to this board.

**Interface board construction**

Transistor-transistor logic is very noisy to work with and the kind of construction used in my original breadboard, Fig. 1 doesn't help. Cute, and all we need is a little tomato sauce. But if you can get it to work like this, you have a better chance of it working in the final version. Although I installed a number of capacitors on my semi-final version, I had to put on a whole bunch more so that practically every i.c. had a 50nF connected to its power connections, plus some 10µF on each power bus. I probably overdid it, but it is a very quiet board now, and all wirewrapped. The sockets were stuck on the board with hot-melt glue and all numbered, both on the sockets themselves, and on the bottom of the board. All pin 1s were given a small piece of wire insulation for identification. This is very helpful when wirewrapping during those late and wee hours of the morning. I wirewrapped with the OK tool that eliminates stripping the wire, and really speeds up the process, photo 9. You can only wrap two layers due to the height of the recommended eight wraps. But this is sufficient, and the redundancy increases the reliability of the wrap; I have yet to find a bad wrap after hundreds of pins.

The board as shown in photo 8 shows the completed interface. It holds 25 sockets and the motion-detector components. The cable from the computer is soldered to a 44-pin connector with wirewrap pins (see Table). The cable is the only component that I didn't get from Radio Shack, but can be purchased from Hobby World, (see parts list). I used the 44-pin connector because they are easy to get, and also this will allow me to add various peripherals and more memory to the system by building a motherboard and connecting it to this single connector. You can see in photo 10 bottom of the completed board, a little more organized, but it still could use some sauce.

To be continued with assembly language program.
WINCHESTER DISC CONTROLLER

Designed for many of the popular Winchester interfaces, the Intel 82062 controller translates parallel data from a microprocessor to a 5Mbit/s m.f.m. encoded serial bit stream. It also provides the drive control logic and control signals, and integrates much of the logic needed to implement a Winchester disc control subsystem.

The 82062 is controlled by the host c.p.u. with six high-level commands: Restore, Seek, Read Sector, Write sector, Scan i.d. and Write format. It can transfer multiple sectors and operates in 128, 256, 512, and 1024-byte sector lengths. It has a 7-byte sector length extension for external error correction. All this is housed in a standard 40-pin d.p. and operates from a single 5V power supply. MEDL Distribution, East Lane, Wembley, Middlesex HA9 1PP.

CAESIUM FREQUENCY STANDARD

Accuracy of 3 in $10^{11}$ is claimed for the FE-5440 caesium beam primary frequency standard. It uses a comparison-and-control system in which a caesium transition frequency (9.19... GHz) is used to stabilize the output frequency of a voltage controlled quartz crystal oscillator of 14.59... GHz. The synthesizer permits instantaneous setting of frequency to within 2x$10^{-12}$. Rugged construction ensures that it meets military standards for reliability, test, construction and r.f.s, and the modular approach means that any module may be changed within 15 minutes. The caesium beam tube lasts for at least three years.

SOLDER FUME EXTRACTOR

Solder fumes can cause respiratory problems so it is important that they should be kept away from the faces of those people who are continually using soldering irons. The Adcola Polysorb MK2 incorporates twin variable-speed fans to draw the fumes away from an operator and pass them through an active charcoal filter. As a bonus the unit also provides a controllable light and an output socket for power, either 240 or 24V.

The unit is metal with steel support poles to attach it to the bench. It runs on a.c. mains rated at 240V. Adcola Products Ltd, Adcola House, Gauden Road, London SW4 6LH.

MANUALS PREPARED

Having a good product to market isn't necessarily the end of the road. Presentation is also important and this includes technical literature and manuals. Woodcote Technical Services specialize in the production of technical manuals for the instruction and training of machine operators and fitters. Their service includes technical illustrations, sales literature and other literature for mechanical, electrical and electronic equipment.

Woodcote aims to provide the end user with a full appreciation and understanding of the often very complex equipment he has just purchased. To do this it is necessary to improve the effectiveness of the information required rather than merely recording it. Good illustrations should be supported by a minimum of clear, concise text, a principle that is often ignored in technical manuals, Woodcote Technical Services, Bramshott House, 139 High Street, Epsom, Surrey KT19 8EQ.

DECOPLED ANTENNAE

A radiation pattern that is absolutely horizontal and not 10-15° above the horizon is claimed for the AEA Isopole omnidirectional antennae which are used in the 2m and 70cm bands. The reason for this achievement is the feed line decoupling system with cones that prevent any radiation from the feed line. This means that distant f.m. transmitters and repeaters can be reached which would otherwise require a very large vertical omnidirectional or a beam antenna. Two models are available: the...
DVM EVALUATION KIT

To permit prospective customers to evaluate the capabilities of the ZN451 digital voltmeter, Ferranti have produced an evaluation kit.

The monolithic d.v.m. has a facility whereby external components may be included into the auto zero loop; output signals are provided to control external auto zero switches so that op amps or other signal conditioning circuits can be included in the loop to boost input impedance or improve sensitivity down to 1.999mV full scale. The kit and further details are available from Ferranti Electronics Ltd, Fields New Road, Chadderton, Oldham, Lancs OL9 8NP.

COMPUTER CONTROL FOR £170

Chum One comes with its own operating system, keyboard and alphanumeric one-line display. It may be programmed in Basic or in Z80 machine code to provide machine control or data logging and it may be used in education.

The standard unit consists of four analogue inputs, one analogue output, 16 programmable digital inputs/outputs, four programmable timers/counters, a serial digital input and a serial digital output. Up to 6K of non-volatile ram is provided and the function of the computer can be altered instantly by inserting a programmed eprom into the external top socket. Programs and data can be loaded or saved on cassette tape through the serial input/output. Warwick Design Group, 12 St George’s Road, Leamington Spa, Warwick CV31 3AY.

THICK-FILM LOW PASS FILTERS

A range of audio-band low-pass filters have been designed by Toko for use with digital audio equipment. The PAL0900 series are all 20kHz active filters which are intended to optimise the phase response from p.c.m. coded digital audio discs. They are available with a variety of terminating impedances and with stopband attenuations up to -95dB. Ambit International, 200 North Service Road, Brentwood, Essex CM14 4SG.

