Automotive electronics
Filter transient response
Radio and the Universe
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25 | 18
25 | 36
25 | 24
25 | 26
25 | 25
25 | 18
25 | 24
25 | 26
25 | 25
25 | 18
25 | 24
25 | 26
25 | 25

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Filter transient response
Radio and the Universe
WIRELESS WORLD AUGUST 1981

Front cover shows spider-like legs and contacts of a jig for testing integrated circuits, photographed at Wentworth Laboratories by Paul Brierley.

IN OUR NEXT ISSUE

Acceleration feedback speaker uses a feedback signal from the bass driver cone to improve low-frequency response and reduce distortion at low frequencies.

Direct memory access in micro systems transfers information rapidly between memory and I/O without involving program control and C.P.U. The principle is explained.

Video discs update. Now that several competing systems are being launched we report latest developments in this consumer electronics technology.

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type TM3B £145

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1mV, 3mV, 10mV, 30mV fsd.

AC: ± 4% ± 1% fsd at 30MHz.

-50, -40, +20dB

< 0.7dB from 30MHz to 400MHz.

LF. RANGES: As TM3.

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30mV, 100mV, 300mV, 1kV, 3kV fsd.

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<th>MODEL</th>
<th>DESCRIPTION</th>
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<td>TF2002B</td>
<td>AM/FM Signal Generator, 9kHz-6MHz, 2 Ch., Mod. 140kHz-200kHz Mod. frequency</td>
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<td>1650</td>
<td>Microprocessor DMM, Scale 0.5mV-100V, Full display</td>
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<td>Yokogawa</td>
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<td>2 Channel Chart Recorder, 0.5mV-100V, Full display</td>
<td>New</td>
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<td>2 Tone Signal Source, 20Hz-20KHz, 0-110dB, 1/3oct, Full display</td>
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**ANALOGUE VOLTMETERS AND MULTIMETERS**

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**CALIBRATION EQUIPMENT**

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**FREQUENCY METERS**

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**SOUND LEVEL METERS**

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**TRANSMISSION MEASURING EQUIPMENT**

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**TIME MEASURING EQUIPMENT**

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**OTHER ELECTRONIC EQUIPMENT**

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P4000 PRODUCTION EPROM PROGRAMMER

This unit provides simple, reliable programming of up to 8 EPROMS simultaneously. It has been designed for ease of operator use — a single program key starts the self check — blank check — program — verify sequence.

Independent blank check & verify controls are provided along with mode, pass/fail indicators for each copy socket and a sounder to signal a correct key command. The end of a programming run.

Any of the 2704/2708/1716 (3 mil. & 256/512/256/1716)/2716/2732/1732 (single rail) EPROMS may be selected without hardware or personality card changes.

PRICE £545 + VAT. Postage paid

BULK EPROM ERASING

MODEL LV141 EPROM ERASER

• 14 EPROM capacity
• Fast erase time
• Built-in 60 minute timer
• Convenient slide-tray loading of devices
• Safety interlock to prevent eye and skin damage
• Rugged construction
• MRS & ERASE indicators
• Price £78 + VAT postage paid

MODEL LV140 EPROM ERASER

Similar to Model LV141 but without timer. Price £61.50 + VAT post paid

AC volts 200mV-760V, 10V resolution DC volts ±10V, ±10V resolution DC/AC current 2mA-2A, 0.1mA resolution

Resistance 200Ω-20MΩ, 0.1Ω resolution. Conductance 2mS-200mS-20mS-200nS, 2mS resolution

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Electronics on the road — 1
An outline of the main applications of electronics to road vehicles
by J. R. Watkinson, B.Sc., M.Sc.

The peculiar circumstances of the world's motor industry, which produces vast quantities of technically conservative products for a market which is largely influenced by cosmetics, dictate that the equipment fitted usually lags the available technology by at least a decade. Accordingly, many of the applications to be described here may at present be found only on expensive vehicles, if at all.

Power units
Alternators. With the possible exception of radios, the alternator was the first quantity-produced automotive device to rely on semiconductors. The benefits of alternators are well known, but their use in road vehicles was only made possible by the development of low-cost reliable rectifiers1. For a long time the regulator remained mechanical in form, but now electronic regulators are becoming more common. Those using discrete components or thick film technology have been more successful than monolithic devices, primarily because of the adverse environment.

An alternator regulator basically controls the field current, as in Fig. 1, and the switching mode is often used to reduce dissipation.

Electronic ignition. Electronic ignition is interesting in the way timing information is derived and in spark generation. The source of timing has now been generally polarized into two major groups, the magnetic pickup, where a rotating part of the engine modules the flux linking a coil, and the optical system, where a light beam is interrupted2. Both of the above use the existing centrifugal advance mechanism, which is not devoid of drawbacks. A notable exception is the Bowstock system, which uses an r.f.-excited capacitance transducer to eliminate the advance mechanism3.

There are now several variations in the spark generator design. In the inductive-discharge system of Fig. 2, the energy stored in the coil is $V_0 L_0$ joules. The primary current has to be limited to that which the mechanical contacts can handle without burning, so the inductance has to be relatively high to allow sufficient spark energy. The time taken for primary current to build up in that inductance reduces spark energy at high revolutions, even in the absence of points bounce. Replacement of the points with a transistor which can handle a higher current means that the inductance can be greatly reduced, allowing spark energy to be maintained to higher revolutions. It follows that the main benefit of an add-on inductive discharge ignition unit will not be realised if the appropriate low-inductance coil is not also fitted.

All commercial inductive-discharge systems are of similar design, with the exception of the Bowstock system, which employs some original thinking. As shown in Fig. 3, this system uses a matching transformer between the coil and the amplifier, which is a part of the push-pull type to give a more rapid rate of flux change. The matching transformer prevents the coil inductance from limiting the spark rate, and the makers claim 1200 sparks per second with undiminished energy. Also unique is the fact that no current flows from the battery except during the generation of a spark.

In a capacitor-discharge system, shown in Fig. 4, a high-voltage inverter charges a capacitor which, at the moment of firing, is discharged into the coil primary, which is used as a transformer. An equivalent circuit of the c.d. system is shown in Fig. 4(b). As the mutual inductance of the coil, $M_{co}$, is in order greater than the leakage inductances, it can be neglected, which simplifies the circuit to that of Fig. 4(c). The resonant frequency can be stated as

$$f_r = \frac{1}{\sqrt{L C_{m}}}$$

where $C_{m} = C_p + C_{s}$

The primary current displays a half-sine characteristic, as in Fig. 4(d). The duration of this waveform, using figures quoted by Hoyer4 is

$$t_{spike} = 2\pi \sqrt{C_{m} L} \approx 10\mu s$$

This is extremely short, and in fact the actual spark will be shorter than this. The rise time of the output voltage is correspondingly short, and as a result resistive losses before the spark gap breaks down are very small, which accounts for the unparalleled cold starting performance of the c.d. system. Unfortunately, the weak mixtures used in modern engines can find the spark too short. Simply stated, a weak mixture is not homogenous, but consists of patches of strong mixture floating about in very weak stuff. If the spark arrives when no patch of mixture is adjacent to the electrodes, a misfire results. Turbulence in the cylinder means that a spark maintained for about 300μs will result in ignition, but this is obviously a function of engine design.

In c.d. systems, the spark can be extended in a number of ways. Most common in constructors' circuits is the configuration of Fig. 4(e), where the inverter rectifier forms a return current path, giving a current waveform shown in Fig. 4(f). In Fig. 4(g), the flywheel diode across the coil primary allows the long current decay shown in Fig. 4(h). Obviously, the spark duration should be ascertained by oscilloscope before using a c.d. system on a leaning-burning engine, particularly since the original coil is often used, and is not necessarily optimal for a c.d. system. Reputable manufacturers offer matching coils for their c.d. systems but, as with inductive discharge, the author has yet to see a reasoned argument for the use of matched components in a motor magazine. The reader is referred to a better-than-average effort5, which also gives an interesting insight into the motor fraternity's colloquialisms.

Enhanced-spark systems have been the subject of research for many years now, but commercial availability is relatively recent. The system depends upon the fact that the voltage required to maintain the spark is considerably less than the breakdown voltage of the spark plug.

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1. Electronic regulator
2. Optical system
3. Bowstock system
4. Capacitor-discharge system
5. Enhanced-spark systems

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WIRELESS WORLD AUGUST 1981

Fig. 1. Basic alternator regulator controls field current.

Fig. 2. Many inductive discharge systems simply replace points with transistor

Fig. 3. Bowstock system uses matching transformer and push-pull amplifier to achieve rapid firing rate at full output. (1 — coil, 2 — transformer)

Fig. 4. Capacitor-discharge system, in basic form at (a). Equivalent circuit at (b) is simplified to that at (c). Coil mutual inductance is ignored. Current waveform produced by circuit at (d) is shown at (e), extended by circuit at (f) to waveform shown at (g). Flywheel diode in circuit at (h) allows long decay shown in (i)

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A d.c. supply of several kilovolts is applied to the spark plug but, as this potential is below the breakdown voltage, no spark occurs until an e.h.t. pulse is superimposed upon the d.c. The spark gap then breaks down and a.c. current maintained across the gap until the charge is exhausted. The principle has long been in use in stroke tubes and flash guns, where the trigger pulse generates an intense electric field around the tube, which breaks down and discharges the h.t. capacity until extinction voltage is reached. The technique has also been used on electric arc welders to assist in establishing the arc. The components of such a system are under a great deal of stress and it remains to be seen how reliable commercial systems are. It should be possible to design a system which keeps working on the trigger in the event of the h.t. failing. A further concern is that emission of the spark plug electrodes may be accelerated by the intense sparks generated by such systems. The greatest advantage would appear to be in application to lean-burning engines.

This type of spark generation has come to be known as the plasma system. Its disadvantage is that the sparks generated by other systems are not also plasma. Although misnomers already perpetrated by the industry, such as fluid flywheels and shock absorbers, which have come under a great deal of stress, and it remains to be seen how reliable commercial systems are. It should be possible to design a system which keeps working on the trigger in the event of the h.t. failing. A further concern is that emission of the spark plug electrodes may be accelerated by the intense sparks generated by such systems. The greatest advantage would appear to be in application to lean-burning engines.

The advantages of fuel injection are that the engine should always be running at an efficient speed, and that the driver can concentrate more on the road, with a reduction of manual operation of automatic transmission being complunged. With some notable exceptions, current automatic gearboxes rely on a torque converter in order to skim on the number of ratios provided. A torque converter is supposed to be capable of varying ratios to achieve the principal of automatic transmission being comp}

**REFERENCES**

11. Electrical System. *Common-bus vehicle wiring, multiplexing and transference of data to display*
12.漖 ABASIA AUGUST 1981

**Fig. 5. Basic electronic (indirect fuel injec**

**Fig. 6. Eight-speed automatic gearbox with three stages combined in binary sequence. Micro processors inputs to arrive at correct engine power to the gearbox proper. The advantages of fuel injection are that the engine should always be running at an efficient speed, and that the driver can concentrate more on the road, with a reduction of manual operation of automatic transmission being comp.
Although capacitance smoothed dc power supplies are common electronic circuits, surprisingly little has been written on how to design them. Much of what has been published gives the impression that a resistive-valve bridge provides it is large enough for the peak-to-peak ripple voltage, \( V_{ripp} \), across it to be a small fraction, say 5\%, of the dc voltage. As shown later, the performance can be easily evaluated by taking \( V_{ripp} \) to be infinite. The ripple voltage is conservatively given by

\[ V_{ripp} = \frac{1}{2} V_e \frac{1}{n} \left( \frac{1}{R_2} + \frac{1}{R_1} \right) \]

where \( V_e \) is the dc output, \( f \) is the mains frequency, and \( n \) is for the circuits in Fig. 1, and 2, for the circuits in Fig. 2. A better approximation for \( V_{ripp} \) is given in equation 11. With 50 Hz mains, \( C_{dc} = 10,000 \mu F \) is about 1\% for a full-wave circuit.

For a second assumption concerns \( V_{osc} \), the forward voltage drop in the rectifiers, which depends on the rectifier peak current is but is unlikely to be more than 1.5V for a silicon device. The design procedure assumes that the rectifiers are ideal, infinite resistance in the reverse direction and zero resistance in the forward direction. When calculating the dc voltage, \( V_{osc} \), from a specified transformer, subtract \( V_{f} \) from the voltage obtained for ideal rectifiers. When choosing a transformer, start by adding \( V_{osc} \) to the required value of \( V_{osc} \). Except for very low currents, \( V_{osc} \) should be taken as 1V per diode, i.e. 2V for a bridge rectifier. Look into the electronic capacitor and in any reverse biased rectifiers causes a voltage drop of up to 0.7V, the forward biased rectifiers. However, \( V_{osc} \) is usually calculated at zero output current so that components with a suitable voltage rating can be chosen, and it is therefore advisable to consider \( V_{osc} \) too.

Transformer considerations

Copper losses are important when determining the transformer performance. Ready made transformers are usually described by some of the following parameters:

- \( P_{core} \) — rated m.r. primary current.
- \( P_{secondary} \) — rated m.r. secondary voltage or the secondary voltage when the current is
- \( \frac{V_{dc}}{V_{rms}} \) — open circuit m.r. secondary voltage.
- \( \frac{V_{rms}}{V_{osc}} \) — regulation (or \( \frac{V_{rms}}{V_{osc}} \))

For a custom designed transformer or one whose parameters are found by measurement, the most readily available quantities are usually

- \( R_1 \) and \( R_2 \) — primary and secondary resistances.
- \( n \) — turns ratio, given by \( V_{osc} = n V_e \frac{1}{n} \).
- \( R_2 \) — output resistance, given by (R)WIRELESS WORLD AUGUST 1981

Simplified design of dc power supplies

Design considerations and formulae for common circuit configurations

by J. C. S. Richards

Transformer considerations

Copper losses are important when determining the transformer performance. Ready made transformers are usually described by some of the following parameters:

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- \( n \) — turns ratio, given by \( V_{osc} = n V_e \frac{1}{n} \).
- \( R_2 \) — output resistance, given by (R)

Because simplified design methods are particularly useful when only a few items are needed as Guidelines, transformer formulas are used, the outline below use the first set of parameters. If the second set is preferred, a conversion can be achieved using

![Fig. 1. Full-wave rectifier circuits. (a) Half-bridge, (b) dual bridge, (c) centre-tapped bridge, (d) two phase. In the design formulae for the bridge circuit, \( V_u \) and \( V_a \) are the ratings for each secondary, For the two-phase circuit, the rating of each secondary is \( V_u \).](attachment://Fig. 1. Full-wave rectifier circuits. (a) Half-bridge, (b) dual bridge, (c) centre-tapped bridge, (d) two phase. In the design formulae for the bridge circuit, \( V_u \) and \( V_a \) are the ratings for each secondary, For the two-phase circuit, the rating of each secondary is \( V_u \).)

