wireless world

MARCH 1977 35p

Rhythm unit

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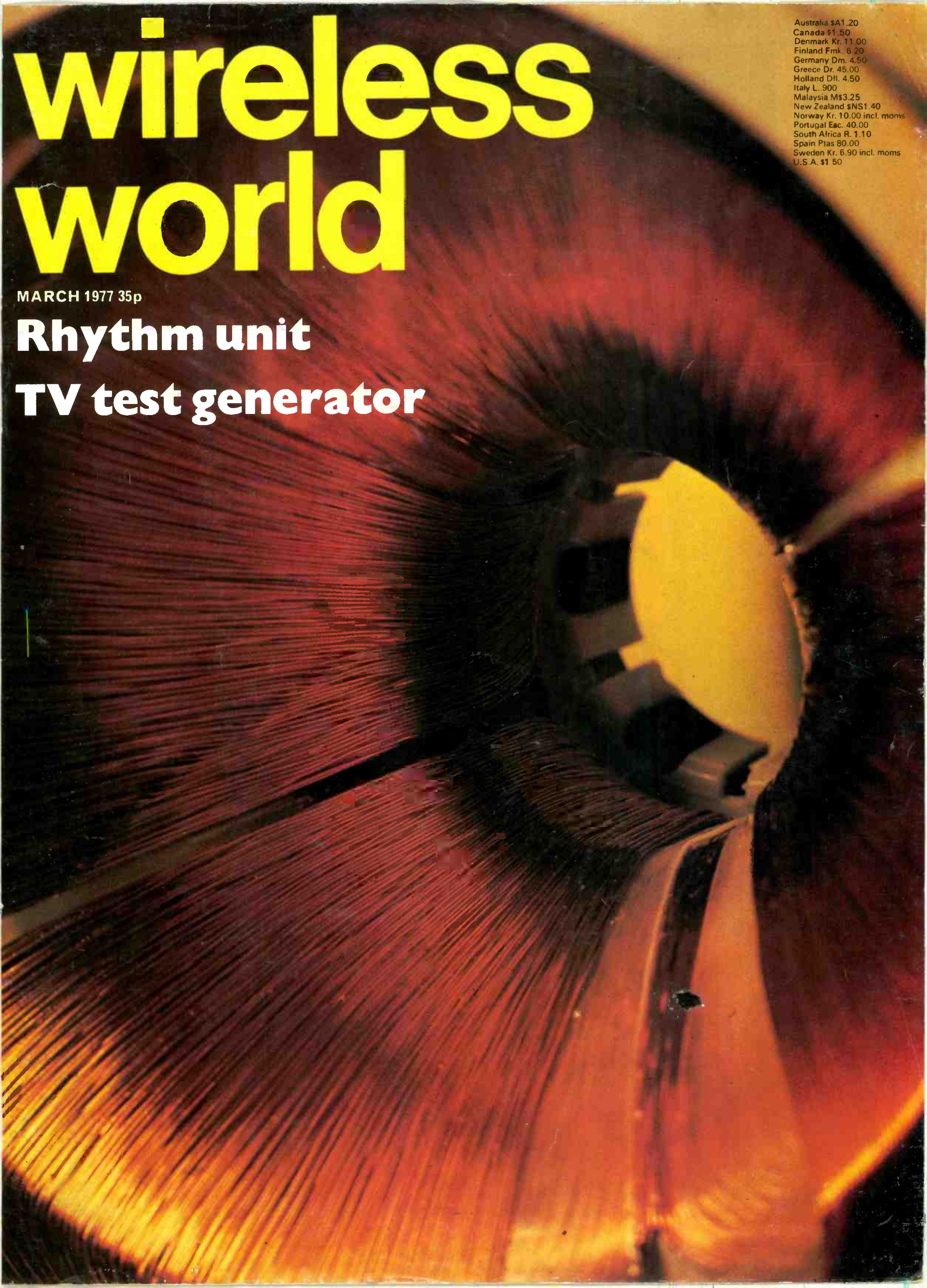

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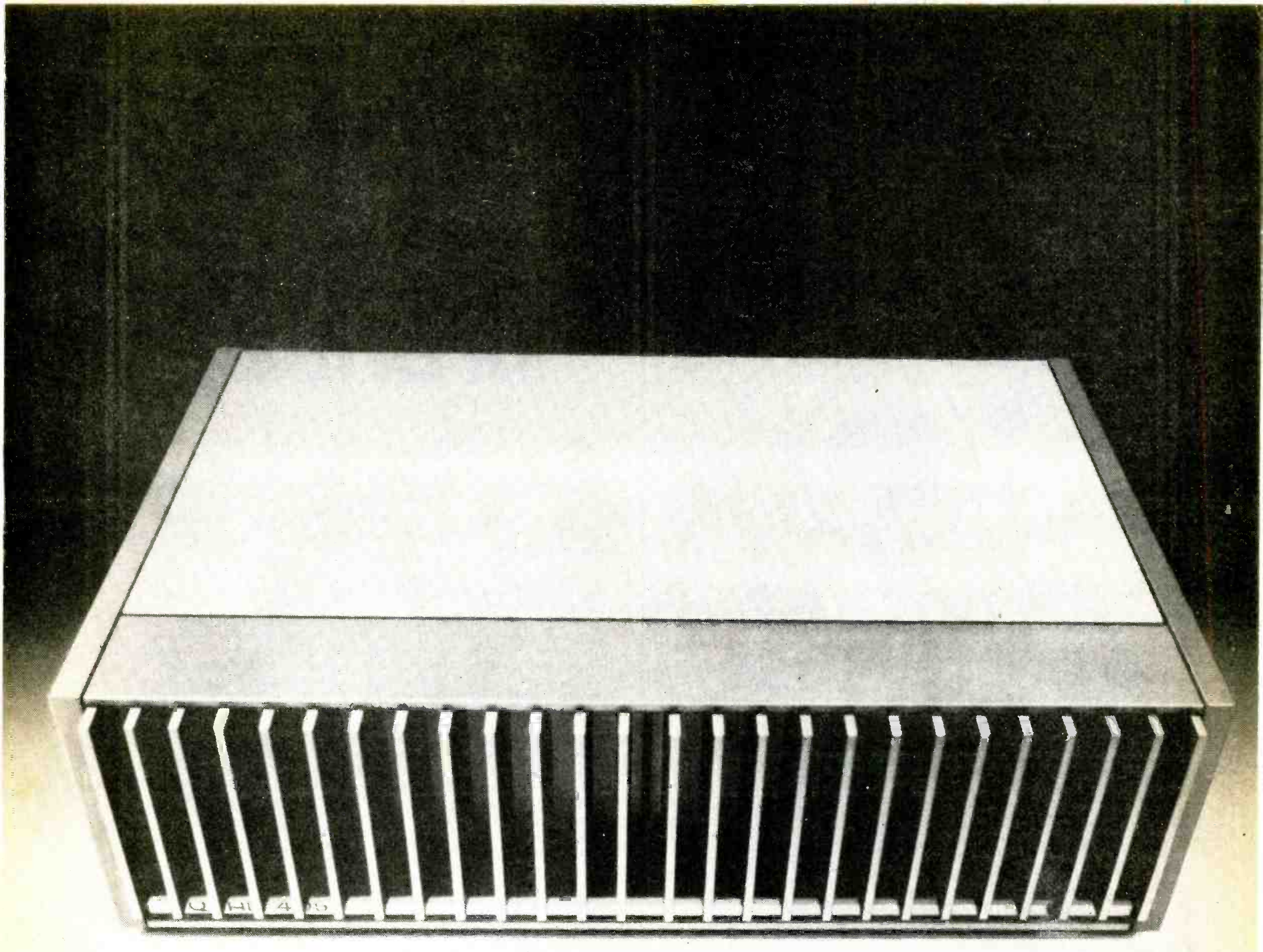

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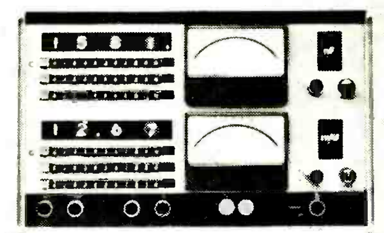

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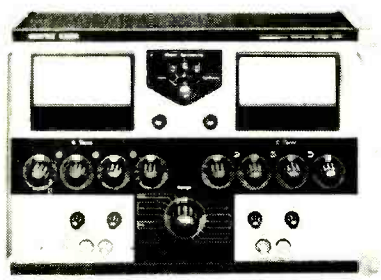

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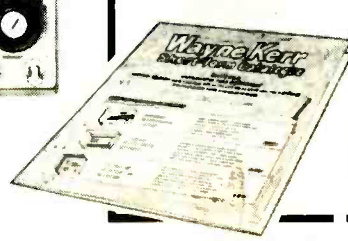

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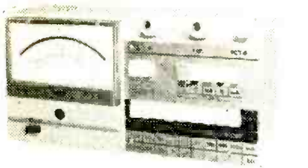

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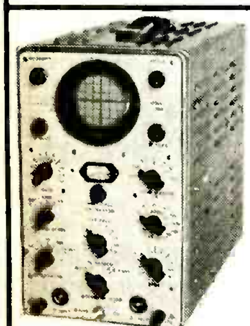

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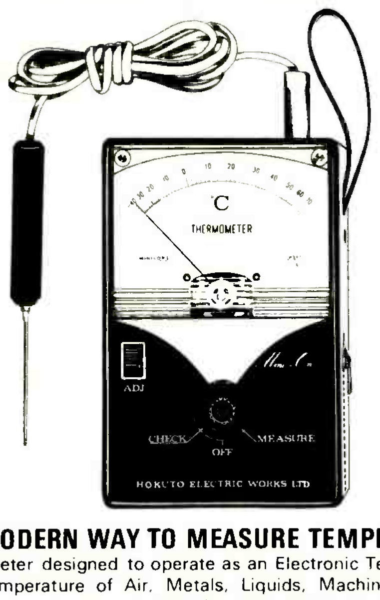

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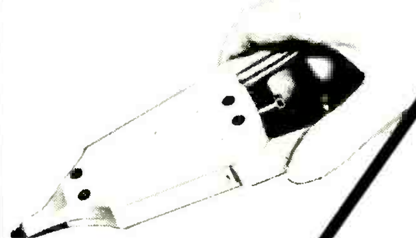

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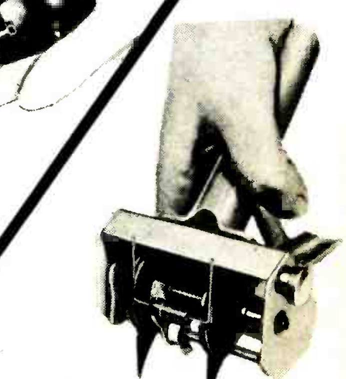

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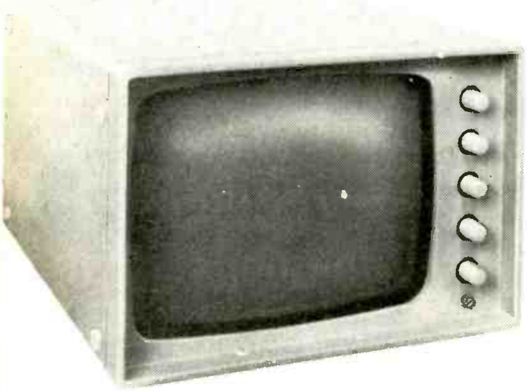