GRAPHICS GENERATORS

Designed to be adapted to almost any 8 or 16-bit microprocessor the GVP (for Graphics Video Processor) 65 is a single board circuit which can generate a 512 × 512 pixels display interlaced or 256 × 256 non-interlaced. It can plot at up to 1,500,000 dots/s, can generate ASCII character which may be tilted or changed in size and pictures may be coloured using 4,913 pre-programmed colour patterns. The commands include pen/eraser selection, pen/eraser up or down, clear screen, light pen handling instructions, memory access and writing, block drawing in different sizes, vector drawing, colour and intensity selection, colour mapping, mixing and removing, characters or figures may flash on and off and there are synchronizing and configuration commands.

GVP 65 generates t. t. i. compatible RGB, B/W and composite sync video signals. Many GVPs can be synchronized together to build up a picture image. Greatech Electronics Ltd, Hoy Lane, Braintree, Essex CM7 6ST.

SCREW STARTERS

One of the bugbears of assembly and maintenance of electronic equipment is the limited access to the screws that hold it together. We can usually get them out, but the difficulty is in re-assembly. Screw starters which can grip the screw while it is being positioned are very useful and three are available from Toolrange. The D2 is for slotted screws, the PD-10 for cross-slot (Phillips) heads. These are both ocketed sized with pen-clip. The D-1 is longer and double-ended for both slotted and Phillips heads. Toolrange Ltd, Upton Road, Reading, Berks RG3 4JA.

If you would like more information on any of the items featured here, enter the appropriate WW reference number(s) on the maue reply-paid card.
**WORDS**
I dare say we all use certain words without bothering too much about their meanings. They sound right and seem to fit the context and, indeed, fall into common usage; yet sometimes the accepted meaning is far from that given in the dictionary.

The most useful ones are not in the dictionary at all, and they can be given any meaning that happens to be appropriate. Take the noun "snodgett", for example. Do you know what a snodgett is? No, of course you don't, but it is a very handy universal word to use as the name of almost anything when you can't think of what to call it.

A snodgett on your car chassis gets in the way of your spanner when you are struggling with the nut that holds your broken exhaust pipe. Or, in contrast, the are four quite handsome snodgetts on the ornamental wall clock over our fireplace.

And again, there is the snodgett in a video amplifier's frequency response that causes overshoot on a fast rise pulse. It's a very handy word, "snodgett". I strongly recommend that you take it into your vocabulary and use it wherever you get stuck for a suitable noun. Eddie Snipks has a universal adjective, "hydrofluous!", but I think it sounds a bit pompous.

However, it was not the non-dictionary words that prompted this literary outburst so much as the misuse of well-established words. In particular, have you noticed how the word " sophisticate " is now fashionable as a kind of universal adjective to imply some degree of vague cleverness associated with its subject. It appears in all kinds of technical sales literature and even in serious technical articles. We frequently read of sophisticated techniques, circuits, machines and the like. And I must confess to having used the word myself in such context without really appreciating its meaning. But, being a bit of a pedant, when I realized my ignorance I looked up the word in the Concise Oxford Dictionary. The entry reads: "Sociophisicate (v.t. & i.) involve in sophistry; mislead thus; deprive of simplicity; make artificial (p.p.) worldly-wise; adulterated (wine, etc.)."

Not very nice, is it? I see now why these "very sophisticated" computer systems often seem to be full of anomalies, using advanced technology (whatever that means) to achieve results that seem utterly inconsequential. Are they actually intended to mislead? And, as for these "highly sophisticated" weapons that we read about - one wonders whether they are designed to deceive the enemy or the chaps at the sending end. Probably the only one to be deceived is the fool who looks up the word in the dictionary. Everyone else assumes a meaning relating to cleverness of design, which is just what the authors intend.

**WORDS AND MUSIC MAESTRO**
They're at it again with gimmicky auto-mobile electronics. This time it's not an entirely Japanese venture but the new British Leyland Maestro. I overheard a fragment of a television programme the other day in which there was a short piece of leaked information about this car, which, I gather, has not even been announced under the Maestro name yet.

Anyway the programme included a statement that the more superior versions would feature an audio readout of dashboard information. Do we call this a "Speakout"? This feature is, of course, in addition to such refinements as electric windows and remotely controlled door mirrors.

As I understood the announcement, the car will speak out such information as speed, fuel level, engine temperature etc., but the report was brief and gave no information about the way in which the driver interrogates the system.

Perhaps no interrogation is necessary. Perhaps the thing is programmed to blurt out the information at preset intervals or when an alarm situation occurs; e.g., "We're nearly out of petrol!" Perhaps it announces the speed as each decade multiple m.p.h. is reached - either accelerating or decelerating. If so, it could be quite dramatic when you have just pulled out of a lay-by and you are trying to read the speed of the traffic before the dual carriageway peters out.

In the report that I heard, there was no mention of a microprocessor, but you may be sure that the whole system depends on at least one of these devices. No modern electronic system amounts to much without one. So we are naturally led to speculate on the conversational ability of the car of the future as more-and-more data processing power is compressed into smaller-and-smaller devices.

I read quite recently about a Japanese heavy goods vehicle with solid-state television cameras mounted at "blind" locations on the truck body and a c.r.t. in the cab to augment the conventional rear-view mirrors. We also read of computer programmes for interpretation of the signals from t.v. cameras to exact meaningful information and act upon it. At present such systems are confined to the field of metrology and machine-tool control, but who knows what the future may bring.

With the general trend towards the use of high technology for totally frivolous purposes, it is possible that the techniques mentioned will one day be combined to enable the car itself to utter those helpful comments currently made by ones pass-sengers; e.g., "All clear left . . . if you're quick", "That's a police car you're overtaking" and "Why is that fool dripping with water shaking his fist?"

Such technical developments could ultimately do away with the need for passengers altogether, and one could, perhaps, look forward to the optional electronic "hitch-erker" which gives an authentic account of all the lifts he's ever thumbed while you are trying to listen to the test match commentary on Radio 3.