![Fig. 2a. Half-wave circuit, (b) symmetrical voltage doubler.](attachment://Fig. 2a. Half-wave circuit, (b) symmetrical voltage doubler.)
The relations

(1) \( r = \frac{v}{v_0} \frac{v_{Rc}}{R_c} \)

(2) \( v = \frac{v_0}{v_{Rc}} \frac{v_{Rc}}{R_c} \)

(3) Tolerances are rarely quoted for transformers and it is not uncommon for the open circuit or secondary voltage to be 5% adrift and the regulation, which is often given as a typical or a maximum value for a broad range of transformer, to be 10% or 20% different. However, these errors usually combine to make the full load voltage within about 2% of its nominal value.

When a transformer has more than one secondary winding, the variation of output voltage with load becomes more complicated because current drawn from one secondary affects the voltages on the rest. However, for a transformer with two similar secondaries, each parallel to the line current, the behaviour can be described in terms of \( v_2 \) and \( v_4 \) above. This is the series and parallel connection of secondaries and the rectifier circuits in Fig. 1(b) and (c). For the two-phase circuit in Fig. 1(d), the r.m.s. current in each secondary is the same, but the current flows in only one secondary at a time. To compare this circuit with a bridge rectifier using both secondaries in parallel, suppose that \( v_2 \), \( v_4 \), \( r_2 \), \( R_c \) and \( R_2 \) are the transformer parameters when the secondaries are in parallel. In this case the ratio of each secondary \( v_2 \) to its resistance is 2\( R_2 \). If current is taken from only one secondary instead of both in parallel, the total r.m.s. current which can be drawn without overheating is \( I_{0R}^2+I_{0P}^2 \) and the effective output resistance is increased to \( R_{2P} \), where

\[
\begin{align*}
K = & \Delta \left( R_2 + R_4 \right) \\
& \Delta \left( R_2 + R_4 \right) \\text{(4)}
\end{align*}
\]

The value of \( k \) must lie between 1 and 2, and this expression is approximately true for a transformer designed to have equal primary and secondary copper losses in normal operation.

Design formulae

A characteristic of capacitance smoothed rectifier circuits is that the currents in the transformer and rectifier are pulsed. The performance is easily calculated using a model of a single secondary. The equivalent circuit is shown in Fig. 2(a). The transformer is represented by the transformer current \( i_1 \), the capacitor is represented by \( C \), the load is represented by \( R_L \), and the instantaneous voltage across the load \( v_L \), is given by

\[
\begin{align*}
v_L = & \frac{1}{C} \int \left( v - i_1 \cdot R_L \right) \, dt \\
& \text{(2.6)}
\end{align*}
\]

In the above expressions, \( i_1 \) is the primary current. \( C \) is the value of the coupling capacitor and \( v \) is the transformer voltage across the primary winding. \( R_L \) is the resistance of the load connected to the transformer.

Choosing a circuit

The choice of circuit is usually between a bridge and a two-phase design. Overall the two-phase circuit is usually better if the area is cheap at low voltages and the bridge is better, but the differences in cost and efficiency are small and often less important than the availability of components.

For example, the two-phase bridge has a natural advantage at high voltage. For the two-phase bridge, the secondaries are relatively short and their rating is less than the transformer rating. If the primary current is taken from the transformer, the transformer current is shown in Fig. 2(b), which is displaced from each other by half a cycle. The curve is the most economic way of obtaining a high voltage. The桥形电路的电流和电压是

\[
\begin{align*}
\text{Current } & = \frac{1}{2} v_1 \cos \omega t \\
\text{Voltage } & = \frac{1}{2} v_1 \sin \omega t \\
& \text{(3.1)}
\end{align*}
\]

As a general guide, for outputs between 10 and 100 VA, a regulation of about 0.1% is a good compromise and suitable transformers are readily available. Transformers with a low power rating, <100A, are not much cheaper than larger types and, because the relatively larger surface permits a higher current density in the copper, a larger fraction of the winding area is occupied by insulation which tends to reduce the copper losses and hence the overall efficiency.

For a bridge or a two-phase circuit when the transformer is at current \( I \), the transformer should be about \( 0.8 \) VA and from equations 5 to 11 the following values are found. The figures in brackets are calculated and measured values of \( V_{DC} \). The transformer current is shown in Fig. 4(b), and the voltage across capacitance \( V_{DC} \) is

\[
\begin{align*}
\text{For a two-phase circuit, assuming } & k = 1.5, \text{ the following values are obtained} \\
& v_{DC} = 0.7(0.6) \text{V (0.6V)} \\
& \text{For a bridge circuit, assuming } & k = 1.5, \text{ the following values are obtained} \\
& v_{DC} = 0.7(0.6) \text{V (0.6V)} \\
& \text{Fig. 4(c) and because } & (k+1)b, \text{ is approximately } \\
& \text{the repetition time of } & \text{(3.2)}
\end{align*}
\]

From Fig. 4(c) and because \( (k+1)b \) is approximately equal to the repetition time of the ripple is \( \frac{1}{b} \).

References


Effect of finite capacitance

The ripple voltage across capacitance \( V_{DC} \) is associated with a fast triangle waveform, the diagram in Fig. 4(e) is produced where \( V_{DC} \) and the voltage across a finite capacitance \( V_{DC} \) is shown together. The voltage across the capacitor is given by \( \frac{1}{2} V_0 \cos \omega t \), but the improvement is small if the ripple is small. For example, the change in voltage for a bridge system is around \( \frac{1}{2} V_0 \cos \omega t \), which is <1% provided that \( V_0 \) is small and a transformer with \( r > 0.05 \) is used to ensure the maximum capacity. With such an improvement is justified, a more accurate relationship for the rectifier may be given by \( V_0 \) and the voltage drop should be used. The discharge current out of the capacitor is therefore, if \( u_0 \) discharges for time \( t \),

\[
\begin{align*}
& u_0 = \frac{1}{2} V_0 \cos \omega t \sin \omega t \\
& \text{Because the average value of } & u_0 = \frac{1}{10} V_0 \cos \omega t \\
& \text{is given by} & \frac{1}{\sqrt{2}} \frac{1}{2} V_0 \cos \omega t \\
& \text{This equation can be solved by trial and error or by the} & \text{truncated power series in 0 and then using} \\
& \text{Newton's approximation to obtain equation} & \text{(3.4)} \\
& \text{above.}
\end{align*}
\]
Programmable sound-generator interface

Although the AY-3-8910 programmable sound generator was designed for use with a microprocessor, it can only be directly used with CP1600/1610 devices. This disadvantage allows up to four generators to be controlled by the popular Z80 using I/O instructions.

The AY-3-8910 programmable sound generator, p.s.g., i.e., in a 40-pin i.e., containing 14 read/write registers which determine tone frequency, noise amplitude and envelope shape on three separate audio output channels. These features make the device suitable for computer control and, with simple programming, a wide range of musical and non-musical sounds can be produced.

Fig. 1. Interface decoding logic for two programmable sound generators.

Once programmed, the p.s.g. can produce and sustain a particular sound without further control from the computer, and several devices can generate elaborate contrapuntal effects.

Individual registers in the device are accessed and written/erased via an 8-bit bidirectional bus which is controlled by BDIR, BCI and B2C signals. If B2C is connected to +5V, bus control can be achieved with the signals shown below.

The BDIR BCI Function 0 0 bus inactive 0 1 read data from latched p.s.g. register 1 0 write data to latched p.s.g. address 1 1 latch register address

The BDIR and BCI signals are directly available from CP1600/1610 processors, but with other microprocessors they must be simulated and synchronized to allow data transfer between the processor and p.s.g. bus.

The AY-3-8910 also has an independent general purpose 8-bit I/O channels, registers 14 and 15, which have no effect on the sound generation. These are equivalent to a Z80 p.i.o. without the handshaking lines and interrupt facility, and can be used, for example, to read a keyboard.

Fig. 2. Control circuit for one or two p.s.gs. Z80 connections are marked with a circle.

DISTORTION AT THE AMPLIFIER–SPEAKER INTERFACE

The two-part article "Intermodulation distortion at the amplifier–speaker interface" by Canada's Telecommunications Engineer, Professor McLeod and G. Shepherd, published in the February 1981 issue of Wireless World contains some serious flaws.

The authors have a copy of an Audio Engineering Society preprint, No. 1336 of February-March 1978. Its authors are aware of at least three independent rebuttals of that preprint, one of which has already been published. This published rebuttal is by R. R. Cordell of Bell Telephone Laboratories, and is also available as AES Convention preprint No. 1337 of November 1979, under the title "Open-loop output impedance and intermodulation distortion in audio power amplifiers." One of the unpublished rebuttals is by E. M. Cherry and G. K. Cambrell of Monash University. Originally submitted to the AES Journal in February 1979, a rebuttal to the Cordell article was submitted in October 1980 under the title "Output stages of audio power amplifiers: a review of the intermodulation distortion problem." Cherry and Cambrell make the following comments:

1. If an amplifier uses a common-emitter output stage then, if collector resistance is varied without changes in any other parameter, intermodulation distortion, i.m., increases monotonically as collector resistance is reduced.

2. If an amplifier using a given transistor has a common-emitter output stage, and if this is changed to the common-collector configuration and nothing else is changed except the phase of the feedback connection, i.m. at best remain constant but is more likely to increase.

Taken together, 1) and 2) are absolutely contrary to the suggested "rule" of providing a lower load output resistance (rfw Dec. 1980, p.50).

1) For practical purposes, a loudspeaker is passive and cannot inject a signal back into an amplifier. (2) The transistor is m.p. produced by sources incident on the loudspeaker cone from room or enclosure reflections of from other sources is measured in comparison with the open circuit output voltage. Substantial c.m. m.p. results from the signal applied to the loudspeaker and loudspeaker interface. However, the substitution (or compensation) theorem of network theory shows that an active network which models a loudspeaker and includes such a motional e.m.f. can be replaced identically by the passive RC lattice that completely models the driving-point impedance of the loudspeaker. A loudspeaker is a highly passive so far as any applied electrical signal is concerned, and there is no possibility of i.m. as defined because there is no independent signal source in the load.

4. i.m. is proportional to a product of output current amplitudes in Fig. 4. The constant of proportionality depends on the detail of the circuit, but cannot exceed the constant in a standard two-tone intermodulation test. i.m. at given output current amplitudes cannot exceed standard intermodulation at the same current amplitudes.

Taken together, 3) and 4) suggest that the distortion power produced in a real-life situation by the interface intermodulation mechanism is minuscule compared with the distortion power produced by the standard intermodulation mechanism.

Edward M. Cherry
Deartment of Electrical Engineering
Monash University
Chang, Victoria, Australia

The authors reply:

We are not aware of any rebuttals of our AES paper. The paper of Cordell is based on different premises from ours. Cordell purports to demonstrate that the amplifier open-loop distortion to be constant in the compression, whereas our analysis is based on the closed-loop distortion being held constant. This difference is grounded in our fundamental treatment of such conditions taken into account. Cordell's results are in agreement with ours and the paper can hardly be considered a rebuttal. In many cases, other references quoted are unknown to us, and will be considered if and when available.

The points the writer makes sound familiar to us as if they were our own results taken from our paper:

1. This conclusion is a corollary to our paper. We assume the amplifier closed-loop distortion to be constant, which is a real-life engineering consideration, as discussed in our paper. Cordell's assumption is that the open-loop distortion is constant and the amount of overall negative feedback varies with the collector resistance. This leads to complete agreement with our results, if allowance is made for the different boundary conditions. However, we doubt if the writer's case could be realistic in practice. 2. Our theory shows that the i.m. in this case should in principle remain the same just as the writer states. We cannot see any theoretical discrepancy here either. Nevertheless, this kind of a hat-trick would be impossible in practice, and practical measurements show the common-emitter stage to be inferior because of larger closed-loop distortion.

As we submit this point with as, is stated in our paper, (b) As far as the loudspeaker is concerned, this is just a matter of definition. We wish to point out that the proposed i.m. measurement method was not conservative in simulating the physical loudspeaker. But just to expose the amplifier output port to such a real-case current and voltage relationships which might occur when real loudspeaker loads are being driven.

4. This is a reprinting of the opening paragraph of Part 2 of our paper. In many cases, i.m. will be negligible as compared to the COF-two-tone i.m. However, in a poorly designed amplifier, i.e., as shown in our Fig. 14, it may equal in magnitude the two-tone i.m., as can be seen from our Figs. 15 and 17.

In conclusion, the letter does not seem to indicate any flaws in our paper, on the contrary. Many a thing may seem controversial if viewed from different positions. However, a more thorough examination which takes into account the different sets of boundary conditions show no conflict to exist.

Mark Otsa, Ferma Lamminen, Technical Research Centre of Finland, Oulu, Finland
As the step advances further ahead, extra electrons appear in locations such as that shown in the TEM step guided between two conductors. However, the step does not continue to fill in the new E lines involved in the next gap and therefore there is no increase in the thickness of transmission line width.