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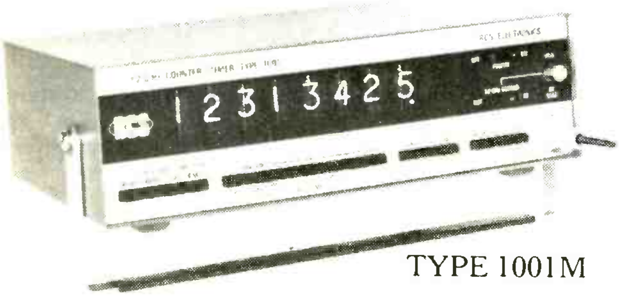

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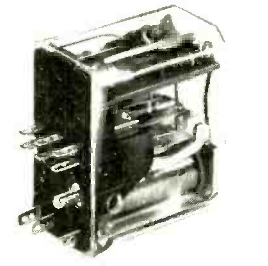

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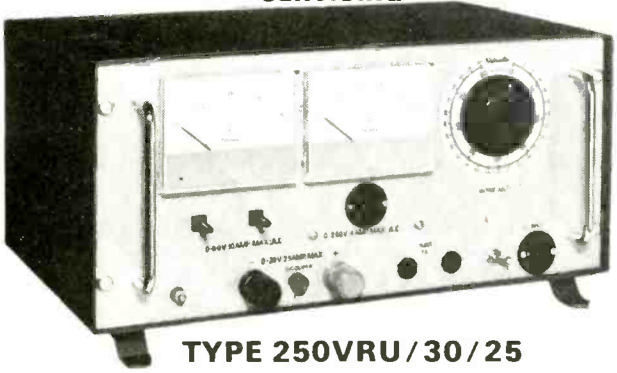

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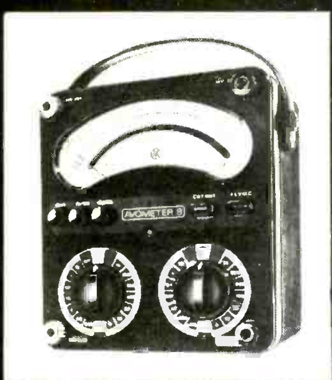

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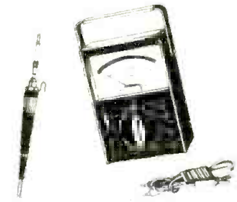

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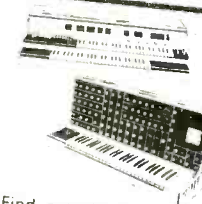

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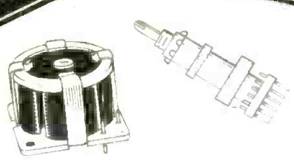

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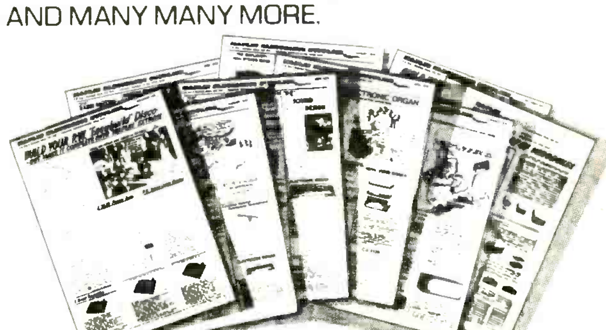

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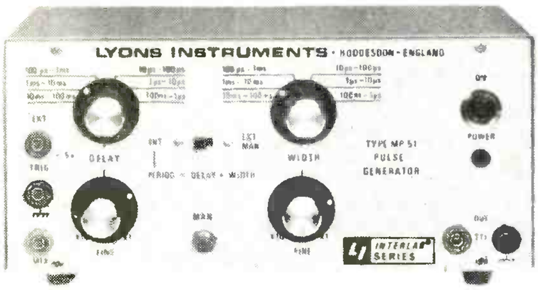

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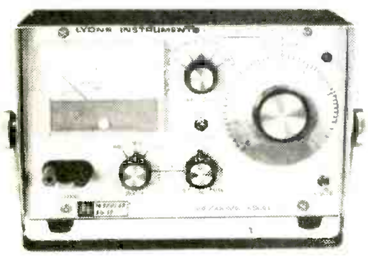

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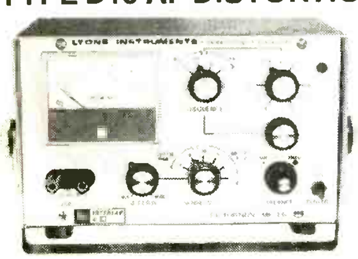

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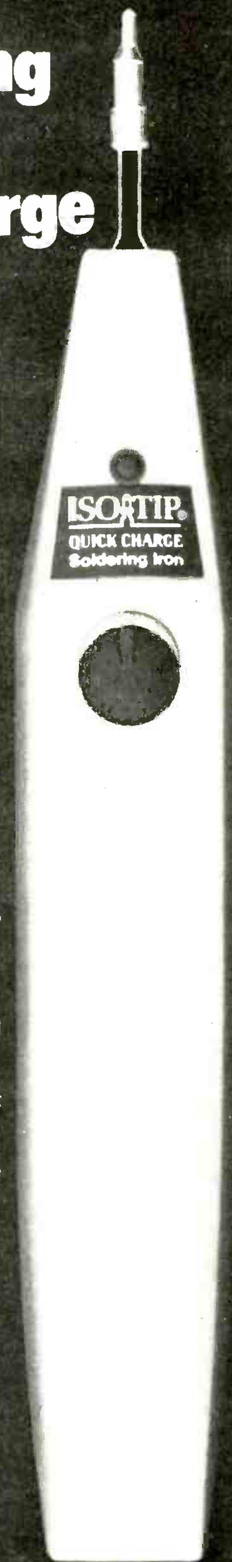

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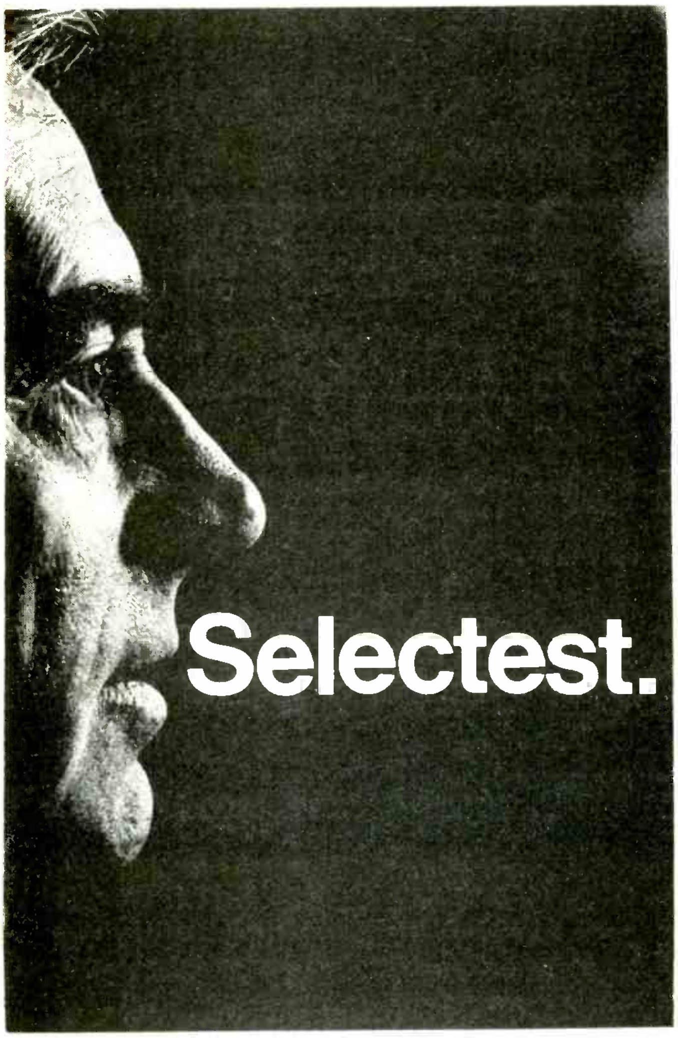

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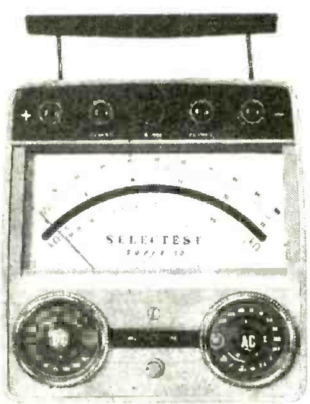

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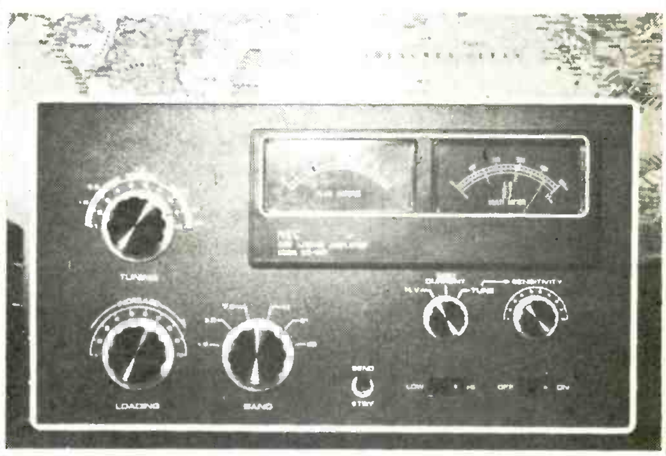

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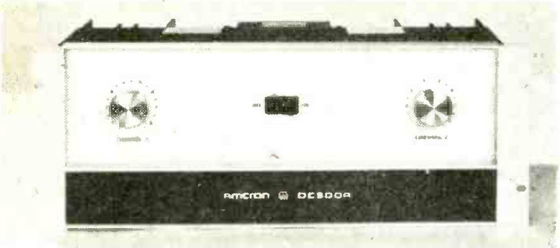

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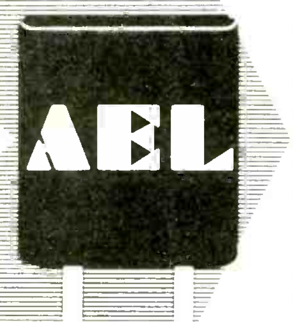

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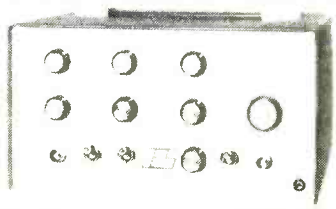

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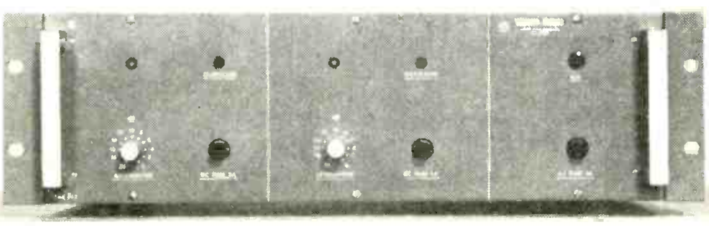

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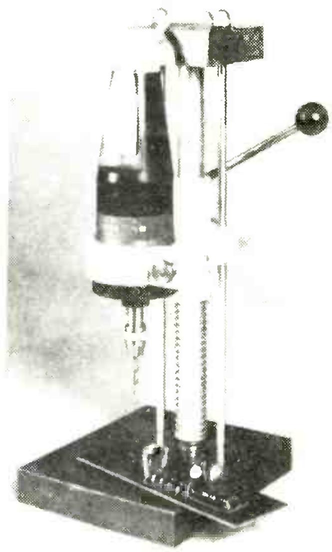

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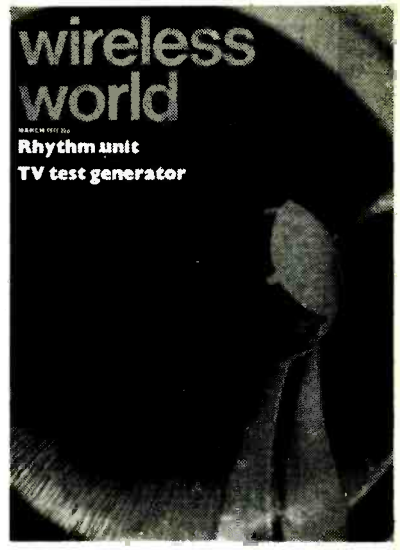

Front cover shows the interior of a Mullard scanning coil assembly for a colour television tube.
Photographer Paul Brierley

IN OUR NEXT ISSUE

Sensitive metal detector constructional design using beat frequency oscillator principle but with beat oscillator frequency mixed with 5th harmonic of search oscillator frequency.