**GETTING THE MESSAGE**
One of the advantages of the printed (as against spoken) word is its immunity to the effects of mispronunciation, extraneous noise, imperfect bearing and, in the case of telecommunications, frequency limitations and distortion.

I was not surprised to read, therefore, about a miniature alphanumerical terminal, complete with keyboard, VDU screen, and printer, for use with mobile radio. The article said it is for applications where integrity of the message is very important. It offers most of the advantages one associates with the telex, and perhaps it is another step in a trend towards transmission of written information rather than relying on speech.

It is bound to be more reliable because the transmitted signal is so much simpler. When you come to think of it, spoken language is an extraordinarily complex way of communicating, even by comparison with the arbitrary shapes of the letters in our alphabet. In the face-to-face conversational environment the sounds are supported by facial expression and gestures, which are inevitably lost in sound-only transmission. So, for communication of information, as distinct from emotion, the trend is to the Telex and Teletext and Viewdata.

Or is it? I've just read a feature about computer controlled voice recognition systems and electronic speech synthesizers. This is really high technology stuff, where the human operator speaks to the machine and the machine talks back. I must admit that the voice recognition systems described were mainly concerned with access-control applications and bar-code grading in an Australian abattoir. But the prediction was the development of voice operated data terminals, where you interrogate the computer verbally and its synthetic voice answers.

If the computer misunderstands your accent, no doubt it will ask you to "spell it out" using the approved phonetic alphabet. And if you misunderstand, I recommend you call for a print-out, of course, you are using the telephone, when it will probably end up with smoke signals.

By Chirp

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PLUS CONFIGURATIONS: basic circuit design ZX81: full software listing of music and sound effects for the ZX81 soundboard. TECH TIPS: readers ideas. READ/WRITE: readers views. DATA SHEET: organ chips. PseudoROM: RAM replacement for 8K ROM with battery back-up.

ALL IN THE MAY ISSUE OF E.T.I. — AT YOUR NEWSAGENT NOW!
<table>
<thead>
<tr>
<th>CERAMIC CAPACITORS</th>
<th>Value (μF)</th>
<th>Case</th>
<th>Price (£)</th>
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<td>2N3906</td>
<td>Transistor</td>
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Terms of business: CWO. Postage and packing valves and semiconductors 50p per order. CRTs £1.50. Prices excluding VAT; add 15%. Price ruling at time of dispatch. In the event of price changes, USA valves will be higher than those advertised. Prices correct when going to press. Account facilities available to approved companies with minimum order charge £10. Carriage and packing £1.50 on credit orders. Over 10,000 types of valves, tubes and semiconductors in stock. Quotations for any types not listed. S.A.E.

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Please send me a requirement check sheet:
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Company
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Tel No
Telex

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- Qualitiy discount

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- 36 way Solder Socket
  - centre tips type
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- 24 way IDC Socket
  - centre tips type
- 24 way Solder Plug, dif. types
  - (IEEE type)
- 24 way Solder Socket
  - (IEEE type)

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- Male-Male
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- Male Female
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- 2163
  - 350p
- 4116-2
  - 85p
- 4166-2
  - 450p
- 6116-1
  - 350p

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  - CRT Controller H/Book
    - £7.35
  - Programming the 286
    - £8.95
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    - £6.25
  - 6800 Assy. Lang.
    - £12.10
  - 6800 Applications
    - £10.20
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    - £9.00
  - 6800 Games
    - £10.25

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**SOFTWARE**
- World Wide Web
  - www.americanradiohistory.com

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**INFORMATION**
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<th>Quantity Item</th>
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<td>Model 6010 (x)</td>
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<td>Model 7030 (x)</td>
<td>£41.34 inc</td>
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<td>Carrying Case (x)</td>
<td>£20.00 inc</td>
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All prices include VAT and post and packaging. All items include a full year guarantee. Allow up to 10 days for delivery. Cheques/Postal Orders etc. should be made payable to AFDEC Electronics Ltd.

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All prices quoted are for UK, Mainland, cash and charge with or in Pounds Sterling ONLY. VAT. Minimum order value £2.00. Minimum Credit Card order £10.00. Minimum BONA FIDE accounts ordered from Government departments. Schools, Universities, Charities and Model societies. £30.00. Where post and packing not indicated, release ACID RDP VAT. £30.00. 9.30 - 9.50 Sat 10.15 - 5.30. We reserve the right to change prices and specifications without notice. Trade, Bulk and Export enquiries welcome.
This event is the first of its kind in the Midlands, and gives you the opportunity to see and compare the enormous range of personal and home computers, small business systems, microcomputers, software packages, cassettes and scores of the very latest computer games – try them for yourself – decide how much, or how little it takes to build up your own personal computer system.

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**WIRELESS WORLD April 1983**

105
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Design an Electronic Device to help the Disabled

Could you design a piece of equipment to help a disabled person? If so, you would—in addition to undertaking this worthy task—be eligible to win a substantial cash prize.

Our competition is open to individuals or groups resident in the UK. You register your entry using the form below, sending it to the Editor to arrive at his office no later than June 30th 1983. The designs themselves must be submitted to his office by 1st October 1983.

Entries, which will be judged by a group of eminent engineers and doctors, must consist of the following:—

1. A statement of design objectives;
2. An overall description of the device;
3. Detailed circuit descriptions and diagrams;
4. A model of the device;
5. A statement of engineering design;
6. A model of electronics content;
7. Design reliability;
8. Originality;
9. Simplicity of operation;
10. Freedom from excessive maintenance;
11. Safety.

Note: All submitted designs must be the original work of the entrant or entrants and must not infringe the rights of third parties in any way.