It would seem from the successes we have had in electromagnetic theory (i.e., radio and stereo systems available to so many people) that our second fundamental concept must be quite a valid and useful way of thinking. I am also a little to see how Mr Cart can develop his theory of the barrier and resistance with the energy current entering the resistor sideways at p. 50. December issues are giving such useful material. The stereo's electronic circuits are still a mystery, even for those of us that are familiar with the simple circuit; therefore if we were able to solve this problem we would certainly be a step closer to understanding the whole device. It would seem, however, that at least to look at the theory behind the problem of the stereo is not as clear as raising it above the ground. The telephone's process. We cannot accept this theory as the only solution, but we can accept it as a step closer to understanding the problem.

As to the electron, although I may allow the existence of the standing-wave electron, I find the second part of the last paragraph, like Osiander, is incorrect. If I have not the privilege of coming to the main theme of the last paragraph, I find that I am not so much in favor of Theory C, which merely removes the possibility of any such other devices but does not clearly explain why the interference current is so much. The author replies: I think the first part of the last paragraph, like Osiander, is wrong. It is a pity that virtually no radio astronomy scientists are so familiar with this important concept. I find it difficult to accept the argument for the man made devices, because it is clear to me that any increase in the thickness of the wire is merely an effect of the change in the resistance.

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Hergebert Dingle

Perhaps I may be permitted to make a brief reply to Dr Wilkie's lengthy attack in the June issue. It may, I suppose, one day be possible to explain that in quoting his father's obituary notice, Dr Wilkie was accused of 'dangerous obscurantism'. As to the second part of the last paragraph, I am not so much in favor of Theory C, which merely removes the possibility of any such other devices but does not clearly explain why the interference current is so much. The author replies: I think the first part of the last paragraph, like Osiander, is wrong. It is a pity that virtually no radio astronomy scientists are so familiar with this important concept. I find it difficult to accept the argument for the man made devices, because it is clear to me that any increase in the thickness of the wire is merely an effect of the change in the resistance.

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LOW-NOISE AMPLIFICATION

In his "Introduction to low-noise amplifier design", J. D. G. Pratt gives a rough system by using my Motorola 6000 evaluation kit Apple II and TRS80. I got rid of the interference by shielding the system completely, which is the least expensive means in terms of time and money. Many power supplies are filtered and data ports are decoupled by bi-polar caps, but in my opinion today's microcomputers are very prone to radio frequency interference. They can be shielded in a cabinet, large p.c. boards, small power supplies, and printed circuit boards (decoupling capacitors).

The author replies: The extent of any print-through is a function of the tape, is the situation responsible for the distortion components. The author replies: The extent of any print-through is a function of the tape, is the situation responsible for the distortion components.

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MICROCOMPUTERS FOR SCHOOLS

While most of us are expert in the field of microcomputers (I am a full-time professional in this field) we need to be aware that the students in schools know a great deal about the subject. In some cases, they are more knowledgeable than we are! As a microcomputer consultant in schools, I have come across a number of interesting situations and would like to share them with you.

One of the most interesting situations occurred at a recent meeting of the Inner London Education Authority (ULEA). The meeting was being held in the main conference room of the Inner London Education Authority offices. It was an important meeting, as it dealt with the future of microcomputers in the schools.

During the meeting, one of the teachers asked me if I could give a presentation on the use of microcomputers in schools. I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a second presentation on the use of microcomputers in schools. I was taken aback, as I had already given a presentation on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a second presentation on the subject. She asked if I could give a second presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a third presentation on the use of microcomputers in schools. I was taken aback, as I had already given two presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a third presentation on the subject. She asked if I could give a third presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a fourth presentation on the use of microcomputers in schools. I was taken aback, as I had already given three presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a fourth presentation on the subject. She asked if I could give a fourth presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a fifth presentation on the use of microcomputers in schools. I was taken aback, as I had already given four presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a fifth presentation on the subject. She asked if I could give a fifth presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a sixth presentation on the use of microcomputers in schools. I was taken aback, as I had already given five presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a sixth presentation on the subject. She asked if I could give a sixth presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a seventh presentation on the use of microcomputers in schools. I was taken aback, as I had already given six presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a seventh presentation on the subject. She asked if I could give a seventh presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give an eighth presentation on the use of microcomputers in schools. I was taken aback, as I had already given seven presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give an eighth presentation on the subject. She asked if I could give an eighth presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a ninth presentation on the use of microcomputers in schools. I was taken aback, as I had already given eight presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a ninth presentation on the subject. She asked if I could give a ninth presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a tenth presentation on the use of microcomputers in schools. I was taken aback, as I had already given nine presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a tenth presentation on the subject. She asked if I could give a tenth presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give an eleventh presentation on the use of microcomputers in schools. I was taken aback, as I had already given ten presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give an eleventh presentation on the subject. She asked if I could give an eleventh presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a twelfth presentation on the use of microcomputers in schools. I was taken aback, as I had already given eleven presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a twelfth presentation on the subject. She asked if I could give a twelfth presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a thirteenth presentation on the use of microcomputers in schools. I was taken aback, as I had already given twelve presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a thirteenth presentation on the subject. She asked if I could give a thirteenth presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a fourteenth presentation on the use of microcomputers in schools. I was taken aback, as I had already given thirteen presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a fourteenth presentation on the subject. She asked if I could give a fourteenth presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a fifteenth presentation on the use of microcomputers in schools. I was taken aback, as I had already given fourteen presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a fifteenth presentation on the subject. She asked if I could give a fifteenth presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a sixteenth presentation on the use of microcomputers in schools. I was taken aback, as I had already given fifteen presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a sixteenth presentation on the subject. She asked if I could give a sixteenth presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a seventeenth presentation on the use of microcomputers in schools. I was taken aback, as I had already given sixteen presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a seventeenth presentation on the subject. She asked if I could give a seventeenth presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give an eighteenth presentation on the use of microcomputers in schools. I was taken aback, as I had already given seventeen presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give an eighteenth presentation on the subject. She asked if I could give an eighteenth presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a nineteenth presentation on the use of microcomputers in schools. I was taken aback, as I had already given eighteen presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a nineteenth presentation on the subject. She asked if I could give a nineteenth presentation on the use of microcomputers in schools.

I agreed, and the presentation was well received. However, after the presentation, one of the teachers approached me and asked if I could give a twentieth presentation on the use of microcomputers in schools. I was taken aback, as I had already given nineteen presentations on the subject.

The teacher explained that she had a number of questions about the use of microcomputers in schools, and that she had been asked by her students to give a twentieth presentation on the subject. She asked if I could give a twentieth presentation on the use of microcomputers in schools.
Satellite tracking by home computer

Both software and aerial rotator interface for the scientific computer
by Neoklis Kyriazis, B.Sc.

This two-part article describes a tracking system for circular orbiting satellites using the Wireless World scientific computer. Part one, this issue, deals with the interface circuit for controlling the aerial azimuth and elevation angles, and with aerial rotators and their mountings. In the next section, the Basic/machine-code program will be presented. This program processes the satellite orbit parameters and converts data for use with the interface.

Many home computers are capable of handling the arithmetic necessary for tracking a satellite but they require large amounts of software to make them behave as a numeric calculator. The Z80/MM57109 combination used in the Wireless World scientific computer enables the complex trigonometry involved in satellite elevation and azimuth angle calculations to be processed with a minimum of software. For the program used here, the MikIII BURP interpreter must be installed in the computer.

Although the program was written for tracking the Amsat Oscar series, any satellite on a circular orbit can be tracked by inserting the relevant parameters in the BURP program.

Aerials and rotators

The aerial system used by the author for tracking Oscars 7 and 8 comprises two yagis, one of eight elements for 145.9MHz and one of 16 elements for 435.1MHz. One aerial is mounted at each end of a 1.5m long tube supported centrally by a 150°-to-150° loop. The aerial is mounted on a metal plate with a tube welded underneath it which is supported by a second rotator for controlling the azimuth angle.

The Alliance U-200 ‘Tenna rotor’ type aerial rotators used by the author have a four-core control cable; two of these cores are for forward/reverse control of the motor, one for the ground connection and one is connected to a cam switch that controls and opens for every 10° rotation of the driven shaft. Semi-air spaced 75 ohm coaxial cable is used to feed the aerials. This type of cable is efficient even at u.h.f. but a matched pre-amp is required for Mode J down-converts. Note that in the system described here, aerial elevation is increased by counter-clockwise rotation of its rotor while the inverse applies for the azimuth rotor.

There is a mechanical stop in the rotators used by the author which prevents the aerial turning through more than 360°. This means that if the satellite’s azimuth changes from 0° to 360° the rotor must turn through 360° before it can resume tracking. As it takes more than a minute for the rotor to make one full turn, the program is arranged so that it calculates orbits passing north of the ground station and adds 180° to the result while keeping 180° elevation so that the aerials rotate in the right direction. The same problem does not apply to the elevation rotor.

The interface

Digital information from the computer drives the two aerial rotators via an interface. This interface also conveys information relating to the positions of the aerials back to the computer. As mentioned earlier, a cam switch on the shafts of the rotators opens and closes for every 10° of shaft rotation. One contact of the switch is connected internally to ground and the other is tied externally to +5V via a 2k2 ohm resistor. A 100μF capacitor and a 220 ohm resistor are used at these connections as a.c. caused by switching high motor currents may affect the operation of the computer.

Each time the cam switch closes and opens, the voltage across one of the two 100μF capacitors shown in Fig. 1 produces an 0° level pulse which is fed into the computer via the 0 input port. The program counts these pulses to keep track of the position and although resolution is only 10°, reception of Amsat Oscar 8 in Mode J using a 10-element yagi is not affected by the error. If a highly directional aerial is to be used, some more accurate method of feedback may be needed.

Each rotor motor has two windings at 90° to each other. One end of each winding is connected to ground and a 150μF, non-polarized capacitor is connected between the other two supply inputs. The capacitor provides phase shift in the alternating current supplied to one of the rotor windings. Two relays are used for each rotor; one to switch the 24V supply from one winding to the other to determine the direction of rotation and one to switch the supply in and out. The aerial output of the computer is used to control the motors via a CD4015 in parallel-out shift register which drives the relay coils through four buffer transistors.

An accurate timer is needed to provide the program with real-time information. For this purpose a main-frequency divider chain consisting of a 7400 and three 7490 ICs is used to produce a short pulse every 10 seconds. This pulse activates the maskable interrupt of the Z80 and sends the processor to a routine that increments the value of the real-time variable, named T in the BURP program, by 100μS, i.e., 10 seconds. Since the INT pin of the Z80 is used by the MM57109 some simple modifications are necessary to give an OR function between the timer and the number cruncheer, details of which will be given later.

Circuit details

Figure 1 shows the complete circuit diagram of the rotator controller. Transformer T1 supplies 24V a.c. for the rotor motors and 10V a.c. for the rest of the circuit. Diode D5 and a 2200μF capacitor provide 12V d.c. for the relay coils and for the 5V regulator which supplies the CD4015 c.m.o.s. shift register and the timer section i.e., logic signals to and from the computer are fed through a 6-way DIN socket and to and from the rotors via two 5-way DIN sockets. The buffered D7 line from the computer is connected to the data input of the CD4015 at pin 7 whilst a clock pulse to pins 1 and 9 of the IC is supplied from pin 10 of D6.

Thus, a control word from the computer is fed to the CD4015 in serial form from output port HEX A0. The parallel outputs Q0 to Q3 drive transistors T7 to T10 through 1k ohm resistors and any spurious pulses caused during data transmission are bypassed through 47μF capacitors. Outputs Q0 to Q3 of the 4015 are not used but are available for controlling additional circuits if required. Transistors T10 to T13 drive the four relay coils from the c.m.o.s. shift register outputs so they have a high input. Thus, a Darlington pair can be used if necessary.

Relays RLA and RLG, switch the direction of the elevation and azimuth motors respectively while RLB and RLD switch the 24V a.c. supply to the motors on or off. Each rotor can switch output is tied to the +5V supply through a 2.2k ohm resistor and a 220μF series resistor and 100μA bypass capacitor in each line prevent a.c. from the motor ground return turns passing through to the computer input. When a relay switch is closed a logic ‘1’ is sent by the computer and when a switch is open a logic ‘0’. Switch S4, between ground and the azimuth cam switch input
Radio and the birth of the universe

The cosmic microwave background in the Big Bang theory

by Eric Eastwood, F.R.S.

The radiation which mediated the processes of nucleosynthesis at the birth of the universe and controlled the helium/hydrogen radiation during the inflationary era is one that was cooled by adiabatic expansion, now described as the 3K cosmic microwave background. This article first reviews the growth of radio astronomy from the 1940s until 1964. In 1964, Arno Penzias and Robert Wilson made their momentous discovery of this cosmic radiation background. It outlines the meaning of the programme and the immediate effects of the radiation, offered by Dicke and his colleagues. Also it deals with the measurements presented and the degree of anisotropy in the radio background and describes how the antenna temperature variation led to a determination of the "peculiar" velocity of the galaxy. The theory of the "hot big bang" is touched upon and there is a summary of the modern state of the theory which has been able to build upon the essential fact supplied by the temperature measurement of 3K of the cosmic background – the ratio of the number of photons to the number of nucleons.

When Karl Jansky set up his aerial and receiver system at Holmdel, New Jersey, in August 1931, his purpose was not to launch the science of radio astronomy but simply to use an instrument derived from atmospherics that might occur with new radio circuits being planned to operate in the F band (2–2.5 MHz). From the inception of wireless telegraphy in 1896 long waves had dominanted world radio communications but in the 1920s Marconi showed that cost effective radio systems could be engineered using the so-called short waves. Jansky recognised that the commercial success of such high frequency radio communication circuits depended upon a good understanding of atmospheric interference effects. Such interference was familiar at long waves and varied with the seasons of the year and time of day; little experience of terrestrial interference had been accumulated, however, and these were the effects which Jansky set out to investigate. 

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Fig. 1. Solar (S) and galactic (G) noise signals on the p.p.i. of a metric wave radar.