Power semiconductor survey on construction and characteristics of transistors, thyristors, power Darlingtons and f.e.ts and related devices with applications and circuits.

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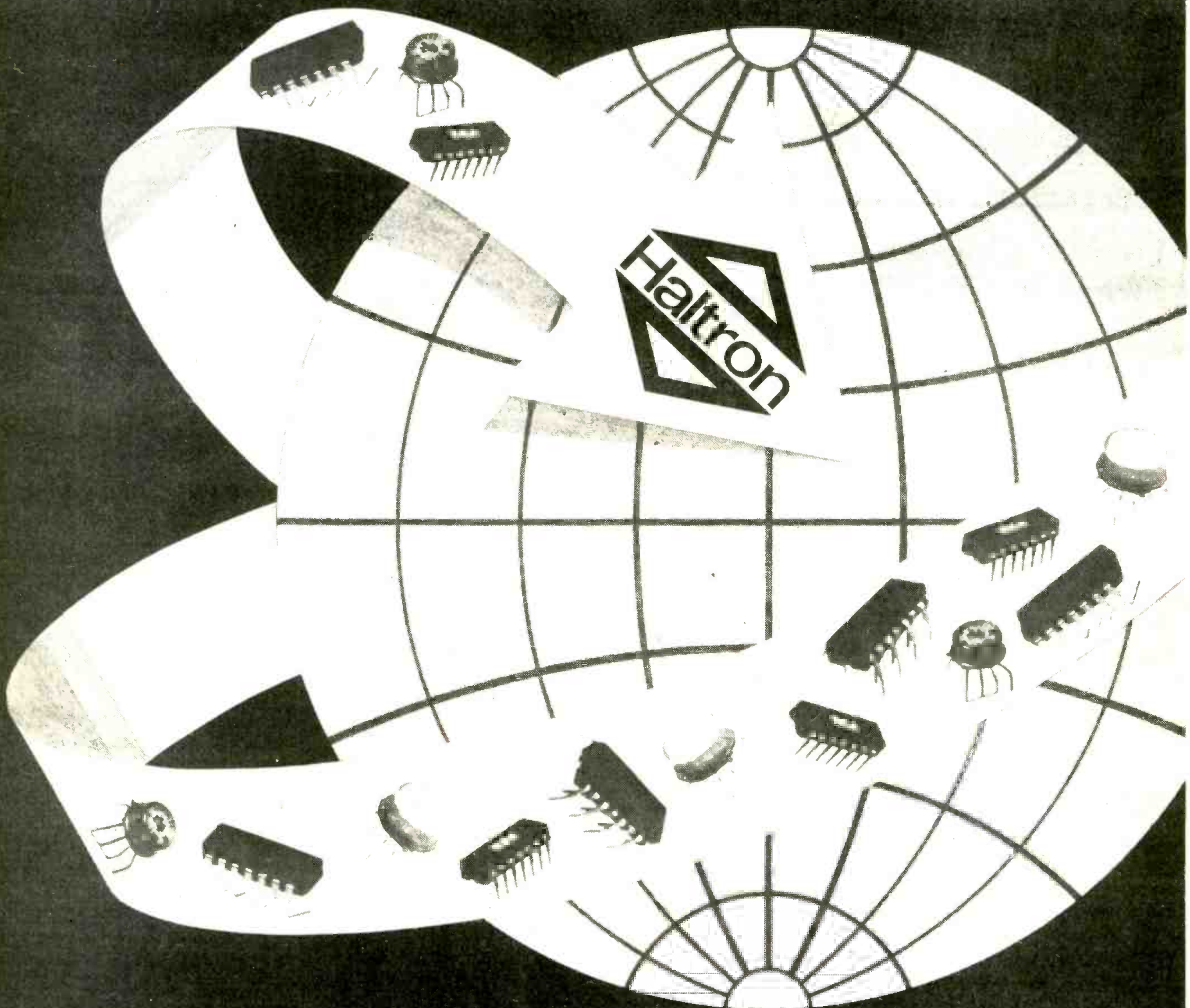
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The consciousness industry

James Hillier, an executive vice-president and senior scientist of RCA, recently warned "Every individual today is suffering from an information overload. We have more information than we can absorb . . ." If an important member of a large corporation that lives by processing and selling information can admit this publicly it must be serious. No doubt Mr Hillier's main concern is the effect of such saturation on his business. But there is another aspect of this saturation which deeply concerns us all: its effect on our consciousness and, by introjection, on the very nature of our being.

For information is not just an extraneous thing. As Norbert Wiener once pointed out, information is "the content of what is exchanged with the outer world as we adjust to it, and make our adjustment felt upon it." Similarly, the anthropologist Gregory Bateson has postulated that what we call "mind" is the process of information transfer within closed loops, not only those circuits which are completed within the brain or brain-plus-body but those which extend through the larger system of man-plus-environment. Nowadays electronics technology is increasingly involved in this man/world exchange process. Beyond the telephone and broadcasting one can see a whole host of new systems becoming part of our environment: teletext and Viewdata (see this issue), radio paging, video telephones, conference television, programmed learning, electronic transmission of mail and newspapers, selection of goods and services by two-way cable television, and personal communication through satellites and wrist radio sets. All these systems introduce special constraints into the exchange process — of time, space, power, bandwith and so on — and in using them we have to submit to the disciplines imposed by these contraints. Together with the well known mass media they form what has been described as "the consciousness industry."

There are two things we must watch. The first is who controls the consciousness industry — whether the state, business monopolies or a middle-class elite with assumptions of superiority — and for what purposes. The second is how this industry is modifying our central beliefs of what a human being should be. What sort of people is the consciousness industry manufacturing to satisfy the wishes of its masters? There are some interests, for example, that would wish to create man in the image of the ideal consumer.

It is true that the new two-way information systems, such as public information retrieval and "access" programmes on radio and tv, seem to give the individual a greater sense of autonomy and free will, but in the end what a person can select or say is restricted to a certain range or context by those who edit or control the systems.

The ecological movement has been successful in showing us that man cannot go on ravaging the biosphere without in the end impoverishing himself. We may soon have another movement to teach us that man cannot go on making himself even more of a slave to deterministic systems — from clocks and machines in the 19th century to information mills in the 20th — without impoverishing his own humanity.

Electronic rhythm unit

Up to 15 programmable rhythms for electronic organs

by A. Battaiotto and G. Ronzi *SGS-Ates Application Laboratory, Agrate, Italy*

Two m.o.s. integrated circuits designed to drive eight electronic musical instruments according to a programmed rhythm are described. With these i.cs, a rhythm section based on simulated percussion instruments can be incorporated into an electronic organ. Type M252 has 15 programmable rhythms. A general introduction to the rhythm generator is followed by device details and their principal electrical characteristics. A second article deals with the application of the devices and gives circuitry for inclusion of a rhythm section in an electronic organ.

The description rhythm generator is used to refer to a system which generates trigger or excitation pulses for oscillators, whose amplified, damped outputs simulate the acoustic sensation of the musical instruments in the rhythm section. The rhythm generator is not itself a source of sounds, but only a means of timing the switch-on of the oscillator circuits which constitute the sources.

To realize such a system each cycle of the complete rhythm must be divided into a number of "elementary times" using a counting technique. A fixed memory then determines whether or not a given instrument should be triggered during each of these elementary times. The elementary times or counter states, which constitute the smallest subdivisions of the rhythm can be grouped into bars or measures, usually 1, 2, 3 or 4. Within the complete rhythm, each of these bars can be programmed differently.

Each bar, then, consists of n elementary times in which the beats of each instrument will be programmed to occur. In musical notation the length of these beats is described as a fraction of a known reference period see Fig. 1. When the sum of the beats in any bar comes to 4/4, the rhythm is described as 4/4.

The number of elementary times in the bar fixes the minimum duration of each beat; in other words, the greater the number the elementary times the shorter will be the minimum length of the beats and the richer the resulting rhythm. For example, a 4/4 rhythm programmed in four bars over 32 elementary times, i.e. eight per bar, can only use musical beats of length 1, 1/2, 1/4 or 1/8 and not of 1/16, 1/32, 1/64. If the same rhythm is programmed in two bars of 16 elementary times each, musical beats of length 1, 1/2, 1/4, 1/8 and 1/16 can be used, 1/32 and 1/64 being still excluded. The basis of such a rhythm generator is illustrated by the block diagram of Fig. 2.

Table 1. Count requirement

1st case:	Rhythm 4/4 Minimum duration of each beat 1/16 Number of bars per rhythm 2 ∴ Count is 16 elementary times × 2 bars = 32
2nd case:	Rhythm 3/4 Minimum duration of each beat 1/16 Number of bars per rhythm 2 ∴ Count is 16 × 3/4 × 2 = 24
3rd case:	Rhythm 5/4 Minimum duration of each beat 1/16 Number of bars per rhythm 1 ∴ Count is 16 × 5/4 × 1 = 20

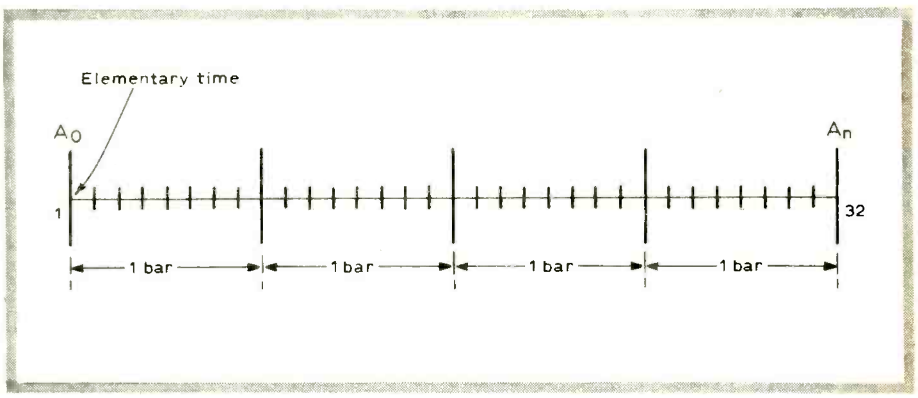
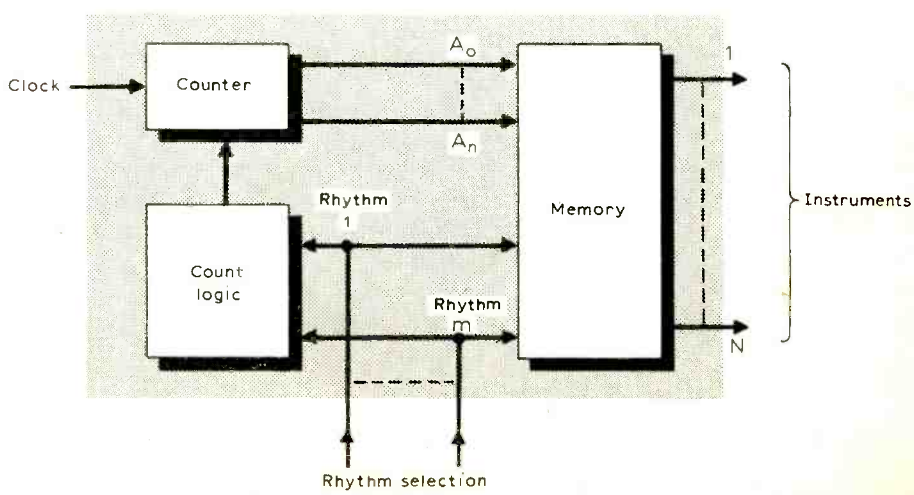


Fig. 1. Division of the rhythm into elementary times and bars.