The finalists will be invited to London to talk over their entries with the judges and be awarded their prizes. The prizes are:

1st prize £2,500
2nd prize £1,500

and the 4 runners up will be awarded prizes each of £1,000

To make sure you have the maximum time to undertake your design, return your entry form now!

wireless world COMPETITION ENTRY FORM

"Design an electronic device to help the disabled"

Name of competitor

Address

Telephone (home)

Address

Signature

Date

COMPETITION RULES

1. The competition is open to U.K. residents only.
2. Entries can be submitted by individuals or groups.
3. All entries must register their interest in entering the competition on the form provided when submitting the Wireless World Editorial Department by the 30th June 1983.
4. All entrants agree not to use Wireless World first serial publication rights to write an article describing the entry.
5. All entrants confirm Wireless World has no liability in respect of injury to people or damage to property arising from the use of any design.
6. All submitted designs must be the original work of the entrant(s) and must not infringe the rights of third parties in any way.
7. All submissions shall consist of:
   a) A statement of design objectives;
   b) An overall description of the device;
   c) Detailed circuit descriptions and diagrams;
   d) A model of the device or the unique aspect of the design sufficient to demonstrate its feasibility;
   e) A statement describing the entry, including:
      i) Originality and benefit to the handicapped;
      ii) Potential for production;
      iii) Elegance of engineering design;
      iv) Electronics content;
      v) Design reliability;
      vi) Originality;
      vii) Simplicity of operation;
      viii) Freedom from excessive maintenance;
      ix) Safety;
   f) Software-only solutions are not accepted.

8. The design will be judged on:
   a) Originality and benefit to the handicapped;
   b) Potential for production;
   c) Elegance of engineering design;
   d) Electronics content;
   e) Design reliability;
   f) Originality;
   g) Simplicity of operation;
   h) Freedom from excessive maintenance;
   i) Safety.

9. The prizes are:
   a) First prize £2,500
   b) Second prize £1,500
   c) The 4 runners up will be awarded prizes each of £1,000

10. Your entry must be submitted to the Wireless World Editorial Department by the 1st October 1983.
11. All submitted designs will be prepared for a national competition on London premises on 7th November 1983.
12. Entrants will be invited to attend the competition on 7th November 1983 to demonstrate their designs. All entries will be judged by the judging panel.
13. Entries are open to all persons or groups who wish to enter the competition.
14. The Editor reserves the right to accept or reject any entry, and all entries shall be judged according to the rules and regulations as laid down in this competition.
15. The Editor reserves the right to make any changes to these rules and regulations without notice.

Please send this form as soon as possible, to:
The Editor, WIRELESS WORLD
Room L302, Quadrant House, The Quadrant
Sutton, Surrey SM2 5AS

Receipt of the form will be acknowledged.

WIRELESS WORLD APRIL 1983
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**FEED YOUR MICRO BYTES WITH OUR SOLENOID CONTROLLED CASSETTE DECK**

Brand new high quality stereo cassette unit with built-in record and play electronics. Ideal for use with any hi-fi system or music centre. Only a single 9-volt DC supply is required to power the unit. Microphone and line input are provided on both channels and the line output will feed into any normal hi-fi amplifier. Easiness and bonus is provided by an ultrasonic oscillator, automatically switching to the correct level when a chrome or ferric cassette is put in place. Overall size 180mm x 130mm x 73mm. Complete with 3-digit counter.

We value this deck at about £30. OUR VERY SPECIAL PRICE INCLUDING VAT AND POSTAGE — THIS IS ALL YOU PAY — ONLY £18.34 (while stocks last).

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One inexpensive test cassette enables you to set up VU level, head azimuth and tape speed, all important when selecting, fitting new heads.

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Brand New Governor 12v DC Tape Drive Motor Type MM-500 6000 RPM 500, 300, 200, 100, 60, 50, 40, 35, 30, 26, 25, 24, 22, 20, 18, 16, 14, 12, 10, 8, 6, 4, 3, 2, 1 RPM. Free run 3000 RPM. £4 each.

Lancio 2200 RPM. We have a small quantity of spares motors for these decks at £8 each. Contact us for details. Ask for your FREE copy NOW.

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Require an assistant to the technical director to plan and install and occasionally service sophisticated sound and lighting installations worldwide.
Candidates should have creative ability, common sense and at least one year’s industrial experience as well as an electronics degree. Extensive travel is involved and we expect the ideal candidate will be aged approximately 25 and single.
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Supervise small production line, purchasing materials establishing regular sources of supply and supervision of staff of four technicians. Applicant required possess strong engineering and practical background in manufacturing procedures, reliability tests, cost estimates, etc.
RF communication and telephone systems experience is essential. Qualified applicants only. Good future. Salary will depend on experience starting with £7,500 as negotiable salary minimum.
Please reply in writing giving details of qualifications and career to date, to Box 2022.

WIRELESS WORLD APRIL 1983

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BRITISH ANTARCTIC SURVEY
Radio Officer (Marine)

A vacancy exists for a Radio Officer (Marine) to serve initially aboard the Antarctic Research Vessel RRS John Biscoe. The successful applicant will be required to commence duties on 1 June. Voyages are normally seven months long and the vessel will sail from the United Kingdom on 21st June. RRS John Biscoe’s primary role is to support shipborne marine biology and associated oceanography in the southern ocean. She has a secondary responsibility to resupply Antarctic land stations as well as to support scientific parties in the field.

Candidates should possess valid certificates of proficiency recognised by the Department of Trade and have served the necessary sea time to work a single-handed station.

Salary: In the scale £7,773, £8,291, £8,398, £8,640 . . . to £10,917 per annum. In addition an allowance of £1,200 is payable for periods of service spent south of Montevideo.

For further details and an application form please write stating full qualifications and experience to:
The Establishment Officer, British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET.

Please quote Ref: BAS 75

Closing date: 30 March, 1983

NATURAL ENVIRONMENT RESEARCH COUNCIL

(2035)
**CAREER OPPORTUNITY WITH TOP BRITISH MICRO MANUFACTURER**

**ELECTRONICS TECHNICIAN**

**PRODUCTION ENGINEERING**

£5.8K-8.7K
DEPENDING ON AGE AND EXPERIENCE, OXFORD BASED

Research Machines is an expanding UK manufacturer of microcomputer systems for scientific, engineering and educational applications. We are looking for an experienced electronics technician to support the Production Engineering team.