13.40 HRS.

15.30 HRS.

15.50 HRS.

15.54 HRS.
World Radio August 1981

Theorv of the expanding universe

Improvements in telescopes during the early 18th century were such that astronomers were able to distinguish clearly between the nebulae and other more extended luminous regions which appeared to be of the nature of the Milky Way.
In order to measure the received noise power absolutely a comparison method was employed whereby the receiver was switched between the incoming sky signal and the noise signal delivered by a resistive load placed in the receiver’s high frequency circuit, so that any noise effects in the receiving system were eliminated. Although several precautions to eliminate such effects might still be introduced by noise signals generated in the antenna structure itself, it was believed that this was not an important source of error.

### Microwave radio noise background

Just as Jansky in 1931 was looking for sources and magnitudes of noise that might preclude the performance of a high-fidelity radio communication circuit, so in 1964 two later Bell Laboratory scientists working at the same Holmdel Field Station—Penzias and Wilson—were engaged on a not dissimilar task. Their operational objective was in fact to detect and monitor any radio emissions from the galaxy at microwave frequencies, and also propagation effects in the atmosphere.

In order to study seasonal effects the antenna was set up on the side of a 100-ft diameter balloon made of the same metalized fabric which was erected from a gantry after launch into orbit and inflated from the balloon’s interior. On the other end, a radome was a shielded parabolic antenna which had a very low level back-up, it was virtually impossible to detect the presence of noise from the earth’s surface since all the observations were made in the daytime, the antenna being directed to the zenith. It seemed most unlikely that such a well engineered structure would be weak in a wind, but it was necessary to confirm that such an effect was totally absent before they made their first observations at a wavelength of 10 cm. The magnitude of the interfering emissions from the atmosphere and from myriad of man-made molecules could be allowed for by taking measurements at various angles of elevation.

In spite of these precautions to eliminate all possible sources of error it was found that there still remained a level of noise power in the zenith direction at 10 cm higher than expected and corresponded to a variability of some 3.5 ± 1.0 K. The antenna temperature when directed to the zenith was 6.7 K, even after allowing for the effect of the Earth’s atmosphere and 0.9 K due to back lobe and feed losses. No account could therefore be taken of the variation of the signal could be detected. This was in sharp contrast to Jansky’s original discovery of the radiation from the galaxy and eliminated the galaxy as a source of the isotropic signal. It appeared that the antenna and the earth itself were bathed in the radio flux and the conclusion seemed to be inevitable that the whole universe must be filled with this radiation. This was the microwave background radiation, which is produced by a black body radiation and, if so, what was its significance and from whence had the flux originally derived?

### Anisotropy of microwave background

In the letter to the Astrophysical Journal describing their measurement of the 3.5 K excess antenna temperature Penzias and Wilson stated, “This excess temperature is, we believe, a very real and consistent isotropic, unpolarized and free from seasonal variations”. This question of isotropy was of course of concern to workers at the same time as the back body nature of the radiation was being established. In their work at the same time much of the radio based experiments had permitted any anisotropy to pass unnoticed. Later, when observational limits began to be less than one part in five hundred, which corresponds to a few millidegrees in the angular diameter, it became necessary to define this measurement still further it was necessary to try and reduce this source of interference – which was Jansky noise from the galaxy, but at microwave frequencies. Radio astronomers have shown that such radiation is indeed produced by the motion of energetic electrons, not in the simple thermal agitation model of the hotter hot black body, but by spiralling about the lines of force of the galactic magnetic field – the so-called synchrotron effect.

Such synchrotron emission falls off with the square of the frequency, so that for two selected wavelengths this galactic noise interference would be reduced and, at the same time, a radio signal originating in the cosmic background would be increased. This was the observational problem that Mulder and his colleagues at the University of California when planning an experiment sensitivity and could be identified as the time when the expansion of the universe in which the temperature difference between the two sky regions could be measured. Microwave astronomers in the millimeter region set up their antenna on the beam of the antenna due to the diurnal rotation of the earth; the same is substantially the same as when a radiation thermometer is used in an aircraft.

In order to study seasonal effects the right programme extended over the whole of 1977 and clearly revealed that some new method of comparison was needed. They found that the temperature of the sky varied smoothly according to a cosine law from a minimum in December at the constellation Leo to a maximum in the summer at the constellation Virgo. The temperature differences between these two directions and the central point of the sky were extremely small and the observed effect was attributed to the velocity of the receiving antenna with respect to the cosmic microwave background.

When Lord Kelvin made his calculation of the age of the earth, based upon the cooling of a large sphere from an initial high temperature, he recognized that his estimate was much too high to satisfy the geologists and he included in his thermodynamic argument the effect that there might be within the earth some undiscovered source of heat that would lengthen the time scale. We now know that certain nuclei disintegrated in the earth, which was to provide the answer to Kelvin’s objection. This was due to the decay of neutrons to protons, and the energy released was sufficient to cool the earth. Later it was discovered that this was one of the many examples of the Mexican hat or Mexican hat potential, which is a form of the black body character of the radiation almost throughout the visible spectrum. The temperature of the microwave background due to the characteristic dipole dependence of the velocity of the galaxy.

When’s law the typical wavelength is inversely proportional to the intensity of the radiation field, or $T_e = 300$ K in the 10 cm band. This was the design decision made by Muller and his colleagues at the University of California when planning an experiment sensitivity and could be identified as the time when the expansion of the universe in which the temperature difference between the two sky regions could be measured. Microwave astronomers in the millimeter region set up their antenna on the beam of the antenna due to the diurnal rotation of the earth; the same is substantially the same as when a radiation thermometer is used in an aircraft.

### Cosmic role of radiation

Most important of the contributions to cosmology which stem from knowledge of the nature of the cosmic microwave background is the fact that the temperature of about 3 K is the fact that it permits the estimation of the ratio of the number of deuterium to hydrogen. This is the so-called D/H ratio or the number of deuterium nuclei in the present universe. This ratio would have been maintained...
was in thermal equilibrium. The principles

two reactions:

the temperature is well above the threshold

indicates that 8% of the atoms are helium, 0.1%

prepared the essential material from which

hydrogen; thus the percentage by weight

abundance of various nuclei in our galaxy

taken as a mix of protons and neutrons at a

photons of the radiation (5.9×

processes

radiation which controls the reactions at

to

accurate calculations shows the figure to be

 tons per litre is in the order of a million;

of the peak emission is about 1mm. Now

and in particular, to monitor the produc­

is necessary to study the progress of the

to Weinberg

lived long enough to be

conversion in the presence of a strong radiation field

came transparent to radiation; expansion

of the radiation and matter followed,

were rapidly converted into helium. Thus

in the presence of a strong radiation field

in the early universe that

preceded the

11 states of the early universe that

WIRELESS WORLD AUGUST 1981

Digital storage and analysis of speech

2 – Coding in the time domain

by Ian H. Witten, M.A., M.Sc., Ph.D., M.I.E.E., University of Calgary

The modern version of the Big Bang

cosmology has already achieved some notable successes, not least being the way it has

been able to explain the origin of the cosmic microwave background. Steven Weinberg,

awarded a Nobel Prize in 1979 for his work in particle physics, discusses in

his exciting book "The First Three Minutes" the early universe that may have preceded the 108 K stage which was taken as the starting point of this

study. However, many of the problems in particle physics are involved in the description of the back-burning of the universe in time. What is certain is that the present

theory of the foundation of the universe

predicts that the universe will continue to expand for a long time. Then further research and

searches the need for more observations, many of which will have to be performed

in space vehicles. The techniques at least of microwave communica­

Sylvan coding

We have already studied one time-domain

coding technique, namely logarithmic quantization, or log p.c.m. (sometimes

"constant modulus coding"). A more sophisticated encoder could track

slowly varying trends in the overall ampli­

tude of the speech signal and use this infor­

mation to adjust the quantization levels

independently for each frequency. Speech coding methods based on this principle are called adaptive pulse code modulation systems (a.p.c.m.). Because

the overall amplitude changes slowly, it is sufficient to adjust the quanti­

zation levels relatively infrequently (compared with the sampling rate), and this is

often done at rates approximating the syllable rate of running speech, leading to the term

"syllabic companding". A block floating­

point format can be used, with a common exponent being stored every M samples

(with M, say, 125 for a 100 ms block rate at 8 kHz), followed by the actual difference

in the block. Thus

M ∑ ≠ k (x(n) − x̂(n+k))2

is used to determine a suitable exponent, and every sample in the block – namely

x(k), x(k+1), ... x(k+M−1) – is scaled according to that exponent. Note that for

speech transmission systems this method necessitates a delay of M samples at the encoder, and indeed some methods base the exponent on the energy in the last M blocks to avoid this. For a given speech signal, however, the delay is irrelevant. A rather different, nonsylvan, method of adaptive p.c.m. continues to change the step size of a uniform quantizer, by multiplying it by a constant at each sample which is

given by

(1 − 10−11)

where the parameter α is adapted (and stored) on a syllabic time-scale. This leads to a slight improvement in signal-to-noise ratio which is combined with the adaptation by quantization. Much more substantial benefits can be realized by using a weighted sum of the past several

difference signal for a given overall

Actually, the improvement is not all that

great – about 4–5 dB in signal-to-noise ratio – or just under one bit per sample for a given signal-to-noise ratio – for the differ­

ence signal can be nearly as large as the basic signal level.

If p.c.d.m. is used in conjunction with adaptive quantization, giving one form of

adaptive differential pulse code modulation (a.d.p.c.m.), both the overall ampli­

tude variation and the sample-to-sample correlation are exploited, leading to a com­

bined gain of 10–11 dB in signal-to-noise ratio (or just under two bit reduction per sample for telephone-quality speech).

Reference

1. Karl G. Jansky. "Directional Studies of Atoms in

Weather at High Latitudes", Proc.


2. Karl G. Jansky. "Electrical Disturbances

in the Immense Radio-Absorbing Layer in


4. E. Eastwood. "Some New Applications of


Deficiency in the Absorption at a Temperature of

742, 419, 1963.

6. R. H. Dick, P. J. E. Peebles, P. G. Doll, and

D. Wilson. "Cosmic Black Body Radiation

at a Temperature of 2.73 K.", Nature, 214, 1965

7. E. E. Mullin. "The Cosmic Background


at a Temperature of 0.1 mK.", Science, 182, 215, 1975.


Fig. 6. Conversion hardware for delta modula­

tion.

www.americanradiohistory.com
Delta modulation

The coding methods presented so far all increase the complexity of the analogue-to-digital interface (or, if the sampled waveform is coded digitally, they increase the processing required before and after storage). One method which considerably simplifies the interface is the limiting case of p.c.m. with just 1-bit quantization, in which only the sign of the difference between the current and last values is transmitted. Figure 9 shows the conversion hardware. The encoding part is essentially the same as a tracking d-a converter, where the value in a counter is forced to track the analogue input by incrementing or decrementing the counter according as the input exceeds or falls short of the analogue equivalent of the counter's contents. However, for this encoding scheme, called "delta modulation", the increment-decrement signal itself forms the discrete representation of the waveform, instead of the counter's contents. The analogue waveform can be constituted from the bit stream with another counter and d-a converter.

However, an all-analogue implementation can be used, both for the encoder and decoder, with a capacitor as integrator whose charging current is controlled digitally. This is a much cheaper realisation.

It is fairly obvious that the sampling frequency for delta modulation will need to be considerably higher than for straightforward p.c.m. Figure 10 shows an effect called "slope overload" which occurs when the sampling rate is too low. Either a higher sample rate or a larger interval between samples will reduce the overload; however, larger steps increase the noise level of the alternate 1s and 0s which occur when no input is present - called "granular noise".

A compromise is necessary between slope overload and granular noise for a given bit rate. Delta modulation results in lower data rates than logarithmic quantization for a given signal-to-noise ratio if that ratio is low (poor-quality speech). As the desired speech quality is increased, its data rate grows faster than that of logarithmic p.c.m. The crossover point occurs at a much lower rate than would be needed for telephone quality speech, and so although delta modulation is used for some applications where the permissible data rate is severely constrained, it is not really suitable for speech output from computers.

It is profitable to adjust the step size, leading to adaptive delta modulation. The common strategy is to increase or decrease the step size by a multiplicative constant, which depends on whether the new transmitted bit will be equal to or different from the last one. That is, stepsize (n+1) = stepsize (n) x 2 if x(n) = x(n+1), or stepsize (n) x 0.5 if x(n) ≠ x(n+1) (slope overload condition); stepsize (n+1) = stepsize (n) if x(n) = x(n+1), x(n+1) = 1-x(n) (granular noise condition).

Programmable sound generator interface

The interface decoding logic, shown in Fig. 1, uses A0-A7, J0 and WR signals from the Z80 and four i.c.s to provide BCI and BDIR signals for two p.s.g. The two separately addressable p.s.g.s require four Z80 addresses, which can be selected by using one or more of the three spare gates to invert the address lines before IC 1.

The p.s.g.s are programmed by latching their relevant register and then writing or reading data. The following instructions must be achieved with the following instructions:

L.D.A   R is the p.s.g. register address (up to 15)
OUT (252), A latch register address R in p.s.g. 1.
L.D.D   D = output data, D = 0-255
OUT (253), A output data to latched register in p.s.g. 1.
 Maiden character and dot-row code bits to 745262

Literature received

Monthly news sheets, which contain details of a host of electronic components, accessories and instruments, are sent out free of charge by J. Bull (Electrical) Ltd, 346 America Lane, Haywards Heath, West Sussex RH16 3QU.

Instruments and accessories for measurement and test, and a number of instrument case are illustrated and specified in a catalogue from Global Specialities Corporation, Short Hill, Distary Estates, Units 1 and 2, Saffron Walden, Essex CB11 3AQ.

A large range of active and passive components for thick-film hybrid circuits is fully detailed in a new catalogue from Norsem Thick Film Products, Level 1, The Civic Centre, Harrogate, Cleveland.