Fig. 2. Block diagram of a trigger generation system for the oscillator circuits.



Counter

The counter must be able to count the number of elementary times corresponding to rhythms of 3/4, 4/4 and 5/4. This means that the counter must stop and reset to its initial position (to repeat the rhythm) after a certain number of counts which depends on the selected rhythm.

Two characteristics of the rhythm determine the count requirement i.e. the minimum beat of the rhythm, and the number of bars in the complete rhythm Table 1.

Making a practical rhythm generator

The system described in principle above can be realized with integrated circuits or discrete devices, illustrated in Fig. 3. If i.cs are used the counter can be produced in t.t.l. although due to the large amount of storage required, the memory will almost certainly have to be in m.o.s. Using a 4096-bit memory such as the M240, organized in 512 words of 8 bits, it is possible to program 16 rhythms selected by lines A5, A6, A7 and A8, each consisting of 32 elementary times (the counter drives lines A0, A1, A2, A3 and A4). As the r.o.m. outputs are not of the reset-to-zero type they must be reset by an external clock before being applied to the instrument oscillators. If the generator were to be built with discrete components both the memory and the count decoder could be realized with a diode matrix. The return to zero of the outputs can be achieved by resetting the decoder. But such a system would lead to the use of a very large number of diodes. As a result the reliability would be poor and the assembly cost very high.

The ideal rhythm generator

The characteristics of an ideal rhythm generator can be summarized in the following points.

1 The entire system described above would be contained in a single device thereby achieving maximum reliability in the minimum space. The labour required for assembly is also reduced.

2. The counter should have the highest count possible. For a rhythm containing a fixed number of bars this means that the rhythm can be subdivided into shorter beats and will consequently be musically more interesting. Similarly for a given number of elementary times the rhythm can be made up of a greater number of bars, possibly different, resulting in a more interesting musical effect.

3. The system should provide a large number of rhythms. Here it is necessary to make a distinction between rhythms which can be superimposed and those which cannot, as the concept of superimposition is closely linked to the number of available rhythms. Two rhythms are said to be superimposed when, selecting both simultaneously at the system input, the output commands for each instrument correspond to a combination of the commands that would have been produced by the rhythms selected separately, see Figs 4 & 5. Technically, rhythms can only be superimposed if they are selected by means of separate lines and not by a coding technique. Superimposition, therefore, involves a greater number of input pins (one for each rhythm), but does not call for a very high number of rhythms because the organist can choose any combination of those available.

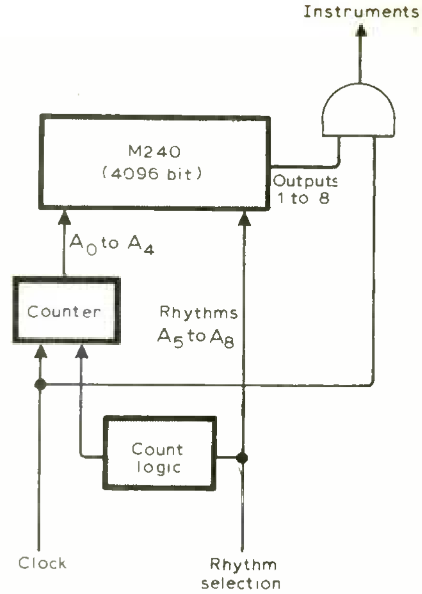
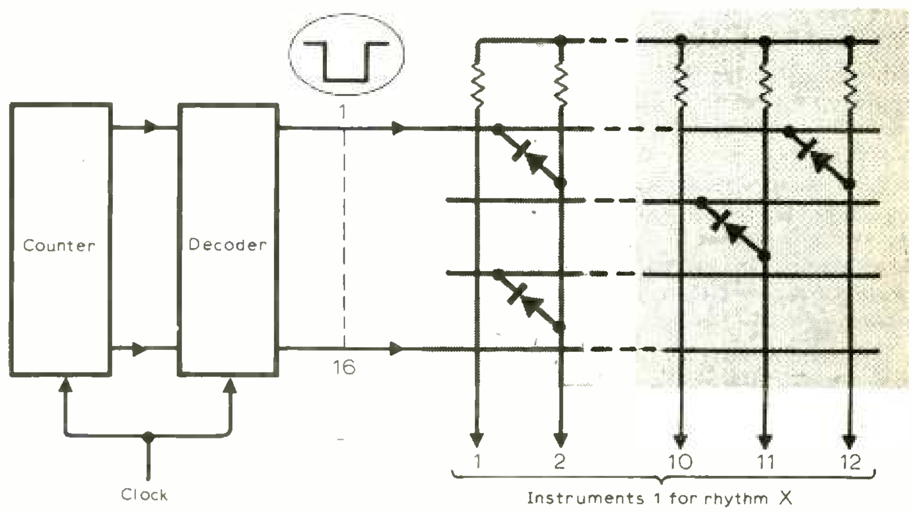


Fig. 3. System realized with i.cs (right) and with discrete devices (below).



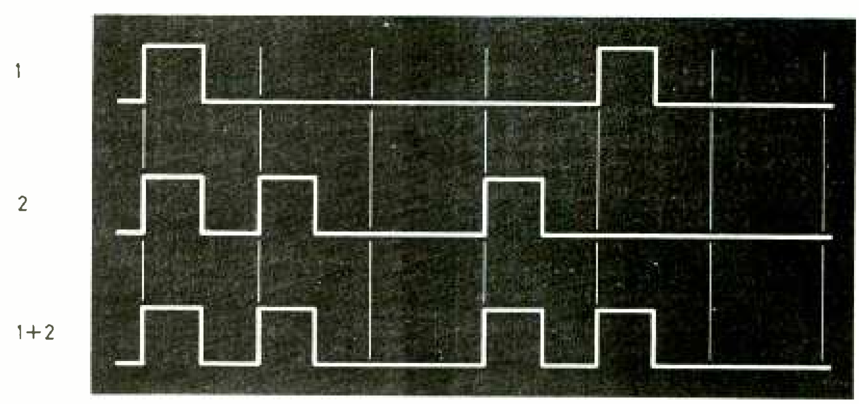
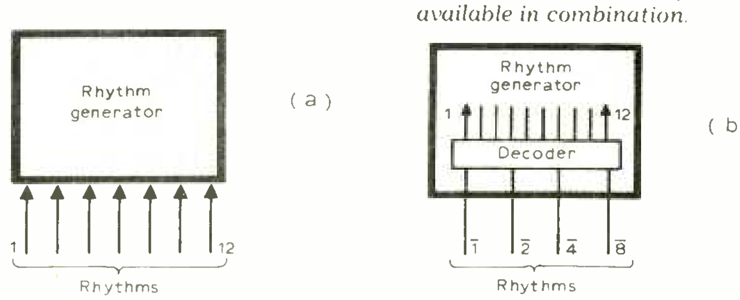


Fig. 4. Instrument trigger for combination of two rhythms.

Fig. 5. Rhythms superimposed and not. At (a) 12 rhythms are available in combination, at (b) 2^4 rhythms not available in combination.



In general, 12 is a sufficient number of rhythms if they can be superimposed, but there have to be more if superimposition is not possible, usually 15 or 16.

4. The system must have a large number of outputs (instruments). The number of instruments programmed for each rhythm will generally vary between 3 and 6. Eight represents a maximum number which is rarely used.

5. The system must be programmable in any time, 3/4, 4/4, 5/4, 6/8. It must therefore be possible to intervene at the mask programming stage, on the reset of the elementary time counter for each rhythm.

6. The system must produce no spikes on the memory outputs caused by successive decoded counter states. This creates undesired triggering of the instrument oscillators.

7. The system must provide the possibility of externally resetting the elementary time counter, so that it restarts from the first elementary time of the first beat. This enables key or touch operation in which the rhythm generator remains reset until at least one key is played.

8. The system should supply a down-beat output signal corresponding to the first elementary time of the first beat of each rhythm. This signal allows synchronization between the organist and the device's internal counter.

9. The system must be realized with a static form of logic designed for the low frequency operation of a rhythm generator (20 Hz).

Table 2: Rhythm selections
The following binary code must be generated to select each rhythm (logic positive)

Rhythm	8	4	2	1		
1	1	1	1	0	Waltz	3/4
2	1	1	0	1	Jazz Waltz	3/4
3	1	1	0	0	Tango	2/4
4	1	0	1	1	March	2/4
5	1	0	1	0	Swing	4/4
6	1	0	0	1	Foxtrot	4/4
7	1	0	0	0	Slow Rock	6/8
8	0	1	1	1	Rock Pop	4/4
9	0	1	1	0	Shuffle	2/4
10	0	1	0	1	Mambo	4/4
11	0	1	0	0	Beguine	4/4
12	0	0	1	1	Cha Cha	4/4
13	0	0	1	0	Bajon	4/4
14	0	0	0	1	Samba	4/4
15	0	0	0	0	Bossa Nova	4/4
No selected rhythm	1	1	1	1		

10. The system must be input compatible with t.t.l. and d.t.l. level signals so that it can be interfaced with an oscillator realized with such devices.

11. The system must have low dissipation — 150 to 300 mW.

12. The system must have a single standardized supply.

Points 2, 3 and 4 together create a single requirement, namely that the system must have a maximum memory capacity in terms of the number of bits. The maximum number of bits is limited by the die-size of the device which in turn is determined by the cost of the device itself.

Once the memory capacity has been established by economic factors, it follows that a compromise between the number of rhythms, the number of instruments and the number of elementary times will be made. An effective solution is

— a maximum of 32 elementary times
— 8 instruments
— 15 rhythms

with a memory capacity of 3840 bits (32x8x15).

The SGS-ATES solution

Rhythm generators type M253 and M252 fulfil all the requirements of the ideal system, see Fig. 6.