We are offering the opportunity of varied and satisfying work on technically advanced equipment. Applicants should be capable of prototype construction, carrying out validation work/writing reports on engineering changes and testing new peripherals and components.

You should be educated to HNC or degree level in electronics and have at least one year's experience in digital electronics and computer hardware/software.

We offer a particularly attractive range of benefits, including good salary; 25 days paid holiday; free BUPA, life and disability insurance; pension scheme and help with relocation expenses.

If you are interested in this post, please contact Mary Oakey at Oxford (0865) 728224 and ask for an application form, quoting T/WW.

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**CHIEF MAINTENANCE ENGINEER**

required for factory manufacturing musique cassettes and computer software. Some experience of Audio Techniques as well as Electronics to HNC standard or equivalent would be essential.

This responsible position would be ideal for someone with an interest in the maintenance of machinery from computers to packaging machines.

Please write with full career details to:
Malcolm Shepherd
BiBi Magnetics Ltd
101/105 Plough Road
London SW11 2BJ

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**ELECTRONICS TECHNICIAN**

The post involves the routine maintenance of an Elscint wholebody CAT Scanner as well as other associated electromedical equipment. Applicants should have wide experience in analogue and digital servicing together with a working knowledge of microprocessor programming techniques.

The post is graded as Medical Physics Technician II or III depending on experience and qualifications. (Entry to Technician II grade is open to applicants who have served at least two years as a Technician III.)

Salary scales from 1st April, 1983:

Please apply for an application form without delay to: The Secretary, Department of Clinical Measurement, Westminster Hospital, 65 Romwey Street, London SW1 or telephone 01-828 9811 Ext. 2640.

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**Electronic Engineers – What you want, where you want!**

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £5000-£15000.

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

Please send me a TJB Appointments Registration Form:

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Address: ____________________________

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Kent TQ4 8AS.
Tel. 0892 39388

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We are paying very high rates for contract design and test engineers who have a background in RF, MICROWAVE, DIGITAL, ANALOGUE OR SOFTWARE, at sites throughout the UK.

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ASSISTANT EXPERIMENTAL OFFICER (ELECTRONIC INSTRUMENTATION)

The department, which has an active neuroscience-based research programme, requires a person with design experience to work in collaboration with the academic staff in the development and maintenance of equipment for research laboratories. Degree in electronics an advantage. This post offers a challenging opportunity for those interested in developing the latest electronic technology in a biomedical environment.

Salary range: OR IB £5,550-£9,370 p.a.
Duties to commence as soon as possible.

Applications (2 copies), together with the names and addresses of two referees, should be forwarded to the Vice-Principal (Administration) and Registrar, University College, PO Box 78, Cardiff CF1 1XL, from whom further particulars may be obtained. Closing date 15th April, 1983. Ref. 2527.

FIELD SERVICE ENGINEERS
(based in UK or Italy)

Electronics engineers to work on the installation and maintenance of television studio equipment at customer sites throughout Europe, Africa and the Middle East.

Key requirements are:
- Thorough knowledge of video and audio principles – HNC/Degree Electronics preferred
- Experience in broadcast television industry
- Previous knowledge of TV Systems would be an advantage

Please 'phone or write
Maureen Brake
Ampex Great Britain Limited
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ELECTRONIC DESIGN ENGINEERS

We are a small highly successful manufacturing company specialising in RF communications, digital and low frequency analogue equipment.

We require young highly motivated engineers wishing to develop their experience. The ideal candidate must have complete confidence in his ability.
- Starting salary £10K + (neg).
- 37 1/2-hour week. Overtime available.
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Contact Keith Penny on (01) 250 0894

SCOTTISH OFFICE
DIRECTORATE OF TELECOMMUNICATIONS

WIRELESS TECHNICIAN

Applications are invited for two posts of Wireless Technician in the Central Services Department of the Scottish Office. The posts are based in East Kilbride and Edinburgh.

Candidates must have a sound theoretical and practical knowledge of Radio Engineering and Radio Communications equipment both fixed and mobile, in the frequency range HF to 2 GHz. They must also be able to use test equipment and simple machine tools. A sound basic knowledge of digital techniques would be an advantage. They should have a minimum of 3 years' appropriate experience and should hold an Ordinary National Certificate in Electronic or Electrical Engineering or a City and Guilds of London Institute Certificate in an appropriate subject or a qualification of higher or equivalent standard. Some assistance may be given with relocation expenses.

A valid UK driving licence is essential.

Application forms and further information are obtainable from Scottish Office Personnel Division, Room 110, 16 Waterloo Place, Edinburgh EH1 3DN (quote ref PMPTS/52/1/83 031 556 8400 Ext 4317 or 5628)).

Closing date for receipt of completed application forms is 11 April, 1983.

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FOR BROADCAST TELEVISION

Ampex Corporation is the leading world manufacturer of professional video/audio recording equipment and a wide range of associated broadcast products, including computer controlled editing systems, cameras, digital effects and vision switchers.

We are looking for:

SYSTEMS PROJECT ENGINEERS

To join our innovative project team involved in the design, installation and commissioning of TELEVISION STUDIO AND OUTSIDE BROADCAST VEHICLE PROJECTS.

The Broadcast Systems Group based in Reading supplies complete studio and mobile systems to broadcast installations worldwide.

The appointments involve occasional overseas travel for on-site commissioning.

Key requirements are:
- Thorough knowledge of video and audio principles – HNC/Degree Electronics preferred
- Experience in broadcast television industry
- Previous knowledge of TV Systems would be an advantage

FIELD SERVICE ENGINEERS
(based in UK or Italy)

Electronics engineers to work on the installation and maintenance of television studio equipment at customer sites throughout Europe, Africa and the Middle East.

Key requirements are:
- Thorough knowledge of electronic engineering – HNC/Degree Electronics preferred
- 3 years' experience in a television studio/production environment with specific experience of either videotape or studio equipment, e.g. cameras, switchers, etc.
- Ability to travel throughout Europe, Africa and the Middle East, together with ability to work on own initiative while away from base.