Improving the 74S262 character generator

A disadvantage of the 74S262 character generator is that it is the display output for zero and upper-case O are identical. This circuit simulates the style of zero found in other types. The ISO-7 code for zero, 011000, is converted to letter A, 000000, and the dot-row address is modified so that the lower half of the displayed character is a reflection of the upper half. Because only the address inputs to the r.o.m. are modified, other functions such as character rounding are not affected. This change can be included to disable the circuit if required.

A. Pemberton
Sheffield

Voltage-change detector

This detector produces a negative pulse when the input voltage changes direction by more than about 15mV. The differentiator in section A detects and amplifies the leading edge of a voltage change and the output switches positive or negative depending on the polarity of the input voltage change. Section B converts any pulses from IC 1 which are 4.5V or greater to negative pulses. Section C is standard monostable circuit with a delay of 5s set by the RC network. The output goes high on the falling edge of the pulse. Section A is necessary if the detector is used with a cadmium sulphide cell or a thermistor. The voltage fed to the detector input is restricted to between 1/3 and 2/3Vcc. Other op-amps can be used for IC1 provided they have an input impedance of around 20MΩ.

M. L. Ford
Wincatter
By combining two sets of K.V.D. digits, clock and the time offset to be added, both clocks can be produced from 1 to 23. This variation is not only effective in reducing cost, parts of the design can be integrated with other devices to a great extent.

When combined data, for instance,

\[ \text{true potential difference} \rightarrow \text{true potential difference} \]

Thus it

\[ \text{true potential difference} \rightarrow \text{true potential difference} \]

If the components of the device are set, it can be programmed for use anywhere. It can be used as

- A microprocessor
- A microcomputer
- A minicomputer
- A mainframe

Assembling the device is relatively easy, it can be programmed as

- A microprocessor
- A microcomputer
- A minicomputer
- A mainframe

The device is available for a variety of uses, such as

- As a simple calculator
- As a simple computer
- As a simple microprocessor
- As a simple microcomputer

The fact that the device can be programmed for use anywhere is remarkable. It can be used as

- A simple calculator
- A simple computer
- A simple microprocessor
- A simple microcomputer

No hidden extra price is for a "BUILT IN"atu digital

- No hidden extra price is for a "BUILT IN"atu digital
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- As a simple microprocessor
- As a simple microcomputer
New Line of Wave Solderable Heat Sinks

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MCP Electronics Ltd.,
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The correlation function of a signal has been tied up with pitch and coloration by Bilsen, who found the experimental subjective weighting function shown in Fig. 4. The pitch and coloration threshold, according to Bilsen, is given by

$$R(t) = 0.063 \frac{R(t)}{R(0)} p(t)^2$$

That is, if the normalized white noise autocorrelation function of the system exceeds 0.063(p(t)) coloration may be detected in the signal.

The pitch of white noise fed through a high-pass or low-pass filter is closely related to its cut-off frequency. This would be expected from its autocorrelation function, Fig. 3(d), which shows substantial ripples of a period corresponding to the cut off frequency: compare this with the autocorrelation function of a sine wave, Fig. 3(a). This pitch and cut-off frequency relationship was confirmed experimentally by Small and Daniloff and by Fast. However, with high-pass filters having a cut-off frequency below about 600Hz anomalous results are obtained which suggest that coloration is not audible with high-pass filters in the frequency range where they are usually used.

The sensation of pitch becomes more definite as the slope of a sharp cut-off filter is increased. Rakowski has reported experiments with filters having slopes of 15, 50, and 150Odec above -3dB frequencies of between 200Hz and 5kHz. He found that "The accuracy of the pitch judgement decreases for extreme low and high frequencies. The increase in steepness of noise band skirts improves the accuracy of the pitch judgements but at 150Odec the judgement may still be made with considerable consistency." This is in accordance with an autocorrelation theory, which predicts increased coloration as the filter cut-off frequency increases towards the ideal frequency-domain filter.

From the weight of experimental evidence then, an autocorrelation theory of hearing including a suitable weighting function appears to explain the phenomenon of filter coloration satisfactorily.

Step response

The white-noise autocorrelation function of a filter is not a very familiar quantity to many electronics engineers although it is one of the time-domain descriptions of signals. (An oscilloscope is a time-domain display system, invaluable for studying the effect of networks on pulses.)

The step response of a network is closely related to its white-noise autocorrelation function: the autocorrelation function of a signal is the time domain description of its power spectral density (its "frequency spectrum") and contains the same information. Given a white noise input, the power spectral density directly depends on the transfer function of the network. Taking the transfer function one can find the impulse response or the step response of the network by means of the Laplace transform. So the step response is a close cousin of the white-noise autocorrelation function and contains all its information, as well as additional phase information.

If the step response of a network is known, the response to an arbitrary signal, for example speech or music, can be found. The input signal can be approximated by a staircase function, as in Fig. 5, and by taking smaller and smaller steps one can get as close to the original as necessary. This staircase function can be decomposed into the sum of a large number of positive or negative steps of varying magnitude each of which has its own step response when passed through the network. If these are added together the resulting waveform is the response of the network to the input signal. There is therefore a direct connection between the step response of a network and its response to real signals.

By studying the step responses of some idealized and real filters these can be related to their white-noise autocorrelation functions and criteria for audio filters can be established. Consider first the ideal frequency-domain filter shown in Fig. 6(a). The step response shows considerable ringing as would be expected. There is also a precursor, that is a response before the input step is applied, pointing to the non-realizability of this ideal filter. A real approximation to this type of response is the third-order Butterworth response shown in Fig. 6(b). There is now no precursor but there is still a lot of ringing. This sort of filter is common in audio equipment although it is by no means optimal for the application.

The ideal time-domain filter is one with a fast rise time and no overshoot or ringing. This is achieved if the amplitude response follows a Gaussian shape and if the phase response is linear. The step response of a Gaussian filter has a precursor, but a practical filter, a third-order Laguerre Gaussian approximation, gives a delayed response with no precursor and negligible ringing.

The subject of filter families such as Butterworth, Bessel, Chebyshev, is too wide to cover in one article but is well covered in the literature.

Design criteria

Basically, there is a need for as much attenuation as possible in the stop band with a flat amplitude response in the pass band. A steep slope in the stop band is not harmful in itself (the Gaussian filter approaches an infinite slope) but the shape of the response curve in the transition region between the pass band and the stop band is important. Looking at the Gaussian, Laguerre and simple RC filters, there is little or no ringing when the cut-off is approximately Gaussian over the first 10dB or so of attenuation. The phase response associated with this type of cut-off tends to be linear in the case of practical transfer functions, and this has sometimes led to the misconception that filters should be specified to have a linear phase response to minimize ringing. The step response contains information which is discarded in the autocorrelation response. This implies that a pure autocorrelation theory of hearing does not take account of the ears' sensitivity to phase information, but there has been considerable controversy over the degree to which phase shifts are detectable. What is important in the present context is that phase linearity, by itself, is no guarantee of adequate audio filter design.

One could choose a sharp cut-off response characteristic and then add an all-pass phase equalizer to give good phase linearity, but this would not give freedom from ringing. The ideal frequency-domain filter is a good example of this: even with zero phase there is bad ringing. Adjusting the phase response near the band edge can alter the symmetry between precursor and overshoot but can never remove the ringing.

The conclusion must be drawn that the main factor governing transient response is the shape of the amplitude response roll-off in the transition region. For best results this should have a Gaussian shape, that is

$$V_{out} = \exp \left( -\frac{s}{s_{\text{HB}}} \right)$$
This is unrealistic as it stands but it can be approximated by either a Taylor or a Laguerre series expansion. Several other filter approximations also produce a quasi-Gaussian roll-off, for example the well-known Bessel or Thomson family and the in-line pole approximations.

While a Gaussian roll-off is ideal from the point of view of step response, the ear is not so critical of ringing as the cut-off frequency is raised. This implies that a sharper cut may be used at high frequencies without being objectionable.

As filters can be broken down into first and second-order terms, the last being responsible for ringing, the maximum allowable Q-factor of the various terms in the transfer function could be related to frequency as a criterion for audio network design.**

** High-pass filters are less critical in their design. As previously mentioned, although at high cut-off frequencies ringing is noticeable, below about 600 Hz this effect subjectively disappears. The design of high-pass filters can be based on conventional frequency-domain considerations. For example, a typical rumble filter might have a third-order Butterworth response with a -3 dB frequency of 24 Hz, giving 1 dB drop at 30 Hz.

** Research into the effect of similar transfer functions in introducing audible coloration has been carried out at the University of Surrey by J. M. Bowsher and R. Martin.

Variable low-pass filter

One solution to the problem of ringing adopted in some high-fidelity preamplifiers is to use a switched cut-off frequency and to add another filter control known as a slope or roll-off control. In one type of slope control mainly affects the rate of fall-off in the stop band, thus sacrificing unwanted attenuation to reduce the unwanted coloration. The provision of three switched frequencies plus a slope control gives a comprehensive filtering facility in the sense that the user has a wide choice of filter characteristics. I believe this is unnecessarily complicated and that a single control can be adequate for most applications if correctly designed.

Essentially what is required is a steep final rate of attenuation, say 18 dB/octave, but with a gradual initial roll-off approximating a Gaussian shape. Filter control is possible if the cut-off frequency is made smoothly variable rather than switched. Secondly, the ear is less sensitive to ringing at the upper end of the spectrum than toward the middle and a sharper cut-off is more permissible (and desirable) near the band edge. The object of this design was therefore to obtain an 18 dB/octave slope which could be shifted along the frequency spectrum whilst automatically changing its shape in the transition region to give the maximum amount of attenuation without coloration at any setting. This aim has been achieved in the following way.

A second-order low-pass section has a peak in its response which depends on its Q-factor. If the Q-factor is allowed to increase as the cut-off frequency is increased, curves like those of Fig. 8 are obtained. If this rising response is offset by a first-order response falling at 6 dB/octave the result is an almost-flat pass-band response with a variable cut-off frequency, the initial roll-off becoming steeper with increasing cut-off frequency. (In practice, the first-order section must also have a variable cut-off frequency to avoid a peaked response.)

The filter was designed to be variable between a Bessel response with a cut-off at 6.3 kHz, and a 0.5 dB ripple Chebyshev response with a 20 kHz cut-off. The subjective sensation of pitch is approximately linear with logarithmic frequency and as there is evidence to show that the subjective effect of reducing the bandwidth of a signal is also nearly proportional to the logarithm of the cut-off frequency, this law has been incorporated in the variable control. The resulting circuit is analysed in the Appendix and computed response curves are given in Figs 9 & 10.

Practical circuit

A practical circuit suitable for use in a high-fidelity preamplifier or in professional audio equipment is given in Fig. 11. In addition to the variable low-pass facility there is a fixed rumble filter built around the input stage which cuts off at 18 dB/octave with a Butterworth characteristic.
Designing with microprocessors

10 – Concluding interrupt-driven circuits

d by D. Zissos and G. Stone

Department of Computer Science, University of Virginia, Canada

The last two articles on interrupt-driven circuits, June and July 1981, described operation, applications and design procedures. This article covers interrupt controllers and routines for the operation and use of two common interrupt chips.

The function of interrupt controllers is to generate an interrupt request, IRQ signal when one or more flags are present, and to provide the microprocessor with information which will allow it to identify the source of interruption. Fig. 1 last month showed the basis of interrupt systems, and the step-by-step operation is described in reference 1. Interrupts are classified as vectored or non-vectored depending on the type of information available to the microprocessor. In vectored interrupts, the vectoring address is generator externally prior to program interruption. In non-vectored types, the controller provides the microprocessor with information about the state of the individual flags, and it is left to the programmer to identify the source of interruption. For describing interrupt controllers, it is assumed that the higher the suffix of an interrupt flag, the higher its priority unless otherwise specified.

Controllers for vectored interrupts

The function of controllers for vectored interrupts is to identify the source of interruption before generating the interrupt signal, and to load the program counter with the appropriate vectoring address when the microprocessor is interrupted. Fig. 4 shows two methods for generating vectoring addresses. In (a), the vectored address is generated directly by the interrupt controller but in (b), the interrupt controller sets a pointer to the memory location which holds the appropriate vectoring address and releases it. The first method is used by the Intel 8085, and the basic operation of this device depends on the execution of the three-byte Call instruction which allows direct access to the program counter. This is because the data bus is linked to the program counter during the last two machine cycles as shown in Fig. 5. The 8259 issues an interrupt request signal when the microprocessor operating system is interrupted, and waits for the processor to respond with INTA. When this occurs it reads the data bus with the opcode of the Call instruction and then the two-byte vectoring address. The opcode is loaded into the instruction register and the vectoring address into the program counter as shown in Fig. 5. Before the vectoring address is loaded, its contents are automatically stored in stack. The second method of generating vectoring addresses is used by the Motorola 6828. In common with all interrupt controllers, the 6828 generates an interrupt request signal in response to external flags and waits for the microprocessor to respond. The procedure responds by outputting consecutively addressed signals

Controllers for non-vectored interrupts

The controller for non-vectored interrupts in Fig. 2a consists of an i/o port and two gates. The IRQ signal is generated by ORing the flag signals. When program interruption occurs, the programmer saves the processor status and reads the flag bits into the accumulator by simply executing an Input instruction with address Ap in this case. The processor status is saved to allow the interrupted program to continue correctly.

After the flag bits are stored in the accumulator, the programmer tests the value of each bit in turn by shifting left one position the contents of the accumulator through the carry flip-flop, and checking whether it is set, C=1, or reset, C=0, see Fig. 2b). If the flip-flop is set, control of the program is transferred to the appropriate interrupt routine, otherwise the shift operation is repeated as shown in Fig. 3.

At the end of each service routine the processor status is restored, the interrupts are enabled and the interrupted program is resumed by executing a Return instruction. This method, commonly called soft-pend, involves no special hardware and is often favoured by people familiar with software. However, it is slow and if a large number of interrupts are necessary, the response time may be too slow for certain real-time applications.