● The M 253 has:
– 12 rhythms which can be superimposed
– 3 instruments for 3/4 or 4/4 tme or 7 instruments for any time
— a maximum of 32 elementary times
— external reset

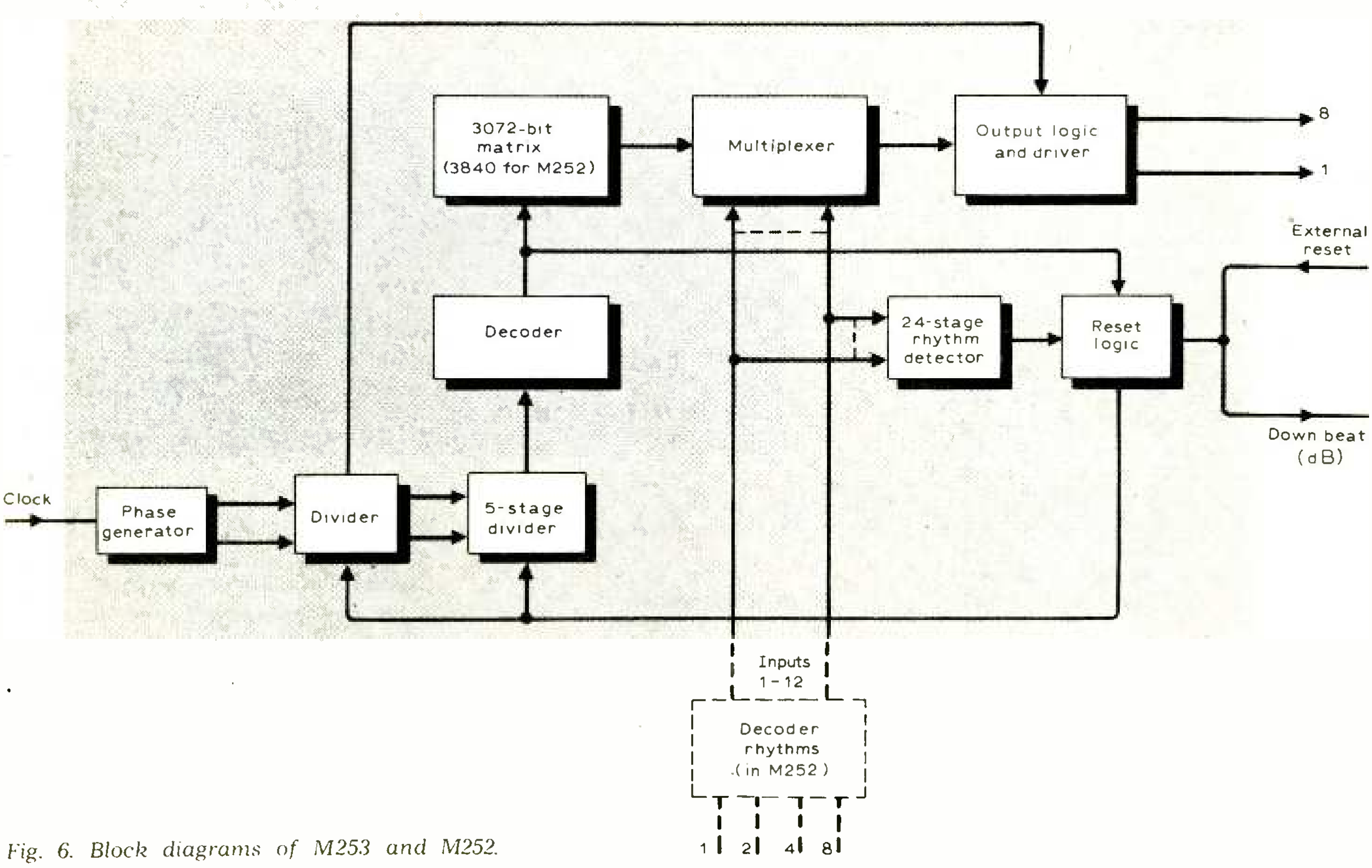


Fig. 6. Block diagrams of M253 and M252.

— down-beat output
— internal anti-spike circuit
— single supply
— low dissipation, typically 100 mW
— pin-to-pin compatible with the M250
— directly coupled
— 24-pin plastic or ceramic package

● The M 252 has:
– 15 rhythms which cannot be superimposed
– 8 instruments for 3/4 or 4/4 time or 7 instruments for any time
— maximum of 32 elementary times
— external reset
— down-beat output
— internal anti-spike circuit
— single supply
— low dissipation, typically 100 mW
– can be directly interfaced (input) with t.t.l, d.t.l.
— directly coupled
— 16-pin plastic or ceramic package.

Both of these devices are derived from the same chip which, during the processing stages, is provided with the memory pattern specified by the customer and the ancillary functions that distinguish the particular system.

How the M 253 works

The phase generator uses the incoming clock signal to produce the two non-over-lapping phases at regenerated levels which are required for driving the following divider.

This divider has to create a reset signal for the return to zero of the outputs. Width of this pulse is independent of the duty cycle of the incoming clock. The divider's outputs also serve as timing signals for the first stage of the five-stage counter, which uses master-slave static flip-flops.

The counter states are decoded to drive the rows of the memory matrix. The columns of the matrix are divided into 12 groups of 8, representing the 12 rhythms and the 8 instruments. One particular state, the 24th is decoded, logically combined with the rhythms in 3/4 time and is used as the counter's internal reset for rhythms programmed in this time. This device is therefore suitable for programming any rhythm in 4/4 time over 32 elementary times or in 3/4 time over 24 elementary times. This means that when a rhythm is programmed over a single bar the intervals can be as short as 1/32 allowing great musical flexibility.

The counter can also be reset by an external signal which, when driven directly by an output of the M253 itself, sacrificing one instrument, can be used to reset the counter to any position for times other than 3/4 or 4/4. If, for example, we want to reset at the state n for a rhythm X, a beat must be programmed at the elementary time $n + 1$ at the output of the rhythm to be used as reset. This output, connected at the input of the external reset, immediately zeroes the counter and therefore causes the disappearance of the reset signal; other than the $n+1$ beat there should be no program on the output used as the reset.

The columns of the matrix are

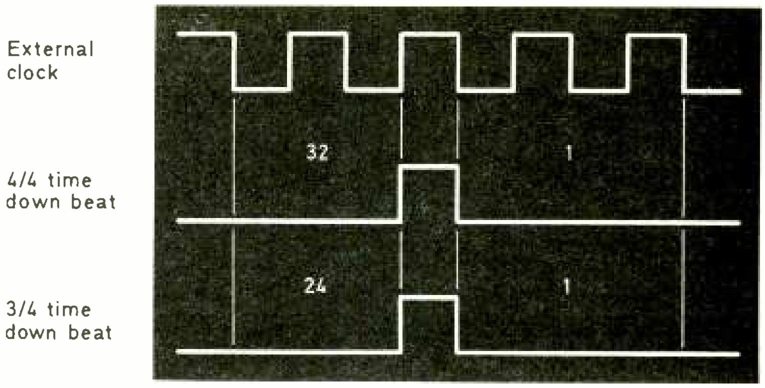


Fig. 7. Down-beat timing and duration.

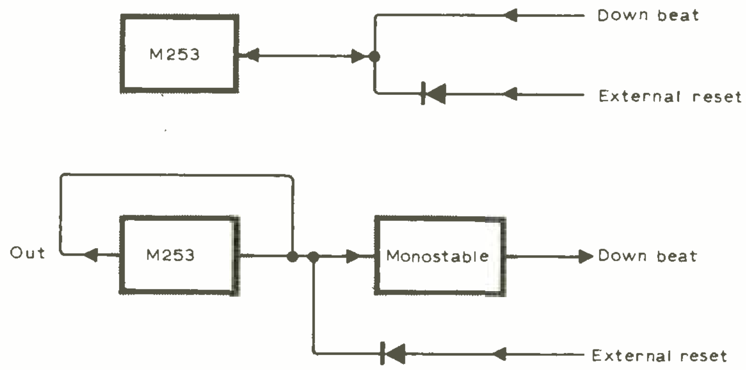


Fig. 8. Use of the down-beat signal.

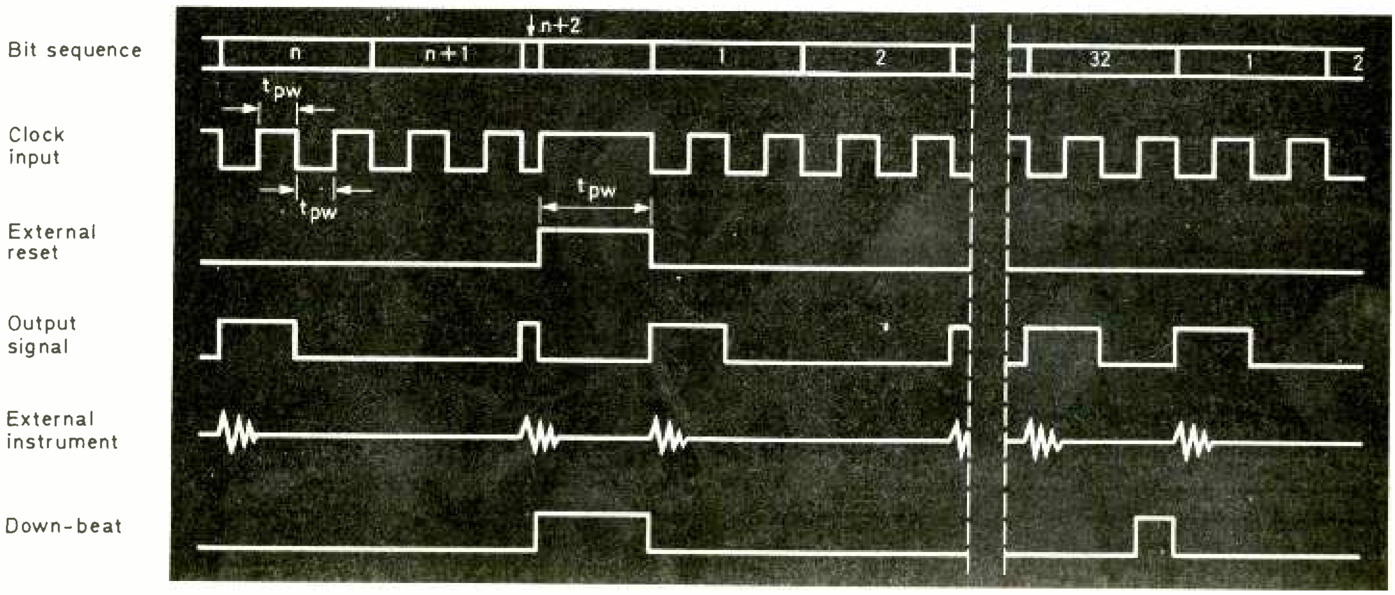


Fig. 9. Timing waveforms.

enabled, singly or in groups (the rhythms can be superimposed) via the buffer according to the rhythm or rhythms selected. The presence of one rhythm, therefore, does not exclude the possibility of another rhythm being selected contemporarily, and the result on the output of each instrument for each rhythm is the sum of the beats of the single rhythms, see Fig. 4. One particular case is when the rhythms are selected contemporarily with a different matrix, eg a 3/4 or 4/4 rhythm. In this case the count cycle will correspond to the rhythm with the lowest number of elementary times, in the example the cycle will be of 24 elementary times.

The delayed, decoded signal from the 24th state (3/4 rhythms) and the 32nd (4/4 rhythms) are used as down-beat signals, i.e. as starting signals to indicate the first beat of the first bar, see Fig. 7. This signal, whose usefulness will be seen in the application section, was brought out to a pin already used for an input signal — the external reset signal — since no supplementary pin was available in the package used. In reality, the presence of an external reset signal is compatible with a down-beat signal although the reverse is not true as a down-beat signal must not have the effect of an external reset. This can be achieved by using a diode to separate the two signals as shown in Fig. 8.

For rhythms other than 3/4 or 4/4 the pulse present at the output connected to the external reset can be used to trigger a monostable circuit, whose output will be the down-beat signal. When no rhythm is selected the down-beat signal is present and the counter counts to 32.