Attractive salaries and other benefits, including pension, life assurance and permanent health scheme, blue chip option, product training, overseas allowances and relocation expenses as appropriate.

Please 'phone or write
Maureen Brake
Ampex Great Britain Limited
Acre Road, Reading RG2 0QX
Berkshire, England
Tel: Reading (0734) 875200

WIRELESS WORLD APRIL 1983

113

www.americanradiohistory.com
Senior Engineer - Vision Control

We are looking for a Senior Engineer to lead the Vision Control section at The Television Centre, Mold, which is part of the impressive Theatre Clwyd complex, where we are currently completing the installation of a second studio.

Experience in broadcast television is an essential requirement, and familiarity with Link 110 and 120 cameras would be a distinct advantage.

Salary, including supplements, is £11,884 per annum, and assistance towards the cost of relocating to this very attractive part of Wales may be available.

Suitably qualified candidates should write for an application form, enclosing a self-addressed envelope and quoting reference WW/146 to The Personnel Manager, HTV Limited, The Television Centre, Cardiff CF1 9XL.

WE ARE AN EQUAL OPPORTUNITIES EMPLOYER.

Network Supervisor

Channel 4 Television requires a Network Supervisor at their transmission centre in Charlotte Street. The successful applicant should be fully conversant with all aspects of television technical operations, and will have occupied a position of responsibility within a broadcast television environment.

He/she is the senior technical operations staff member on shift who will deputise for management in their absence. Excellent salary and promotion prospects.

Please write giving details of past experience, age and salary to The Personnel Department, (Ref 4G6), Channel 4 Television, 60 Charlotte Street, London W1P 2AX by 25th March 1983.

Channel 4 is an equal opportunity employer. Applications are welcome from candidates regardless of marital status, race, nationality, ethnic or national origins, or sex and from registered disabled persons.

BRITISH ANTARCTIC SURVEY

Radio Technician/Operators

Radio Technician/Operators who have experience in maintenance and operation of HF and satellite communications are required to work single-handed at stations in the Antarctic.

Because of the isolated nature of Antarctica the ability to work on their own initiative is absolutely essential. Applicants should appreciate that they will be solely responsible for all aspects of communications. Ability to operate to MRSCG standard with some knowledge of maritime procedures is also necessary. Appropriate training on specific equipment will be given if required.

The period of employment will be from 4 July, 1983, until Spring 1986 which entails working in Antarctica for two consecutive winters.

Applications are invited from single men (to work mainly overseas) who are physically fit and aged between 22 and 35.

Salary: from £5,709 per annum, plus annual increments. Also Antarctic allowance of £586 per annum. Accommodation provided whilst overseas. Clothing, messing and laundry are provided free on bases and free messing on voyage.

For details and an application form please write to:
The Establishment Officer, British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET

Please quote ref BAS 74

Closing date 13th April, 1983

NATURAL ENVIRONMENT RESEARCH COUNCIL

GOODHEAD PUBLICATIONS LIMITED require an EDITOR for its monthly magazine, Amateur Radio

An experienced radio amateur is preferred, although not absolutely essential. Editorial experience a definite asset. Freelance Editor would be considered.

Write, with a brief cv to the Executive Editor, Chris Drake, Goodhead Publications Limited, 27 Murdock Road, Bicester, Oxon OX6 7RG. Telephone: Bicester (08692) 44517.
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Clip this advert and you can stop hunting for your next appointment. We have a wide selection of the best appointments in Digital, Analogue, RF, Microwave, Microprocessor, Computer, Data Commis and Medical Electronics and we're here to serve your interests.
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Psion is a substantial and rapidly growing microcomputer applications house.

We require an electronics technician/engineer to support design staff in the following areas:

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The successful applicant will have at least 5 years’ experience in an electronics design environment. Salary range £7,000 - £11,000 per annum depending on skill, experience and ability to work with a minimum of supervision.

**PSION LTD., 2 Huntsworth Mews, Gloucester Place, London NW1.**
Telephone: 01-723 6919 or 01-723 9408

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**County Surveyor’s**

**M1 Strengthening phase 1, 1983/4**

Provision of a site Radio Telephone System

Applications are invited from companies wishing to be considered for the supply and maintenance of a site radio telephone system, on the basis of a short term hire contract. The equipment is to be used for a period of approximately 16 weeks on the above mentioned contract on the M1 in Bedfordshire.

Companies wishing to be considered should apply to:

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For an application form, please send your coupon to George A. Low, Beechwood Appointments, Register, FREEPOST, London W3 9HB (no stamp required).

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Name

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WIRELESS WORLD APRIL 1983

(2049)
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Production Engineer £9,000+

The person appointed will join a small team which provides technical support to the production department.

Responsibilities include assembly and test procedures, and interfacing with sales and design engineers on product improvements and new product introductions.

The successful applicant will ideally be a graduate electro-mechanical engineer experienced in electronic assembly. He/she may also have particular knowledge of ATE.

Production Technician c £7,000

To support the production engineers by building jigs, debugging prototypes, running machinery schedules and coping with day-to-day equipment failures.

Qualifications: HND or equivalent and some practical experience of an electronic nature.

Write or telephone PHIL MARSHALL,
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346 Clapham Road.
London SW9.
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DOLBY

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Medical Physics Technician

Grade IV

required to work as part of a technical group in the busy Radiotherapy Department of this postgraduate teaching hospital.

The successful candidate will be involved mainly in the work of the new T.B.I. Unit. Applicants should possess ONC, HNC, HND or similar qualification in electrical engineering or electronics. This post is for a fixed-term period of one year only.

Salary scale from 1st April 1983 £5767-£7394 per annum.

Candidates wishing to discuss the post further should contact Mr Edser, Radiotherapy Department, Tel: 01-642 6011 Ext. 280. Application form and job description available from the Personnel Department, Royal Marsden Hospital, Fulham Road, London SW3. Tel: 01-352 8717 Ext. 446/447.