References
FFF8 and FFF9. The presence of these signals on the address bus activates the interrupt controller, which then modifies their values in accordance with the interrupt flags, as shown in Fig. 6. Address bits 1 to 4 are replaced by four new bits z1 to z4. One method of achieving this, using a priority encoder (flag sorter) and some logic, is shown in Fig. 7. The priority encoder identifies the flag with the highest priority, see Fig. 8. For example, \( q_4 q_3 q_2 q_1 = 010 \) when flag 2 is identified and \( q_4 q_3 q_2 q_1 = 111 \) if flag 7 is present. The values of the modified address bits are also given in Fig. 8 which shows:

\[
\begin{align*}
z_1 &= q_0 \\
z_3 &= q_2 \\
z_2 &= q_1 \\
z_4 &= q_2
\end{align*}
\]

A priority encoder and inverter circuit is shown in Fig. 9.

**Restarts**

Restarts are one-byte instructions whose format is 11dddd111 where ddd are variables. When this instruction is executed, the program counter is pushed on stack, and bytes 00000000 and 00000000 are written into it. This means that the execution of a restart instruction transfers program control to one of eight locations specified by 00000000 0ddd0000, see Fig. 10. The restart instruction can be generated by a priority encoder and, because it is loaded into the instruction register rather than the program counter, all that is required is an i/o port and one AND gate.

**References**


**Fig. 6. Basic operation of the 6828 interrupt device.**

**Fig. 7. Modification of the 6800 address signals FFF8/9 during interrupt cycles.**

**Fig. 8. Modified vectoring addresses, see Fig. 7.**

**Fig. 9. Practical circuit for modifying address signals as shown in Fig. 7.**
Electronic detection of meteors

Two young avionics engineers, armed with a portable 'all-sky camera', plus material help from their company, are making a contribution to an international scientific experiment this summer, involving a comet which appears once in every 119 years. David Fosberry BSc, 25, Project Engineer with Marconi Avionics Limited and his partner Joe Cardwell, 22, Development Engineer, have designed an electronic detection instrument, the first of its kind, which can tell the presence of meteors and count them automatically.

The new Electronic Meteor Detection System (EMDS) is to be used as part of an international experiment, organised by the Meteor Section of the British Astronomical Association. Known as Project Perseid, it involves studying the appearance of the Perseid meteor stream, which is associated with the comet known as Swift-Tuttle 1862 III, recorded only once before and due to reappear this year.

The EMDS has been designed to meet the requirements of Europe's largest amateur group for meteor observation, the South Downs Astronomical Society, whose president, celebrated amateur astronomer and broadcaster Patrick Moore, is associated with the comet known as (EMDS).

The EMDS responds to the transient streaks of light which characterise part of each meteor's path. The relatively constant background light from stars and planets is cancelled out automatically and an electronic tally is kept of the total number of meteors, together with the times at which they occur, to an accuracy of 10 microns (one hundredth of a second). All the hourly data collected is stored in the 'Lincoln Study' computer system and it is used in and with this that the new electronic detection system is associated.

Project Perseid winners are planning to observe the comet and its many thousands of rapidly-travelling members every 119 years. David Fosberry (known as the "radiant"), institutes which meteors are of the Perseid stream. To aid the study, the "all-sky camera" system is designed to be used and it is with the help of this new electronic equipment that the EMDS is associated.

When one considers that British Telecom charge £90 for each telephone evaluation and this is almost as much as a new television receiver, it is an interesting fact that the full EMDS system is expected to cost no more than £400 and that the EMDS is to be used as part of an international study jointly by N. M. Rothschild, the merchant bank, David Trundle, Goodwood, near Chichester, before mid August, when the number of meteors expected to be at a maximum.

The results will help to determine whether or not the Perseid meteors are occurring at random and whether a periodicity is present in the stream—questions of particular importance to the better understanding of comets and their movement.

New Quad electrostatic loudspeaker

For many years, whenever one read a review of a new loudspeaker, the chances were that it had been used in a/d comparisons was always the Quad ESL. Now comes another model that is also being advertised for its transparency and high fidelity, and it is expected to be at a maximum.

Patrick Wormald pointed out that a very light diaphragm could be made to reproduce the air particle motion to an imaginary plane some distance away which could represent the same image as if he were hearing that ideal source. The Quad ESL-63 achieves this by means of the relatively constant background light of light which characterise part of each meteor's path. The relatively constant background light from stars and planets is cancelled out automatically and an electronic tally is kept of the total number of meteors, together with the times at which they occur, to an accuracy of 10 microns (one hundredth of a second). All the hourly data collected is stored in the 'Lincoln Study' computer system and it is used in and with this that the new electronic detection system is associated.

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Recharging dry batteries

With a flourish on trumpets Fidelity have announced their new portable radio, The Battery Saver, which runs on an ordinary PP9 or type battery or from the mains. When connected to the mains, an automatic battery charger operates and continues to do so even if the set is switched off. Fidelity claim that the battery will last four times as long as that the radio would almost pay for itself in the cost of batteries over a five-year period.

Recharging Lead-acid cells in a subject which has recurred many times; as long ago as 1953 World Wireless published an article by R. W. Hallowes on 'Reactivating the dry cell'. In 1955 we published a description by the same author of the Elektrorhoor reactivator. This used a half-wave rectifier with a resistor in parallel to provide 'dry' dc and proved to be very successful in recharging zinc in the cells. In a follow-up article in 1956, Mr Hallowes reported: "One's biggest surprise on opening the can of a cell which has been many times discharged and subsequently reactivated by the Elektrorhoor is to find as a rule no trace of lumpy or spogy deposits, but a hard, even, inner surface. The superimposed (on the dc recharging supply) not only produces this most desirable result, but speeds up the process of depolarisation and makes it more complete.

The Elektrorhoor was the invention of a Dutch engineer, Minstre Beer.

An Ever-Ready spokesman has told us that their PP9 batteries can be recharged as long as they are not discharged by more than 10 to 15% and as long as the charging current is very carefully controlled. Any overcharge would lead to the production of gas inside could lead to a build-up of 'component land'. At the same time they have found that if the charging current is kept below a very high internal resistance or open circuit value, the layers of the battery being forced apart can normally be used on the mains with occasional use at different locations when powered by the batteries. Early ready sources should be recharged.

The Fidelity Battery Saver portable radio set which incorporates a battery charger for the dry cell battery.

After the crash

When a mammoth corporation crashes a lot of the dependent companies are affected and in the case of Rank many offshoots, some of them older than the Rank corporation were involved.

We have heard that the Bush Radio brand name has been acquired by Interstate Electronics, who market radios, cassette players and electronic clock radios manufactured in the Far East. They have changed their company name to Bush Radio but will continue to market their existing product ranges under the Interior label.

Following the closure of Rank-Toshiba, their Plymouth factory for the production of of receivers is to be re-opened by Toshiba Consumer Products (UK) Ltd. The company is operated through Toshiba (UK) Ltd, the British-based marketing company of the Toshiba Corporation. The company has recruited its employees almost entirely from former Rank-Toshiba personnel.

Meanwhile one of the surviving branches, Rank Hi-Fi, have appointed a new research and development manager, Mr Ken Russell, who will be responsible for co-ordinating all research at Wharfedale, the loudspeaker manufacturers, and at Eico, the West German sister company.

Mr Russell will also be in charge of speaker development and new product co-ordination for the Rank Hi-Fi group.

Raising standards

For a quarter of a century leading recording, broadcasting and loudspeaker engineers have used the Quad electrostatic loudspeaker as a standard of reference. Its influence on the quality of reproduction which we have come to expect has been considerable.

The introduction of its successor, the Quad ESL-63 is an event of great significance, destined to set the standards for the future. It is no coincidence that the first customers for the Quad ESL-63 have been recording and broadcasting engineers and loudspeaker manufacturers.

The Quad ESL-63 is a major advance in the art of high-fidelity recording. Its superiority is due to a combination of four principal factors: the use of a high-quality, large membrane loudspeaker, the use of a high-quality, large membrane loudspeaker, the use of a high-quality, large membrane loudspeaker, the use of a high-quality, large membrane loudspeaker, the high-quality, large membrane loudspeaker, and the use of a high-quality, large membrane loudspeaker.

Ken Russell, newly appointed research and development manager of Rank Hi-Fi.

Inmos are ready to sell

Described recently in the Guardian as the world's biggest venture capital operation, Inmos have announced that they have appointed Rapid Recall and Hawke Cramer to distribute their products in the UK. At the same time they have launched the Inmos IMS1400 a 16K x 1 static RAM.

The IMS1400 has 455 access time and a maximum power dissipation of 160mW, which allows for high-density packing. It is the first commercially available product, claims Inmos, to incorporate redundancy, allowing the resynchronization of memory cells. Currently manufactured in the US, European production of the IMS1400 will commence in the large scale 'manufacturing facility' due to go into operation in Newport, Gwent in mid-1982.

Considering that £50 million of public money has been spent to set up Inmos, we wish it all success.

News in brief

Technomatic has opened a new retail shop at 305 Edgware Road, London W2 in the centre of 'component' land. At the same time they have become an official distributor for the Texas Instrument range of components.

End of public broadcasting now in sight? is the provocative title of the Royal Television Society Convention to be held in Cambridge, 17-20 September 1981. The Convention will examine the transformation of broadcasting which is already under way. The upheaval resulting from satellite transmission, cable distribution and home video is likely to have a profound effect on the course of broadcasting.

The convention will also consider the financing of broadcasting, the effect of the fourth channel and will take a look at the broadening of television access and relate this to the work of the new Community Commission. Details are available from the Royal Television Society, Tavistock House East, Tavistock Square, London WC1H 9JR.

Wimbledon Radio who supply loudspeakers and kits for loudspeaker design, have moved to new premises at 35/9 Church Street, Wimbledon, London SW19 1AS. Telephone: 081-529 2599.

One of their latest offerings is a range of Wadebridge kits, the ESL-70 and ESL-80. The kits are supplied with all panels accurately cut to size and the baffle boards have the necessary speaker apertures cut and rebated as required. All the available kits are on demonstration at the new location.

When a home computer becomes popular the people will not only be interested in writing but in enjoying music. The director of the Luddington Music Group states that the music industry must develop to a market for music.

Ken Russell, newly appointed research and development manager of Rank Hi-Fi.

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One is tempted to think of resistance as being a property of resistors, the latter being typified by lengths of wire of high resistivity, thin films of carbon or metal and suitable bodies of high activity material like carbon, permanganate or silicon. But resistance can be more generally defined either as "that element of a circuit which absorbs power" or as "that element of a circuit which is the seat of Johnson (thermal) noise in accordance with Nyquist's theorem". These two are in fact equivalent, because of the "modified-dissipation theorem" which says that everything which is capable of dissipating energy will exhibit the fluctuations which we call thermal noise.

**Johnson noise**

Looking first at the second criterion, the Johnson or thermal noise, which in material resistors is often described as the Brownian motion of electrons. This is particularly appropriate to receiving aerials. Starting with the work of Lorentz using classical physics and continuing with Bakker and Heller using quantum mechanics, it was possible to show that the application of established kinetic theory of gases to the conduction electrons in a metal leads to the well-known relations between mean-square noise voltage or current and resistance or conductance:

\[
\text{Voltage Noise} = 4kT/R \text{ with } R \geq 10 \Omega
\]

\[
\text{Current Noise} = 4kT \text{ at } R = 0
\]

Here \( k \) is Boltzmann's constant and \( T \) the temperature of the object or circuit. The resistance \( R \) is the presence of any number of degrees of freedom equal to the number of modes of motion which could be established in equilibrium. (This led to prediction of the "ultra-violet catastrophe" and to the introduction of quantum theory.) In due course Nyquist adopted the similar idea that the number of degrees of freedom of a transmission line was determined by the number of standing-wave modes which it would support, and matching the characteristics of the line to a resistive terminus or in the last resort by radiation.


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**Is radiation resistance real?**

A real resistance produces thermal noise and absorbs power, but does radiation resistance? And why does it depend on the ratio of aerial size to wavelength?

by D. A. Bell, F.Inst.P., F.I.E.E.

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Theoretical details of Professor Bell appeared in the January issue, page 60.
Absorption of power

For the radiation resistance of a transmitting aerial one can use the alternative definition: that element of a circuit which absorbs power. It is then said that if \( R_{\text{t}} \) flows in an aerial of radiation resistance \( R_T \), radiant power \( P_R \), then \( P_R = R_T \cdot R_{\text{t}} \). There are then two methods of calculating \( R_T \), when the geometry of the aerial is known.

The first, the Poynting vector method, is to calculate the field and determine the power density at all points on a sphere surrounding the aerial, and so by integration of the power density over the surface of the sphere to find the total power radiated. This is a tedious, but radiation resistance is usually proportional to the square of k, where k is the length of aerial and wavelength: for a straight wire with \( k \cdot R_T = 20 \ln \rho \). 

The second method is to calculate the in-phase e.m.f. which is induced in all parts of the aerial by its own current. In many practical cases this also involves mathematical complexity, but a circular loop can provide a simple example which gives some insight into the reason for \( R_T \) depending on the ratio of size of aerial to wavelength. In the figure a current, \( \sin 2\pi a t \), is supposed to circulate round the loop, having the same phase at all points. The magnetic field adjacent to \( dL \) but due to the current in \( dL \) will be delayed by \( \pi/2 \) rad, and so the two points and so will be slightly out of phase with one another. The current in \( dL \) is therefore a function of the ratio of the current in another loop, which is then given by the e.m.f. in \( dL \) due to the current in another loop.

Appendix 1: Nyquist's transmission line

Section 1 is a loss-free transmission line of finite length \( L \), open-circuited at its ends. This will support a standing wave of every wavelength such that \( L = n \pi / 2 \). It is therefore a function of the ratio of the current in another loop, which is then given by the e.m.f. in \( dL \) due to the current in another loop.

Method of calculating radiation resistance for small-circular loop

The e.m.f. induced in an element \( dL \) will be obtained from the magnetic vector potential \( A \) at that point according to

\[ V = E = \int dl \cdot \mathbf{B} = \int_{-1}^{1} \mathbf{B} \cdot d\mathbf{l} \]

where a negative sign has been added on the left because the e.m.f. is opposed to the current.