Operation of the M252

The phase generator, the counter, the matrix, the output and reset logic, and the 24th state decoder for the reset in 3/4 time, operate in the same way as in the M253. The difference is in the rhythm command inputs, which are in binary logic using the code shown in Table 2. Given that it is impossible to select two different codes at the same time, it follows that it will be impossible to superimpose these rhythms.

One code word has been used to indicate "no rhythm selected." In this state, there are no instrument output signals, the down-beat signal is present and the counter counts to 32.

For the dynamic characteristics note that a duty cycle of 50% is not required for the clock signal. The width of the "mark" of the clock waveform need only be as great as the width of the down-beat impulse internally generated.

Supplies and absolute maximum ratings

All the supplies and levels shown in Tables 3 and 4 are expressed as a function of V_{SS}. As V_{SS} can have any value, various power supply formats can be used, e.g. V_{GG} 0V, V_{SS} 17V; V_{GG} −12V, V_{SS} +5V, and so on as long as $V_{SS}-V_{GG}=17\pm1V$. This makes it very simple to solve the problem of interfacing with input and output devices. The user, however, must always respect the limits imposed by the absolute maximum ratings, Table 5. These voltages, temperatures or currents are values which must never be exceeded, not even momentarily, as the device can be permanently damaged should this occur.

It is of particular importance that a check is kept on the positive overshoot at all the pins with respect to V_{SS} (see Fig. 10). If the positive overshoot, which, on the oscilloscope will always appear limited to one V_{BE} when measured on an in-circuit device, exceeds the values quoted in the absolute maximum ratings it causes a parasitic which discharges the surrounding negative nodes, causing incorrect circuit operation. More seriously, a fixed positive level more than 300 mV above V_{SS} will probably damage the circuit.

(To be continued)

Table 3: Static electrical characteristics (positive logic, V_{GG} −11.4 to −12.6V, V_{SS} 4.75 to 5.25V, T_{amb} 0 to 70°C unless otherwise specified)

Quantity		Test conditions	Min.	Typ.	Max.	Unit
Clock input						
V_{IH}	Clock high voltage		$V_{SS}-1.5$		V_{SS}	V
V_{IL}	Clock low voltage		V_{GG}		$V_{SS}-4.1$	V
Data inputs ($\overline{IN1}$ …… $\overline{IN12}$)						
V_{IH}	Input high voltage		$V_{SS}-1.5$		V_{SS}	V
V_{IL}	Input low voltage		V_{GG}		$V_{SS}-4.1$	V
I_{LI}	Input leakage current	$V_I=V_{SS}-10V$ $T_{amb}=25°C$			10	μA
External reset						
V_{IH}	Input high voltage		$V_{SS}-1.5$		V_{SS}	V
V_{IL}	Input low voltage		V_{GG}		$V_{SS}-4.1$	V
R_{IN}	Internal resistance to V_{GG}	$V_o=V_{SS}-5V$	400	600		kΩ
Data outputs						
R_{ON}	Output resistance	$V_o=V_{SS}-1$ to V_{SS}		250	500	Ω
V_{OH}	Output high voltage	$I_L=1mA$	$V_{SS}-0.5$		V_{SS}	V
I_{LO}	Output leakage current	$V=V_{IH}$ $V_o=V_{SS}-10V$ $T_{amb}=25°C$			10	μA
Consumption						
I_{GG}	Supply current	$T_{amb}=25°C$		7	15	mA

Table 4. Dynamic electrical characteristics (positive logic, V_{GG}, V_{SS} −16 to −18V, T_{amb} 0 70°C unless otherwise specified)

Quantity		Min.	Max.	Unit
Clock input				
f	clock repetition rate	0	100	kHz
t_{pw}	pulse width	5		μs
t_r	rise time		100	μs
t_f	fall time		100	μs
External reset				
t_{pw}	pulse width	5		μs

Measured at 50% of the swing
Measured between 10% and 90% of the swing

Table 5. Absolute maximum ratings

V_{GG}*	Source supply voltage	−20 to 0.3V
V_I*	Input voltage	−20 to 0.3V
I_o	Output current (at any pin)	3mA
T_{stg}	Storage temperature	−65 to 150°C
T_{op}	Operating temperature	0 to 70°C

*This voltage is with respect to V_{SS} pin voltage

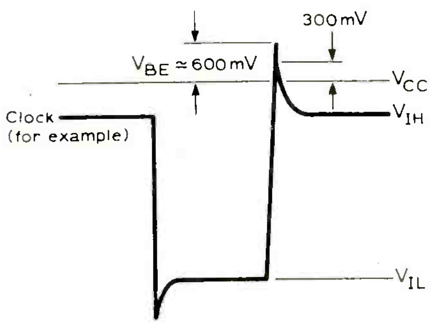


Fig. 10. Positive overshoot.

Low-noise, low-cost cassette deck

Several readers have found that the erase and bias oscillator in this design (May, June and August issues, 1976) can be reluctant to work. The cure is to reduce the value of C_{21} in Fig. 5 of the May 1976 issue from 2.2μF to 1μF.

News of the Month

UK to consult on frequencies

The Home Secretary has invited comment on frequency allocations for the 1979 World Administrative Radio Conference. In a Commons written reply on January 26 he said: "We have already undertaken a substantial measure of consultation with both users and manufacturers of radio equipment during the preliminary phase of our work for the conference; but at this stage, before the United Kingdom's proposals for the conference are formulated, we think a rather wider programme of consultation is desirable. . . In the circumstances we consider it right to make every effort to ensure that any whose interests may be affected should have an opportunity to state their views before our decisions are made. Those known to have an interest will be specifically invited to comment; but comments will be welcomed from any members of the public. They should be in writing and should reach the Home Office Radio Regulatory Department, Waterloo Bridge House, Waterloo Road, London SE1 8UA by 30th April 1977."

The announcement follows meetings between the Home Office and the electronics industry, themselves partly a result of an editorial and other articles in *Wireless World*, revealing parts of still secret Home Office reports on matters to come before the 1979 WARC, and calling for greater consultation.

Tiny tv: now you see it . . .

After years of rumour and many confident predictions that "next year" would see the launch, Clive Sinclair showed his 2in television receiver to a large collection of professional cynics – the press – on Monday, January 10.

Let it be said at once that the Microvision is a remarkable piece of design. Most of the components, including three of the five integrated circuits and the tube, were developed for the receiver, which measures 6 × 4 × 1½in. It is most certainly not a toy – with a £200 price tag it is certainly free of that connotation – since most of the design compromises appear to have been made with low power consumption in mind.

The tube was developed by AEG Telefunken, who based their development on a design by A. V. de V. Krause (*Wireless World*, July 1974, p.259). The screen diagonal is 2in, and the tube length about 4.5in. Electrostatic deflection is used to reduce power consumption. The e.h.t. is about 2kV, derived from an oscillator which provides barely acceptable brightness. (We were not able to look at the picture out of doors because the Sinclair staff seemed so nervous that some acquisitive scribe might make off with the set that we weren't allowed to hold it, let along go outside with it.) Sinclair were unsure of the heater power – at one time the Krause tube consumed 30mW – but that of a similar AEG Telefunken tube advertised in German and Danish magazines is quoted as being 35mW.

Sinclair's notion that the receiver could be of use to travelling businessmen is supported by the flexibility of tuning and standards. The own-design bipolar tuners cover Bands I, III, IV and V with the aid of p-i-n diode switching and varicap-diode tuning. Line standards of 625 and 525 at field rates of 50 or 60Hz are provided, with i.f. selection of 4.5, 5.5 or 6MHz. Tuner sensitivity, assisted by separate, folding v.h.f. and u.h.f. aerials, was good enough to give a reasonable picture in the steel-framed Savoy Hotel. Gated a.g.c. and a.f.c. are included, as is flywheel sync.

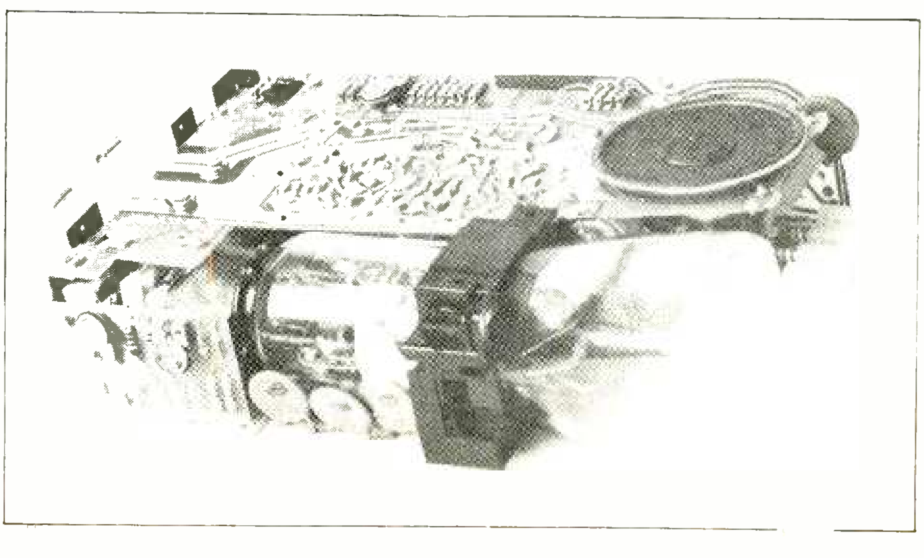
Sinclair decided to use two SGS i.cs for sound i.f. and 50mW audio output, but vision functions are performed by three chips designed by Sinclair and a further 20 transistors. Attention to power-saving in the design has yielded a truly amazing consumption of 750mW from 4.8V. Four 1.2V rechargeable cells are used. These last four hours but an external a.c. adaptor will charge them and run the set as well. A 40-hour battery pack can be used, as can a car battery, which will also charge the internal cells.

It may be said that the size of the picture is too small for comfortable viewing. It is little bigger than a 35mm slide, which is usually projected or seen through a magnifier. Sinclair say that 2in was selected after tests with many people and point out that 2in at a viewing distance of a foot – the distance, they say, at which most people read a paperback book – is equivalent to a 24in screen 12 feet away, provided that the spot size is reduced to enable the resolution of the big picture to be retained, which they claim to have done.

However, the angle subtended at the eye is not the only important measurement. Normally two eyes will be used, and the way they converge, together with apparent size, is part of the process which gives the viewer an appreciation of distance. The brain will recognise a big picture, placed farther away than a small picture, as being bigger than the small one and will automatically assume that the bigger one is more detailed, even though it may not be. C. Burns, in an article in *Wireless World* in January 1953, pointed out that a magnifying lens not only increases the subtended angle but makes the screen look farther away, thereby adding to the apparent increase in size. Sinclair have probably considered the use of a lens, but if so they made no mention of one as an accessory.

The scepticism which has arisen as a result of the previous frequency of false alarms about the Sinclair set's imminent appearance in the shops was compounded by the secrecy which still surrounds its production. At the Savoy press conference on January 10, Clive Sinclair said that they first started the project 14 years ago and had produced

Sinclair's Microvision. Sinclair say the final assembly "requires only the connection of four printed circuit boards, insertion and connection of the tube, and housing the whole in a three-piece black steel case." The circuit uses 300 transistors. The heater needs 15s to warm up as a contribution to its low power consumption.



several complete receivers in that time "but they all lacked something and we wanted to do it properly. We have spent £½ million of our own money to do this in research and development". Yet the National Enterprise Board, which last November took a 43% stake in Sinclair, worth an injection of another £650,000, on the basis of a three-year profit forecast on the Microvision, have not, Sinclair says, committed the company to any production schedule. He would not say when production would start, how many staff would be making them, or what the initial number made would be, yet he insisted that the sets would be in the shops "next month". Who would be stocking the set? He couldn't say: "We haven't invited any orders because we haven't shown before." He would show it to the trade first. "Existing customers are interested in taking sets," he said. (Lasky's have since confirmed that they have ordered an unspecified number of sets for delivery when they become available. An order for the sets has been outstanding for some time.)