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IF YOU REQUIRE A COMPACT GEN, write to number one supplier for exemption, 21 Lodge Lane, Finchley, London N 12


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MCB & PANEL LABELS to your requirements. Design - Production. G. N. See Custom Products, 78 Derry Grove, Thornton, Rotherham, Yorks S6 0TP Telephone (0792) 895232.


MCM COMPANY

19-21, 21 Lodge Lane, Finchley, London N 12

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Electro-Acoustic

Product Development Engineer

North London

C. £11,000

The advent of digital switching systems allied to the rapid development in microprocessor technology means that tomorrow's telephone will provide a highly versatile communications medium. "New Generation" telephones will incorporate such aspects as large scale data memory, automatic call and recall options, visual displays, loud speaking facilities etc.

Our client, an international market leader in the field of telephone design and manufacture, is committed to an exciting product development programme and now needs to strengthen its engineering team through the appointment of an experienced Electro-Acoustic Engineer.

This position will be of interest to qualified engineers, degree level or equivalent, with several years' relevant experience in the design and development of electro-acoustic products. Successful applicants will be expected to demonstrate a high degree of design innovation to meet the critical low cost requirement associated with the high volume production of moulded components and small electro-mechanical assemblies while ensuring optimum acoustic performance.

This represents an exceptional opportunity to join a small, multi-disciplined team of professional engineers working within the framework of a large organisation situated in the North London area. In addition to an attractive salary, the company offers relocation expenses where appropriate.

RF Development Engineers

Our client would also like to meet RF Development Engineers to work on a future range of Personal Communications products incorporating state-of-the-art technology up to 1 GHz.

Whatever your level of experience, if you are qualified to degree level or equivalent and have a sound knowledge of analogue r.f. circuit design, our client would be interested in hearing from you.

In the first instance please telephone for an application form or write with full c.v. stating in a covering letter any companies to whom you do not wish your application forwarded, to: B. Kelly, Moxon Dolphin & Kerby Ltd., 178-202 Great Portland Street, London W1N 5TB. Tel 01-631-4441 quoting ref: BK/955/W.

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Wireless World APRIL 1983
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119