This is the result of two travelling waves moving in opposite directions with velocity \( v \), and therefore carrying power \( KdV/L \) each. Now let the line be extended to an infinite length, but cut at the position of the observer and the right-hand part replaced by a resistance \( R_0 \) matched to the characteristic impedance \( Z_0 \) of the line. Because the termination is matched, conditions in the remaining half of the transmission line are unchanged. Therefore power \( KdV/L \) will flow along the transmission line in equal power must flow from \( R_0 \) into the line. As indicated in section (c) this can be represented by combining voltage \( E \) with current \( I \).

where the double integration along the loop appears as follows. First find the e.m.f. \( E \) in the line as a function of \( t \), and then integrate \( E \) around the circle to find the total effect for the whole of the current.

The rate of change of current in the current is the real part of equation \( A_2 \), but because of the initial \( \sin \) comes from the imaginary part of the integrand, replacing \( \sin \) by \( \cos \).

Now expand the cos as a series of powers of \( \sin \) and \( \cos \), and because division by \( \sin \) is \( t \) to make it constant and \( \cos \).

The cubic term is then the leading term and

This digital correlator, operating by the coincidence of pulses representing angles of rotation, gives the instantaneous cross-correlation between a selected and a measured angle and also its frequency of occurrence. It can be used for checking timing scatter in automobile ignition systems which is suitable for converting a continuous signal electronically scanned omnidirectional surveillance radar receiver into one with a variable scanning rate.

Engineers may wish to compare the performances of automobile ignition systems under laboratory and field conditions in order to select the best system. This might be done, for example, by applying a closed-loop control to engines to optimize performance and efficiency under various road and environmental conditions while minimizing exhaust emissions. Doubts have been expressed about the reliability and consistency of spark ignition at some specified angle of advance and it would seem reasonable to expect a spread in the ignition time, particularly when using the conventional mechanical ignition system. The elimination of spring-operated points contacts, with their inherent contact bounce, high erosion rate, variation of dwell time with speed and other characteristics of the cam-operated mechanical switch, including backlash, friction and wear, should reduce the probability of spread in the ignition time. A high degree of consistency in ignition time can therefore be expected from electronic ignition systems not using mechanically operated contacts.

Because of the statistical nature of the problem, a measure of the spark scatter about a modal value can be obtained by cross-correlating the firing angle with a selected angle (i.e. summing the product of their instantaneous values with time) to produce an angular frequency distribution. This could be defined in terms of the standard deviation, if a theoretical distribution can be determined from the measurements at a given speed. The system having the greatest frequency at the nominal, or modal, angle will have the smallest standard deviation. Two different test procedures (i.e. integrating the cross-correlator output over a range of angles about the modal value. By selecting the most suitable ignition system on this basis, the type of distribution associated with it could be determined, to give a suitable performance criterion.

Cross-correlation

The principle of the correlator used in this technique is as follows. Two independent inputs (f1 and f2) are applied to a coincidence circuit or AND gate, whose output X(t), a function of their product, is then summed over a time T. A continuous train of such outputs may be formally stated as

\[ R_g(t) = \int_{-\infty}^{\infty} R_1(\tau) R_2(t-\tau) d\tau \]

where \( R_1 \) and \( R_2 \) are known and unknown inputs respectively. For the selected three-digit encoder output and a test pulse (e.g. an internal combustion engine spark ignition pulse at a preset or required angle of advance) the output \( R_1(t) \) or \( R_2(t) \) after summing (counting or integrating) over a finite time, equals the frequency of \( \phi \) when coincidence is perfect.

The process of cross-correlation is illustrated in the Appendix. By the output \( R_1(t) \) and \( R_2(t) \) are applied to a coincidence circuit or AND gate, whose output X(t), a function of their product, is then summed over a time T. A continuous train of such outputs may be formally stated as

\[ R_g(t) = \int_{-\infty}^{\infty} R_1(\tau) R_2(t-\tau) d\tau \]

The digital correlator

In Fig. 1, a train of 360 equally-spaced pulses per engine revolution, independent of whether input X(t) is measured or not, is considered to be zero.
of speed, is applied to a 9-stage counter used as a comparator for a 9-bit binary word. Corresponding collectors of each comparator stage are simultaneously applied to all input of nine two-input NAND and NOR gates in parallel. The second inputs of these accept from an encoder one of nine bits defining the selected word or ignition angle. When the comparator input pulse corresponding to the required angle of advance produces simultaneous coincidence at each of the nine parallel two-input gates, each NOR gate output is inverted before enabling its parallel NAND gate output at a selected NAND stage.

Reference to the respective truth tables shown in Figs. 2 and 3. Waveform (h) in the output of the single three-input NAND gate used for inhibiting the comparator input of Fig. 2, and, when inverted, for gating the ignition trigger or plug gap-breakdown pulse in Fig. 1. Its trailing edge is locked to the encoder output, shifting to the left or right with the angular switch positions, and occurs at the instant the measured and selected angles are coincident. The leading edge occurs at that instant, as at the leading edge of (c) inverted.

Waveform (i) is a test pulse obtained by locating a light source and actuator, 1.85V across the 360th pulse in Fig. 1. Its edge is locked to the encoder output, shifting to the left or right with the angular switch positions, and occurs at the instant the measured and selected angles are coincident. The leading edge occurs at that instant, as at the leading edge of (c) inverted.

As the method of measurement depends on the accuracy of a pulse train the correlation between laboratory and field measurements should be good and independent of the speed at which the cable is wound after one revolution, selection will have been made for this in the correlator. The angular resolution is determined by the number of slots on an input chopping disc and is halved by using a zero crossing detector; for a 1° resolution, only 180 slots are required on the chopping disc.

To meet this requirement for constant speed, an electro-mechanical or velocimeter speed control system, in which speed of rotation is held closely proportional to an input voltage by feedback methods, was used with a conventional six-way distributor, 0.25-in.

As the viscous friction damping in the
speed control system of Fig. 4 may be negligible, its response will be highly oscillatory, which is definitely unacceptable for this application, so the damping must be artificially increased. Both smoothed and phase-advanced output control, together with proportional and integral control, has been considered. Analysis of the former gives a velocity error of approximately 3.5 r.p.m. using the constants of a modified Type 73 API184 velocity with control amplifier gain \( G = 60 \text{mAV} \). That is, with a constant input, an output shaft deflection exceeding 3.6 radians will overload the amplifier.

The velocity error or lag can be completely eliminated by the introduction of a term proportional to the integral of the error, in the step response equation. A circuit suitable for use with the two-lag system of Fig. 5, and providing a control amplifier integral proportional to the error and its integral, is given in Fig. 6. (The component values for this have been derived in an appendix which can be obtained by sending a large s.a.e. to Wireless World's editorial office.) In the steady state, the velocity error has been completely eliminated.

An obvious advantage of integral control is that input perturbations, or interference of duration short compared with this response time, will not affect the control system. In determining the step response, the inertia of the distributor and chopper disc were neglected and, provided the control amplifier gain \( G \) is sufficiently high, this should be of no consequence. It can be shown that the peak overload velocity overshoot is only 5 r.p.m.; with a constant input, an output deflection of 29° relative to the input will overload the control amplifier.

The ability of the velocynde speed control system of Fig. 4, with proportional and integral control, is assured by the rapid logarithmic decrement of the step-response, which has a value of 0.64, given by \( b = \sqrt{\text{1.4}} - 1 \), where the damping factor \( q \) is 0.2.

### Alternative Gating

The parallel NOR and NAND circuits of Fig. 1, in each correlator channel, can be gated directly by the trigger pulse of the ignition system under test, thereby eliminating the encoder. By inhibiting the comparator input as before and decoding the 9-bit word stored in it, the angle of advance using either a visual or tape read-out will be known. However, an encoder provides the cross-correlator with a self-test capability without an ignition trigger pulse; it is thus able to synthesize a trigger pulse as well as measure it, which is not possible otherwise.

### Comparison of Ignition Systems

Fig. 7 shows some results from using the cross-correlator technique to test and compare different ignition systems. At (a) are the results from an opto-electronic triggered capacitor-discharge system with variable spark duration; at (b) from a type E contact-operated c-d system; and at (c) from a transistor-assisted contact system. In the graphs the positions of the graph lines along the "angle of advance" are the delays show their spreads of ignition timing at 1° intervals of angle of advance at different engine speeds (in r.p.m.). Thus the bunches of lines can be regarded as spectra. The length of each graph line shows on the "frequency" scale, the frequency or number of occurrences in the test interval, of firing (spark plug gap-breakdown) at a particular firing angle.

The frequency spectrum of Fig. 7 (c) has an angular spread exceeding 10° at the highest speeds; the system (a) distributor with its light-chopper could reduce or eliminate these angular distributions. The bandwidth seems adequate with no reduction in modulator value with speed: the increased scatter with speed is due to distributor contact bounce and inerteria as well as spring inertia. The use of a 22kΩ suppressor resistor in system (b) could contribute to the increased scatter and low modulator values at the lower speeds because of a larger breakdown current.

In a four-cylinder engine, such high distributor speeds are as used for checking the correlator are unlikely, and for engine speeds up to 5000 r.p.m. the performance of system (c), a standard 12V inductive ignition system, is superior to that of system (b) which is more complex. If the current switch was optically rather than mechanically triggered to eliminate the point contacts, its performance should equal that of system (a), which is complex and impracticable. While the use of long or short pulses seem irrelevant here, their effect on engine performance is most important, a fast rise-time is essential, that is, adequate system bandwidth.

The linear speed characteristic of Fig. 7(a) for 100% correlation establishes the accuracy and reliability of the cross-correlator within its 1° resolution. It could be tested without a synthesised trigger pulse by enabling waveform (j) in Fig. 1, with a 5V supply and gating the nine respective comparator outputs at any selected angle within the encoder's range. However, an external pulse source checks the pulse amplifier and the correlator's stability or ability to respond to a test pulse at the set angle of advance and discriminate against spurious pulses over a realistic speed range. The results are confirmed by the uniform correlator angular output of Fig. 7(b) over a 9.1° spread range generated by the photo-epic distributor of system (a) even though the absolute angular values measured in coincidence with Fig. 7(a).

As the correlator's performance is independent of the prime mover, any discrepancy between laboratory and field measurements can only be due to prime mover velocity perturbations, caused by wear and backlash in the mechanical transmission from the engine to the distributor, together with the mechanical imperfections of the spring loaded point contacts, aggravated by the kinetic energy of the advance and retard mechanism.

A quick method of selecting an ignition system is to apply the voltage proportional to the ignition system spark gap breakdown current, i.e. the ignition scatter, to a two-input NAND gate enabled by the zero-crossing detector. The NAND gate output, after inversion, will consist of a train of discrete equally-spaced positive pulses at the gating repetition rate, having the same envelope as the scattered ignition input, i.e. a discrete spectral distribution of the ignition energy per revolution. By integrating this discrete spectrum to give a continuous distribution envelope or sampling and holding it with a box-car circuit to give a discontinuous distribution envelope with time, it may be applied to a c.r.o. triggered by the chopping disc reference pulse. It may then be photographed, for example after one minute, for comparison with other ignition system energy distributions. Unfortunately this method does not provide angular information or permit the measurement of the distributor spark-angle characteristic. However, the standard deviation by inspection of the distribution envelope will immediately indicate the best ignition system at one particular speed, repeating the comparison if necessary over the whole speed range. This kind of selection is an example of the "ensemble" method of averaging while that using a cross-correlator is one of "time" averaging. In system (a) the statistical processes are stationary since from Fig. 7(a) the frequencies at a given speed are the same.

Finally, although the correlator has been designed for selecting an ignition system by measuring the standard deviation of its angular distribution at a given speed, it would be a useful addition to a radar receiver for determining precisely the bearing of a return pulse. It would be particularly suitable for use in a within-pulse scanning system, with its fast modulation or zero-crossing frequency. By squaring the sinusoidal modulation waveform and dividing it electronically into equal parts, depending on the angular resolution required, the chopping-disc and velocity-control loop will be eliminated. Using a synchronized omnidirectional encoder with the same resolution, attention can be focused on a stationary return pulse from any known direction exceeding the threshold level. The encoder effectively converts the continuous electronically-scanned omnidirectional surveillance radar receiver into one with a variable scanning rate, since it could be switched sequentially manually or electronically in either direction at any frequency.