Although he asserted that "To the best of our knowledge nobody else is even remotely close to doing what we are doing," Sinclair added during questions that to give a production figure "would be valuable information for our competitors." What competitors? "Any that care to come along." They had had pilot models for some time, he said, and had been conducting field trials in various parts of the world since last August. There were "dozens of sets in existence," he said. But since they would not be able to supply the demand until the middle of the year any of the £¼ million of advertising they planned would not be spent till then. Later he said he didn't know what the volume of production would be because "we don't yet have it as a viable product".

In one or two years' time they would produce a single-standard, lower-priced model for the mass market, but the main aim was to reach the prestige, executive market, particularly in the US. Most of the current sets would be exported and it would eventually account for half Sinclair's turnover. "The market is comparable with the market for pocket calculators, about 50 million units a year; comparable bearing in mind that it's a more expensive item." He had "no clear idea" what the simpler sets would cost.

In his opening remarks Sinclair said, "We have no plans for colour. It is technologically possible but would add greatly to the cost and we can't see any justification for such an increase." When asked later how much a colour set would cost he said, "We can't put a figure on a colour system." Most of the cost would be in the tube: "We haven't looked at this in great detail. The use of a shadow mask tube would be impossible on such a small screen so it would have to be non-standard."

The price of the black and white set has been fixed at £175 plus VAT. Sinclair says there is no prospect of a reduction: "Firstly because it is such a complicated product and, secondly, we have a monopoly."

Home and small business computers

According to a summary of a $950 report by Venture development corporation, 24,164 computers will be bought for home use in the US this year. The market will increase annually by over a third up to 1981. Over 70% of the hobbyist owners used them for games. The study was conducted over seven months, and was compiled by asking questions of users, makers, retail stores and hobby groups in the United States.

Most of the sales in the five-year period will be of mainframes. The income to computer stores, from whom hobbyists get 61.6% of their equipment, will increase annually by 46.3%, representing unit increases of 47.8%. Mainframe revenues will increase by 42.5% annually, while software, main memory, peripheral and other products will increase only 35.1%. Software will show the biggest increase of those groups, an average 81% up to 1981. The summary does not give a value for any of these figures.

Creative Strategies Inc has produced another report, on the small business market. In 1972 deliveries to this market were worth $794 million in the US. Three years later the figure was nearly double at $1.4 billion. By 1980, they say, it will be worth $2.2 billion. The figures for units shipped in those years are 20,300, 38,000, and about 75,000.

Confirming EEC views of our own position, Creative Strategies say that although IBM, Burroughs and NCR have a large share of the market, their study shows that market is far from "sewed up". "The most explosive action in the small business computer industry is coming from minicomputer-based systems."

Creative Strategies seem to have the same view of the market as the EEC. Although the market is dominated by IBM, Burroughs and NCR, there are about 100 makers in the fray, including system houses. It will take about three years for the market to sort itself out: "The most explosive action in the small business computer industry is coming from minicomputer-based systems and this segment has attracted most of the participants . . . In 1975, 8,500 minicomputer-based systems were shipped and in 1976, 16,000 are expected to be shipped." By 1980, they say, the figure will be 46,000.

Tiny transceivers and satellites

A ten-dollar wrist radio using l.s.i. techniques could be used for personal communications within ten years, according to reports from the United States. *Communications News* reported in September that the National Space Institute predicted "within ten years a new generation of communications satellites could provide the public with highly-reliable interference-free personal communications via a wrist radio which could be used for pleasure, business, emergency situations, rescue, health monitoring." The NSI's executive director, Charles Hewitt said, "With adequate public interest and support, such a satellite system could be developed to service millions of people with the ability to talk directly to each other from wherever they are on land and sea, or enter the telephone networks through the microphone on their wrist radio for a new era in communication flexibility." These radios could use the same techniques now used in digital watches and, if produced in large enough numbers, could sell for less than $10 each.

The NSI is a non-profit-making educational and scientific body chaired by Wernher von Braun, who was in charge of the Apollo space programme. Its function is to communicate the benefits of the US space programme to the American public.

In a speech to the Conference on Satellite Communication and Public Service on December 9, NASA administrator James Fletcher said: "Studies have been made of a personal communications system which involves direct broadcast from a "wrist watch radio" to a high-capacity, multibeam satellite for retransmission to ground communications centrals. The satellite might be 150 feet in diameter with the capacity of handling up to 25,000 switched channels. The ground transmitter could be small and low power,' perhaps 1/25 mW. With large scale integrated circuit techniques, the ground transmitter need not cost much more than $10." Such a system would allow the growth of a large number of ground stations, making space technology available to the man in the street. The basis of the technique was to put large aerials on high power transmitters in space, allowing a reduction in the size of the equipment needed below.

The Federal Communications Commission, according to a report in *The Times* . approved in January a new satellite communications service for business use. The service, first put forward in 1971, will cost an estimated $406.9 million (£239m) and will start in 1986. The proposal was opposed by AT&T and Western Union.

Cash aid to electronics industry

£20 million has been provided under section 8 of the 1972 Industry Act for "a scheme of selective assistance for the electronic components industry". If the industry response to the scheme warrants it, said a Department of Industry statement, the amount may be increased.

The scheme is to encourage UK based firms in the radio and electronic components industry to increase their efficiency "It is designed to promote the design, development and production launching of new products and production technologies, the restructuring of a company or group of companies . . . and independent studies by consultants to identify opportunities for improving efficiency of a company or merged companies . . .

The money is for up to a quarter of the total eligible cost of a new project (or half with a royalty agreement). Eligible projects are those where costs are £50,000 or more. Loans for up to half the project cost will also be available in the case of restructuring.

Besides these, 20% will be available for new equipment, plant and machinery; 15% for new buildings, extension or modification to buildings.

In all cases, says the DI, "The Department would have to be satisfied that the company had the capability to carry out the propositions to a successful commercial conclusion." Applications must be in by July next year.

The announcement, made on January 24, follows an active campaign by sections of the electronics industry for cash aid, notably Mr Jack Akerman of Mullard. He has pointed out, in an article in *Electronics and Power* in September, that the components sector alone employs 125,000 people and has a turnover of £650 million.

The Electronics Components Board has issued a statement welcoming the scheme "as a most important step towards strengthening the capacity of the British electronic components industry and as a clear demonstration of its importance to the economy . . . Many proposals by companies have already been submitted to enable the scheme to get off to a good start without any delay."

New computerised sound mixer

Air Studios in Oxford Street, London, have installed the first Neve computerised mixing console to go into production. The system was demonstrated last March and had been described by Neve managing director Derek Tilsley at an American digital audio techniques conference in April, 1975.

NECAM, as it is called, consists of a sound mixing console, a 3M 24-track tape machine (in Air's case), Computer Automation LSI220 mini-computer, floppy disc store, code reader, display and control panels, transport and control interfaces. An SMPTE time code is recorded on to one track of the multitrack tape, and it is this which enables the engineer to refer to and update any section of the tape. Various takes may be stored and reassembled into a final take by manipulating data through a keypad on the mixing console.

An 8kbyte core store houses the Neve programme and transient data, and is supplemented by two floppy discs. The left-hand disc stores "scratch pad" information and the right-hand disc stores permanent information. It is the latter that the producer takes away along with the master tape. Neve technical director Martin Jones said: "In testing we pile in the data and fill the disc in the equivalent of a couple of takes, but in normal studio use there is more than enough room to store the mixing of a whole l.p. side."

As well as storing mixing information the tape can be labelled in up to 999 places, he said, so that if the engineer wants to identify a particular place on the tape he can give it a number by operating the keypad and later instruct the tape to go to that place. There are other systems which do this, such as the 3M Selectake, but less automated studios may have to identify the beginning and end of different sections of music by inserting strips of paper into the tape reel as it turns.

The installation of the system meant closing studio three for a month. Air, part of the Chrysalis group, has a consistent record of investment in new equipment and, as studio manager Dave Harries put it, "It's better than giving it to Healey." Neve too have persevered with the development of NECAM even though the economic health of the world, the nation and the recording industry have deteriorated steadily since they first gave serious thought to the project three years ago. During that time their holding company, Energy Services and Electronics, have been forced to contract from a fast-expanding electronics group in the days when, as Bonochord, its takeover of Neve provided the company with badly-needed capital, to just two companies, Neve and Livingston Hire.

The market for NECAM may justify the investment. EMI are installing a system at Abbey Road and another is going to De Lane Lea/CTS Studios at Wembley. The use of the SMPTE code makes the system well suited to its use in film and television studios, a market that Neve have done well in over the years with conventional equipment. Neve still appear to do well abroad, and say they have orders in Brunei, Nigeria and South Africa.

The Comsat General terminal in the radio room of the QE2. The terminal links the world's Telex and telephone system with the ship via the Marisat communications satellite chain. The equipment was supplied by STC subsidiary International Marine Radio Company.

Teletext on sale

A teletext add-on adaptor first demonstrated as a prototype at the Home Electronics and Domestic Appliance Exhibition in Birmingham last May is now on sale, "in Harrods" among other places. It is made by Labgear, a Pye subsidiary, who say it was first despatched to customers before Christmas. At first they are making 200 a month but the managing director, Mr S. R. R. Kharbanda, said in a statement that the number would increase as the year went on. The adaptor connects with the aerial socket on a receiver.

The British Electrotechnical Approvals Board (BEAB) has tested and approved the first commercial colour tv set with an integral teletext decoder, the Rank Bush 22 inch BC6333 receiver. BEAB says the set has passed British Safety Standard BS415. Rank say the set is not available to the public yet, though some have been despatched to the trade and broadcasting organisations for appraisal.

The export prospect for both these units is an interesting one: Labgear say in their statement that they have been invited "overseas" to demonstrate the adaptor. Although the European countries have carried out a great deal of work on their own systems — Sweden for example developed an "Extratext" system which would take into account certain language difficulties which exist there — most of them seem quietly to have dropped their own systems in favour of the British teletext. At a CCIR meeting to discuss various systems in Geneva last year only one other system was advanced besides the British one.

The odd country out, predictably was France. "They're doing another SE-

CAM," muttered one source. Their system is called Antiope, after two Greek mythological figures. Sweden is now using the British system and the Germans and the Dutch are appraising it. Perhaps the only difficulties in the way of its adoption might be those which would accompany the adoption of any system, namely the objections of newspaper proprietors and others unsure of the effect of teletext on their own industries.

NASA in 1977

Of NASA's 23 spacecraft launches scheduled for 1977, 17 will be for paying customers other than NASA. They include NATO, Indonesia, European Space Agency, National Oceanic and Atmospheric Administration, COMSAT Corporation, US Navy, Japan, Italy, RCA and the United Kingdom. In 1976 the number of launches was 16, four of which were NASA launches. The UK launch, the UK-6 high energy physics and astronomy satellite, is tentatively scheduled for October from Wallops Flight Centre, Virginia. The launch vehicle will be a Scout rocket.