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## INDEX TO ADVERTISERS

**Appointments Vacant Advertisements appear on pages 110-120**

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Telephone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acoustical Mfg. Co.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Aeron Electronics (AEL) Ltd.</td>
<td>102</td>
<td></td>
</tr>
<tr>
<td>A &amp; H Supplies</td>
<td>18, 19</td>
<td></td>
</tr>
<tr>
<td>All Electronics Show</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Antech Electronics Ltd.</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Avionics Ltd.</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Avionics Ltd.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Avol Ltd.</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Barrie Electronics</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Black Star Ltd.</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Broadfield &amp; Mayo</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Bull, J. (Electrical)</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td>Carocal Power Products Ltd.</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Carnegie Electronics</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Cil Microsystems Ltd.</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Circuit Services</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Clark Masts Ltd.</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Coral Products (Electronics)</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Colomnon (Electronics)</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>Computer Appreciation</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Cycletronics Ltd.</td>
<td>97</td>
<td></td>
</tr>
<tr>
<td>CT Electronics (Acton) Ltd.</td>
<td>93, 100</td>
<td></td>
</tr>
<tr>
<td>Display Electronics</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td>Dwight Cavendish Ltd.</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td>Electronic Brokers Ltd.</td>
<td>53, 83, 85</td>
<td></td>
</tr>
<tr>
<td>Electronic Components Ltd.</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Electronic Today International</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>Electrovision Ltd.</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Electromation Ltd.</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>Essex Electronics Centre</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Cat. Page</th>
<th>Retail Price incl. VAT</th>
<th>Min. Trade Qty</th>
<th>Price Each for Min. Trade Qty excl. VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>XB54J</td>
<td>Aerial Rotator</td>
<td>25</td>
<td>£39.95</td>
<td>5</td>
<td>£29.90</td>
</tr>
<tr>
<td>YG00A</td>
<td>Ni-Cad AA 500mAH</td>
<td>26</td>
<td>£1.25</td>
<td>50</td>
<td>75p</td>
</tr>
<tr>
<td>FB15R</td>
<td>Electrolytic 2.2uF 63V</td>
<td>90</td>
<td>10p</td>
<td>500</td>
<td>4.5p</td>
</tr>
<tr>
<td>FB27Y</td>
<td>Electrolytic 1uF 25V</td>
<td>90</td>
<td>5p</td>
<td>1000</td>
<td>3.5p</td>
</tr>
<tr>
<td>FB48D</td>
<td>Electrolytic 100uF 25V</td>
<td>90</td>
<td>14p</td>
<td>500</td>
<td>6.5p</td>
</tr>
<tr>
<td>FB73G</td>
<td>Electrolytic 470uF 25V</td>
<td>90</td>
<td>30p</td>
<td>250</td>
<td>12p</td>
</tr>
<tr>
<td>FB85E</td>
<td>Electrolytic 1000uF 25V</td>
<td>90</td>
<td>40p</td>
<td>250</td>
<td>17p</td>
</tr>
<tr>
<td>FR95E</td>
<td>Electrolytic 4700uF 25V</td>
<td>90</td>
<td>80p</td>
<td>500</td>
<td>37p</td>
</tr>
<tr>
<td>YG41U</td>
<td>27MHz Rubber Duck</td>
<td>99</td>
<td>£4.75</td>
<td>25</td>
<td>£2.95</td>
</tr>
<tr>
<td>XG13P</td>
<td>1.5m CB Aerial</td>
<td>99</td>
<td>£13.95</td>
<td>5</td>
<td>£8.45</td>
</tr>
<tr>
<td>LB72P</td>
<td>2-Station Intercom</td>
<td>102</td>
<td>£8.75</td>
<td>10</td>
<td>£4.95</td>
</tr>
<tr>
<td>HRF5G</td>
<td>1/4in. Jack Plug plastic barrel</td>
<td>142</td>
<td>19p</td>
<td>500</td>
<td>9p</td>
</tr>
<tr>
<td>HRF8V</td>
<td>1/4in. Jack Plug plastic barrel</td>
<td>142</td>
<td>28p</td>
<td>250</td>
<td>15p</td>
</tr>
<tr>
<td>HRF8U</td>
<td>1/4in. Jack Plug metal barrel</td>
<td>142</td>
<td>39p</td>
<td>250</td>
<td>22p</td>
</tr>
<tr>
<td>HRF9W</td>
<td>1/4in. Jack Plug stereo metal barrel</td>
<td>142</td>
<td>45p</td>
<td>250</td>
<td>28p</td>
</tr>
<tr>
<td>RW67X</td>
<td>13A nylon Mains Plug British</td>
<td>157</td>
<td>79p</td>
<td>100</td>
<td>45p</td>
</tr>
<tr>
<td>WL27E</td>
<td>LED 0.2in. Red</td>
<td>182</td>
<td>12p</td>
<td>500</td>
<td>6p</td>
</tr>
<tr>
<td>WL26F</td>
<td>LED 0.2in. Green</td>
<td>182</td>
<td>19p</td>
<td>500</td>
<td>10p</td>
</tr>
<tr>
<td>WL29G</td>
<td>LED 0.2in. Orange</td>
<td>182</td>
<td>33p</td>
<td>250</td>
<td>19p</td>
</tr>
<tr>
<td>WL30H</td>
<td>LED 0.2in. Yellow</td>
<td>182</td>
<td>17p</td>
<td>500</td>
<td>9p</td>
</tr>
<tr>
<td>RK07H</td>
<td>Panel Meter 100uA</td>
<td>197</td>
<td>£2.95</td>
<td>25</td>
<td>£1.95</td>
</tr>
<tr>
<td>RK09K</td>
<td>Panel Meter 1mA</td>
<td>197</td>
<td>£2.95</td>
<td>25</td>
<td>£1.95</td>
</tr>
<tr>
<td>RK19W</td>
<td>Panel Meter 2U</td>
<td>197</td>
<td>£3.90</td>
<td>25</td>
<td>£2.30</td>
</tr>
<tr>
<td>YQ71B</td>
<td>Dual MU Meter</td>
<td>197</td>
<td>£3.90</td>
<td>25</td>
<td>£2.30</td>
</tr>
<tr>
<td>YR84F</td>
<td>Professional Plugblock</td>
<td>201</td>
<td>£6.95</td>
<td>10</td>
<td>£4.95</td>
</tr>
<tr>
<td>RX96E</td>
<td>20mm Fuse Holder</td>
<td>250</td>
<td>£45p</td>
<td>250</td>
<td>24p</td>
</tr>
<tr>
<td>MI09B.MUM</td>
<td>Metal Film 0.4W 1% Resistor</td>
<td>262</td>
<td>2p</td>
<td>100</td>
<td>1p</td>
</tr>
<tr>
<td>FW00A-FW09K</td>
<td>Rotary Potentiometers linear</td>
<td>265</td>
<td>£45p</td>
<td>250</td>
<td>32p</td>
</tr>
<tr>
<td>FW21X-FW29G</td>
<td>Rotary Potentiometers log</td>
<td>265</td>
<td>£45p</td>
<td>250</td>
<td>32p</td>
</tr>
<tr>
<td>QL80B</td>
<td>1N4148</td>
<td>270</td>
<td>4p</td>
<td>1000</td>
<td>2p</td>
</tr>
<tr>
<td>RL22Y</td>
<td>741C 8-pin DIL</td>
<td>270</td>
<td>23p</td>
<td>500</td>
<td>12p</td>
</tr>
<tr>
<td>QH66W</td>
<td>NE555</td>
<td>270</td>
<td>21p</td>
<td>500</td>
<td>12p</td>
</tr>
<tr>
<td>QQ06G</td>
<td>4164 6A4 dynamic RAM</td>
<td>271</td>
<td>£5.99</td>
<td>100</td>
<td>£3.84</td>
</tr>
<tr>
<td>BL18U</td>
<td>DIL Socket 14-pin</td>
<td>336</td>
<td>11p</td>
<td>500</td>
<td>7.5p</td>
</tr>
<tr>
<td>BL17T</td>
<td>DIL Socket 8-pin</td>
<td>336</td>
<td>9p</td>
<td>1000</td>
<td>4.5p</td>
</tr>
<tr>
<td>WF14Q</td>
<td>Stereo Headphone with slide volume controls</td>
<td>342</td>
<td>£7.99</td>
<td>10</td>
<td>£4.95</td>
</tr>
<tr>
<td>FH00A</td>
<td>Sub-min Toggle Switch SPDT</td>
<td>347</td>
<td>70p</td>
<td>100</td>
<td>45p</td>
</tr>
<tr>
<td>FH04E</td>
<td>Sub-min Toggle Switch SPDT</td>
<td>347</td>
<td>99p</td>
<td>100</td>
<td>59p</td>
</tr>
<tr>
<td>FF730-FF76H</td>
<td>Rotary Switch break before make</td>
<td>348</td>
<td>74p</td>
<td>100</td>
<td>46p</td>
</tr>
<tr>
<td>HF42V-HF445</td>
<td>Rotary Switch make before break</td>
<td>348</td>
<td>70p</td>
<td>100</td>
<td>42p</td>
</tr>
<tr>
<td>YW93B</td>
<td>1000 ohm per volt Multimeter with Transistor Tester</td>
<td>362</td>
<td>£4.85</td>
<td>25</td>
<td>£2.95</td>
</tr>
<tr>
<td>YM68Y</td>
<td>20,000 ohm per volt Multimeter</td>
<td>363</td>
<td>£16.25</td>
<td>5</td>
<td>£10.45</td>
</tr>
<tr>
<td>BR75S</td>
<td>Box-joint Insulated 4/16in. Cutters</td>
<td>370</td>
<td>£6.93</td>
<td>10</td>
<td>£4.45</td>
</tr>
<tr>
<td>BR78K</td>
<td>Box-joint Insulated 4/16in. Pliers</td>
<td>371</td>
<td>£5.72</td>
<td>10</td>
<td>£3.95</td>
</tr>
</tbody>
</table>

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