### References

NEW PRODUCTS

"Fingernail" switches
These're 10 position binary coded decimal units, called fingernail switches rather than thumbwheel switches because of their small size, have wire-wrap pins and can be joined together to form a solid unit for mounting at the rear of a panel. Switching capacity of the Super Miniature series is 50mA at 25V d.c., (resistive load) with a continueous rating of between 100mA and 10mA. Contact resistance is 200mΩ maximum and insulation resistance at 250V d.c., 100MΩ. Temperatures range of the series is -20 to 80°C and applications include computers, automatic control and measurement equipment and any situation where a numeric value tends to be adjusted periodically but space is limited. Coincord Ltd, Eleanor Cross Rd, Wallingford, Hers, WW301

50MHz oscilloscopes
Growing demands for low-cost, general-purpose oscilloscopes have led Tektronix to design the general-purpose oscilloscopes have been adjusted for use in service departments, educational establishments and other similar situations and will be available through Electron. Tektronix Uk Ltd, Braverton House, PO Box 69, Henden, Hers, WW303

High-voltage probe
Availability of a probe with a built in meter for measuring up to 60kV d.c. has been announced by Sinclar Electronics Ltd. The LHJ-20A, from the Japanese company 6617 and 2215 at £79 both have 50MHz bandwidth, 2mV sensitivity and dual trace. Basic differences between the two are that the 2215 has a dual timebase and cathode bias, whereas the 2213 has a single timebase and uncalibrated decay. As switched-mode power supplies are incorporated, consumption is kept low and mains input variations from 90 to 250V and 48 to 52Hz can be accepted without adjustment. Both units have seven finding, automatic immunity and focus facilities and weight 6.3kg each. For sensitivity settings above 20mV/cm, the bandwidth is increased to 60MHz. These portable oscilloscopes are designed for use in service departments, educational establishments and other such centres and will be available through Electron. Tektronix Uk Ltd, Braverton House, PO Box 69, Henden, Hers, WW303

Low-power r.a.m.
Two 256 x 4-bit c.m.o.s. static r.a.m.s with 50W power consumption in standby mode are available from Rapid Recall. The IM65X53 has 22 pins and separate i/o data lines, whereas the IM65X61 has 18 pins and multiplexed data lines. Both types are t.r.l. compatible, have internal address registers and can be supplied with either 300ns or 220ns access times. A third option is available with 4.5 to 5.5V maximum operating range. These i.c.s can be supplied for various operating temperature ranges. Rapid Recall Ltd, Rapid House, Den­mark St, High Wycombe, Bucks HP1 2ER. WW303

Microprocessor trainer
Many people with a knowledge of logic goes find difficulties when they come to try to understand the microprocessor. Unilab, with their microprocessor trainer, hope to make the transition easier by providing a board which functions as a common microprocessor but using one-bit operation. Instruction words define the microprocessor concepts and how they can be illustrated using the board. The One Bit Microprocessor is divided into sections and 35 J. & L.industry Ltd. shows the broad states of lines between these sections and at the bottom the I.0 can be used for controlling simple demonstration models from programs entered as 256 x 4-bit r.a.m. each. Each unit costs around £60 with options like a 30MHz supply, Unilab Ltd, Clarendon Rd, Blokburn, Lancs BB1 9TA. WW304

Leader, has an analogue meter built into its handle which indicates readings in 25 steps with a maximum error of 3%. The LHJ-40A weighs 500g and costs £11 excluding v.a.t. Sinclar Electronics Ltd, London Rd, St Ives, Huntingdon, Cambs PEI7 4JH. WW304

V.h.f./h.f. converter
Conversion of 144/146MHz band signals down to the range 45.5/46.5MHz for use with h.f. band receivers is the function of Du­ting's DC144/28 converter. At minimum gain, 1dB, the video signal is 3.3mV and 30kHz to 30MHz is available. The third order input interce­ption is typically 40dB. Separate gain controls are provided for the 500 com­pensator input and output. The DC144/28 incorporates a high-level Schottky-diode balanced mixer, m.o.s.f.e.t. input, i.f.e.t. post­amplifier, and fifth-overtone crystal oscillator. 52039 (h.f.) type connectors are used at both input and output. An external d.c. supply of between 10 and 14V is required to power the unit via a jack socket. Two versions of the DC144/28 are available, one with i.p.s. and one with i.p.s. and v.h.f. output. 514MHz to 516MHz signals can be received on 2-metre band equipment. EME Ltd, King Street Lane, Farn­worth, Wokingham, Bersk. WW309

Frequency counter
An eight-digit 10Hz to 150MHz counter for measuring frequency. period and r.p.m. is available through Tektronix. Berkeley. The 1501 resistance frequency period input of the Kikusui 255 has 20% sensitivity and automatic limit control when measuring large signals. Gate times are 10, 1, 0.1 and 0.01s for frequency measurement and 60, 6, 0.6 and 0.06s in timebase mode for measuring up to 100,000 pulses. Periods from 10ms to 1s can be measured. The 10MHz time-base, a t.r.l. compatible output of which is available at the rear of the unit, is stable to within 2.1 x 10^-5/°s. A more stable version of the 255, the 256, is available with an error of 2.3 x 10^-7/°s. Frequency counter WW307

100MHz time-base, a t.r.l. compatible output of which is available at the rear of the unit, is stable to within ±3%. The IM65X61 has a dual timebase and uncalibrated decay. As switched-mode power supplies are incorporated, consumption is kept low and mains input variations from 90 to 250V and 48 to 52Hz can be accepted without adjustment. Both units have seven finding, automatic immunity and focus facilities and weight 6.3kg each. For sensitivity settings above 20mV/cm, the bandwidth is increased to 60MHz. These portable oscilloscopes are designed for use in service departments, educational establishments and other such centres and will be available through Electron. Tektronix Uk Ltd, Braverton House, PO Box 69, Henden, Hers, WW303

Error measurement system
Testing and performance evaluation of digital transmission and terminal equipment are the purposes of the 3781A/3782A error detector developed by Hewlett-Packard. The 3781A pattern generator and 3782A error detector provide a system for testing error susceptibility that can be used with four levels of digital hierarchy up to 50MHz. With the 3781A, errors can be injected individually at or 1 in 10^4 or 1 in 10^5 error rates into a range of predefined pseudo-random binary sequences and 16-bit word test patterns in a.m.i. or b.i.i.-I line codes. Both units are balanced and 1200 balanced pseudo-random outputs and t.r.l. compatible monitor outputs are provided. Binary and code errors detected by the 3782A can be displayed as error rates, error counts, error-second and second between errors over various gating periods. All four parameters are updated simultaneously over the same gating period. A printer output and real-time clock are included in the 3782A. Applications of the system are in research and development of error detection systems, and production testing with remote testing via an IEEE 488 bus is required. Hewlett-Pack­ard Co., Ltd, Ring Street Lane, Wim­nesh, Wokingham, Bersk. WW309

Electro-plating repair kit
Small-area breaks, wear and blemishes in plated surfaces can be repaired using a unit from Automatic Production. The three-piece unit is basically a variable voltage-regulated/current-limited power supply designed to provide power for two brush-driven probe types, one for cleaning the surface to be repaired and one for applying the plating solution. A third point probe provides the earth return from the surface. Various plating compounds are available for use with the unit, including gold, nickel, copper, aluminium, tin-lead and tin. Automated Production Equipment Corp, 142 Po主观 Ave., Medford, NY 11763, USA. WW307

Industrial controller
Smallest in a range of industrial microprocessor controllers from EME is the TIM 101 for use in timing and sequencing applications. Four debounced t.r.l. compatible inputs and seven outputs are provided. Of the seven outputs, five use relay changeover contacts for loads up to 3A and two are open collector outputs for up to 12A. Eight t.r.l. compatible inputs can be selected by programming to operate as either inputs or outputs. Pro­grammations for up to 8-way d.i. switches are available so that different parameters such as time periods, counts, limits and values can be controlled. The controller uses a 4802 microprocessor and can store programs of up to 2K. A single a.c. supply (either mains or low voltage) is required to power the unit via a jack socket. Two versions of the TIM 101 are available, one with i.p.s. and one with i.p.s. and v.h.f. output. The DC144/28 incorporates a high-level

Radio measurement equipment
SRS-069 (b.i.i.-I, a.m.i. and d.b.-3 line codes. Both 7Sn 9 to 14MHz are available at £265 plus VAT. Schottky-diode balanced mixer, m.o.s.f.e.t. input, i.f.e.t. post­amplifier, and fifth-overtone crystal oscillator. 52039 (h.f.) type connectors are used at both input and output. An external d.c. supply of between 10 and 14V is required to power the unit via a jack socket. Two versions of the DC144/28 are available, one with i.p.s. and one with i.p.s. and v.h.f. output. 514MHz to 516MHz signals can be received on 2-metre band equipment. EME Ltd, King Street Lane, Farn­worth, Wokingham, Bersk. WW309
How's that again?

To inform a wide general public about the superordinate relationships of new technologies. It is, a matter of showing trends and tendencies, of creating transparency and of promoting understanding for a life with controlled electronics by means of relevant information. (Institut 81 press handout).

I think it means, Mr. Fowler; it's all about telling Joe Public that electronics is wonderful. There's this big Swiss electronics exhibition in Basel where the purpose, aside from a "mediator function between manufacturer and user" (selling gene), is to "eliminate the fear of excessive mental demands, to help him throw a bridge to (at) the new technologies."

Simple, really.

It's all going to be like that, though, I'm not going. I think one of the younger end should be sent — they have no fear of excessive mental demands.

Yaipecc Yopld

Near enough, anyway. That is, in case you thought the printer was losing his touch, is what you ask for when you go to a bookstall in Russia to pick up the latest Wireless World. It isn't a translation, just a transliteration (Graziela Oswald). What happened is that the Russians buy a few copies from us, copy and reprint them with the above, and sell them out. I don't know how many they print, but it must be quite a lot, or it wouldn't be worthwhile doing at all. It loses a bit in the process — the drawings are all right, but the pictures come out looking a bit wan. And it's all in black and white, so that Paul Briley's colour photos on the cover suffer sorely.

What puzzles me is why we don't receive a few more contributions from the U.S.S.R. They're pretty bright people over there — brighter than most in many ways, and I can only remember two contributors in the last decade or so. It would be good to hear a bit more about what goes on in their electronics — they can't spend all their time orienteering, although they do seem extraordinarily keen on, judging by their magazine Radio.

Long-felt want

It began to look as though I'd have to acquire a computer of some sort, even if it's only to guard against abuse from the younger element here. Three of them have got them now and their conversation has taken a turn towards the grossly guilty-ready: it is not easy to maintain my front of omniscience when all around people are chatting amably about dairy wheats, acne, apples and various other intelligent vegetables.

I still have to solve the problem of what I'm going to do with it when I've got it, but that isn't the vital thing. What is important is that I must put on a bit of a spat to catch up with the language, at least. It's moving so fast now: one hardly dares speak in case one is unwittingly guilty of a serious knock telecom. If Shakespeare were writing today, he wouldn't dare make any mistakes.

Thoughts like that, of course. It is as in case it was taken as an excuse to jump to the next scene. It's even got to the stage now, when people say they mention the world program, they all think I'm talking about Radio 4, not being able to credit that I've heard about computers yet.

Still, having got myself a computer, it will have to work for its living. On the whole, I really think I'd like to use it as a word-processor — I can probably live without all the staff of the prime numbers up to several million, and I know the state of my bank account because the manager keeps writing him little notes to tell me. No, I think a word-processor might well be a great help: the typewriter I use makes too many mistakes and I get so fed up of correcting them that sometimes I don't bother and they get printed. When I do scribble all over the typescript the printers can't read my writing anyway, so mistakes are all right.

All this, so I'm told, will not be a problem with a word-processor. All you do is type stuff in, press a few buttons, and it all leaps into position, mistakes corrected, documents reordered on demand and the right-hand edge straight as a die. Another keystroke and the printer fires it all off at some favourable speed, ready for sending off to the printers. Yes, I think that's for me. It might even do the index every year, so you'll be able to have it before the end of the preceding year.

Breaker breaking

In it has already. There I was, driving peacefully along between Sutton and Cheam, when a disembodied voice rudely told me to stop. It was Frederika von Stade, who had been singing a Canteloube song from the Auvergne, to announce that if any breaker so desired, he was ready to hold converse with them. I think that's what it said, at any rate. I can't claim absolute certainty on this point, because the request was couched in such an unsavoury combination of South London whine and Texas drawl that it might have been anything.

I wasn't able to hear the replies (I suppose he was breaking into the front end because of his proximity) and, in any case, I was trying to listen to Mass F. von S. singing her television commercial, but he must have conveyed a reply from somewhere who was similarly baffled by the double talk, since the reference was all to do with this old creep in front of him who was driving too slowly. The impudence of the fellow was in the next moment all the more nudging speed at which I feel safe — nearly 25 m.p.h., in fact, to be exact.

It wasn't the reflection on the verve and dash of my driving that hurt, though, nor the slighting reference to my noble vehicle by anyone who was at this point I realised that the c.b. was a great help: the typewriter I use makes too many mistakes and I get so fed up of correcting them that sometimes I don't bother and they get printed. When I do scribble all over the typescript the printers can't read my writing anyway, so mistakes are all right.

All this, so I'm told, will not be a problem with a word-processor. All you do is type stuff in, press a few buttons, and it all leaps into position, mistakes corrected, documents reordered on demand and the right-hand edge straight as a die. Another keystroke and the printer fires it all off at some favourable speed, ready for sending off to the printers. Yes, I think that's for me. It might even do the index every year, so you'll be able to have it before the end of the preceding year.

Little boxes

People keep telling me that the audio boom is coming, and the way it must be if the experts say so, but I haven't seen much indication of it myself. The magazines which concern themselves with audio are still with us and I haven't noticed any diminution in the number of impressive-looking boxes with knobs on shop windows.

But if the experts are right and the boxes are falling to the size of a thimble, I can't say I'm surprised. The public can be taken for a ride by anyone with enough money for ever. For ever. For ever.

There is no doubt that some technology is on the point of being able to grasp the 'latest' of anything, and when it is introduced on us that the row of L.E.D. on the new cassette deck is so much better than the meters on the old one that the expenditure of a wad of fivers is an nothing compared to the enhanced quality of music we can now enjoy, we fall for it — for a time, at any rate.

Comes the time, though, when a chap begins to wonder. How can it be, they'll muse, that the new amplifier doesn't sound any different to the old one, even though it costs twice as much and has a pair of meters? Meters? If the thing sounds as though it's overloading, you turn the wick down, and if it doesn't, you don't. Who needs meters?

The truth is, that manufacturers have exploited the public's weakness for gimmicks for years, and if the time has come to cool it, they ought not to flinch. Maybe they could start on video machines next — there's a fortune to be made there.

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- Evaluation of Micromodeller - a business modelling package similar to VISICALC.
- How a solicitor in Weymouth is using a microcomputer in his practice.
- Education - which comes first - hardware or software?

Guidelines for those in schools who are getting to grips with microcomputers.

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One of the latest directories to fall foul of this criticism is the **Instruments and Science** directory, which is intended to provide a comprehensive guide to the world of electronic instrumentation. The directory is divided into two sections: **Instruments and Science** and **Instruments and Technology**. The former section covers a wide range of topics, including electronics, computer science, and telecommunications. The latter section is devoted to technology, and includes topics such as manufacturing processes, materials science, and environmental engineering.

The directory's editors have taken great care to ensure that it is up to date and accurate. The directory is published annually, and each issue contains a detailed index of the topics covered. This makes it easy to find specific information on any topic of interest. In addition, the directory includes a comprehensive list of suppliers, which makes it easy to find the best products available in any given field.

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