The first launch of the year, at the end of January, is a NATO communications satellite, but NASA say the emphasis this year is on applications satellites 'for the direct benefit of people on earth." 17 of the launches are in the communications, geodetic, environmental, navigation, meteorological or earth resources fields.

'Send no money!'—FCC

The Federal Communications Commission in Washington has stopped the collection of fees for licences from January 1. On December 16 the District of Columbia appeal court released a verdict on four actions taken by the National Cable Television Association, the Electronic Industries Association, the National Association of Broadcasters and Capital Cities Communications Inc, all of whom had appealed against the fees they were charged. The court directed the FCC to justify each fee assessment and to calculate "the cost basis for each fee". The Commission has therefore suspended all fees and will study the "legal and administrative implications of refunding fees in order to determine the extent and nature of any refunds that might be necessary." They would make any necessary refunds "as soon as possible."

The decisions mean that the FCC's authority to assess any fees is in doubt. The Commission says it had urged the congress to pass legislation clearing the matter up when it had adopted its 1975 scale of fees but nothing had been done.

On December 30 the FCC issued a notice urging the public not to send money, particularly for c.b. licences, though the court's decision also affects fees from tv stations and telephone companies. But the FCC also warned that purchasers of c.b. equipment must send in licence applications since operation without a licence was illegal. At the end of the year about 7.8 million people (1.8 million more than we forecast in our article on citizens' band in January) held c.b. licences, and applications were coming in at 400,000 a month.

Any cheques coming in after the beginning of 1977 would be destroyed, said the Commission. Postal orders and cashiers' cheques would be returned but there would be a delay. It is not yet clear what will happen to fees sent in before then.

Some sources in the UK have attributed the refusal of the FCC to collect c.b. fees as a sign of the chaos resulting from the large number of applications. There seems no basis for this interpretation.

Canadian satellite broadcasts television

In spite of early power supply difficulties (August 1976 issue) the Canadian-American Communications Technology Satellite "Hermes" is now successfully demonstrating direct broadcasting of television programmes at 12GHz to home-type installations in Montreal, Ottawa and Toronto. Ground aerials of 60cm, 1m 1.2m, 1.6m and 2m diameter are being used. According to a report by C. A. Siocos in the *ABU Technical Review* for January 1977, the satellite's effective isotropic radiated power achieved is 59dBW. Representative values for weighted single-to-noise ratio are 47dB with the 2m receiving station, which has a noise figure of 6.5dB, and 40dB with the 60cm station which has a noise figure of 4.5dB. "Other transmission impairments are very small and . . . there are no ghost reflections received in any of the sites." Fading due to rain is short-lived. "Observed fadings . . . resulted in a visible increase of noise (more so with the smaller antennas) but no interruptions, except for some five minutes."

Earlier the CTS was demonstrated as an outside broadcast relay station (Bromont, Quebec,-to-CTS-to-Montreal) during the 1976 Olympic Games. Also, in a co-operative Canadian-American experiment, engineering classes at Stanford University, California have been televised to Carleton University 2,500 miles away in Ottawa and vice versa. In this experiment a NASA developed technique called real-time digital video signal compression was used to reduce transmission bandwidth and power requirements. NASA say that ". . . initial student response has been favourable". Broadcasting by satellite to schools is considered a possibility.

The year's Commons c.b.

In a written answer on October 19 Mr John R. Rathbone, the Conservative member for Lewes, asked the Secretary of State for the Home Department "whether he will review his policy regarding establishment of a v.h.f. citizens' radio band and if he will make a statement."

Mr Brynmor John (Lab, Pontypridd), a Home Office Minister, replied for the Home Secretary: "No".

On October 21, under the heading "Walkie-talkie equipment", former BBC and ITV producer Phillip Whitehead (Lab, Derby North) asked: "Is my honourable friend aware of the great concern that exists about the amount of interference caused in the 27 and 28MHz band by illegal walkie-talkie equipment? Is it not absurd that the Home Office, which has a responsibility here, will not impound such equipment or ban its importation when by definition it can only be used illegally? Can we not take some action now instead of waiting for the formation of policy on a citizens' waveband?"

Mr John: "I share my honourable friend's concern about the use of walkie-talkie equipment, and particularly about the interference with equipment sustems which are located on this frequency, many of which systems are performing a useful function. But it would be wrong to legislate piecemeal when in 1979 there will be a world administrative radio conference which may well put forward many more general recommendations which will need legislation to gather them all together, and that many be a more appropriate time to act."

Mr Rathbone: "Will the minister explain why he gave such a peremptory "no" to my question for written answer a few days ago, seeking the establishment of a citizens' band on v.h.f.? Is he aware that the establishment of such a band would meet exactly the exigencies of the problem which the honourable member for Derby North (Mr Whitehead) raised? It would have the additional advantage of raising money for the government and an even greater advantage to citizens wishing to use such a band in being able to do so."

Mr John: "I gave a peremptory answer "no" because the honourable member asked, as I recalled, whether it was the government's intention to set up such a citizens' band. Our answer is still "no" but I shall consider these matters, and if the honourable member has further representations to make to me perhaps he will do so."

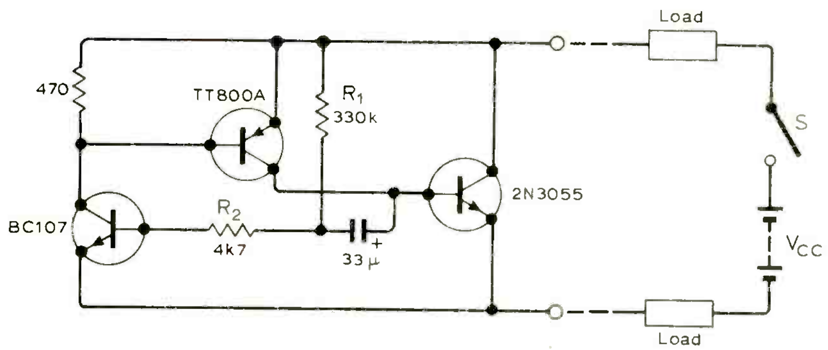
In another answer on the same day Mr Whitehead was told that in 1974 there had been ten prosecutions for the illegal use of walkie-talkies. In 1975 the figure was four.

Circuit Ideas

Two terminal circuit breaker

The unit functions by sensing a load current across the base-emitter junction of the output transistor (voltage sensing requires a third terminal). Resistors R_1 and R_2 control the off and on times respectively provided V_{cc} and I_{load} do not change. The capacitor undergoes a small amount of reverse bias (~ 0.7V). Good tantalum capacitors will stand this and, unofficially, so will most electrolytics with voltage ratings above 16V.

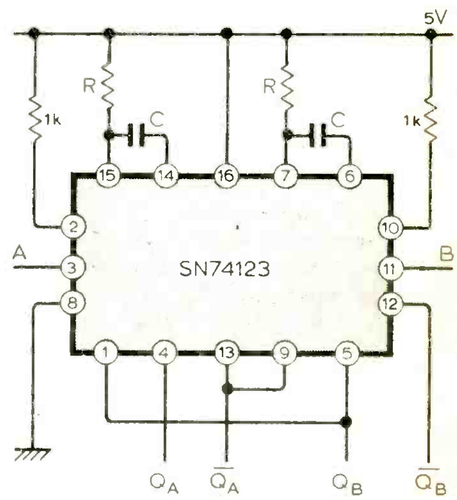
M. Faulkner,
New South Wales,
Australia.



Simple ring oscillator

This i.c. oscillator can be disabled by applying a 0 at either input, and will be retriggered when the low input is returned to a logic 1. Although under normal operation there are only two outputs, when the oscillator is disabled only one pair of outputs undergoes a further transition before oscillation stops. Therefore, this circuit is suitable for applications where it is necessary to have control of the stop and start point in the duty cycle.

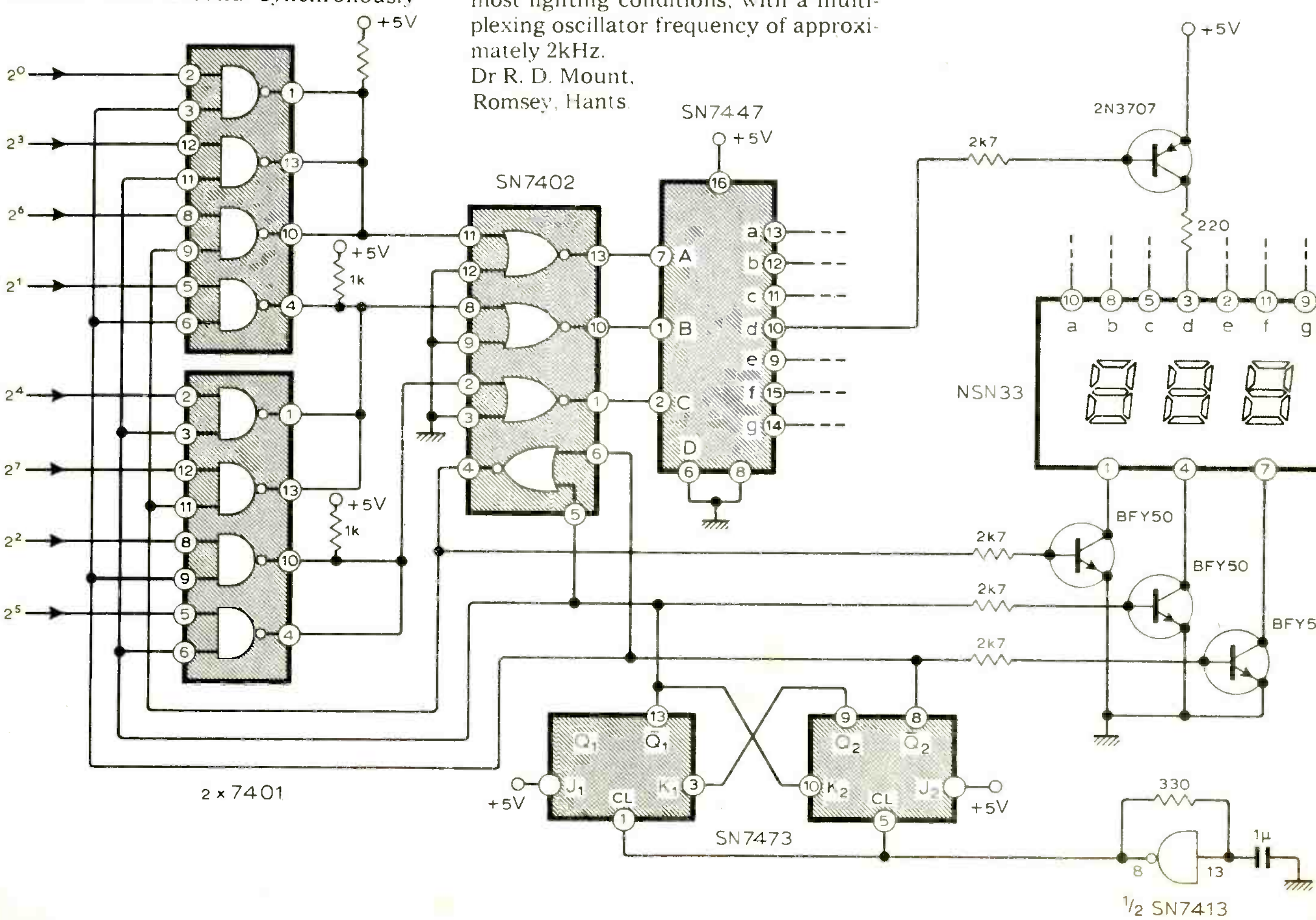
A. R. Ward,
Bassett,
Southampton.

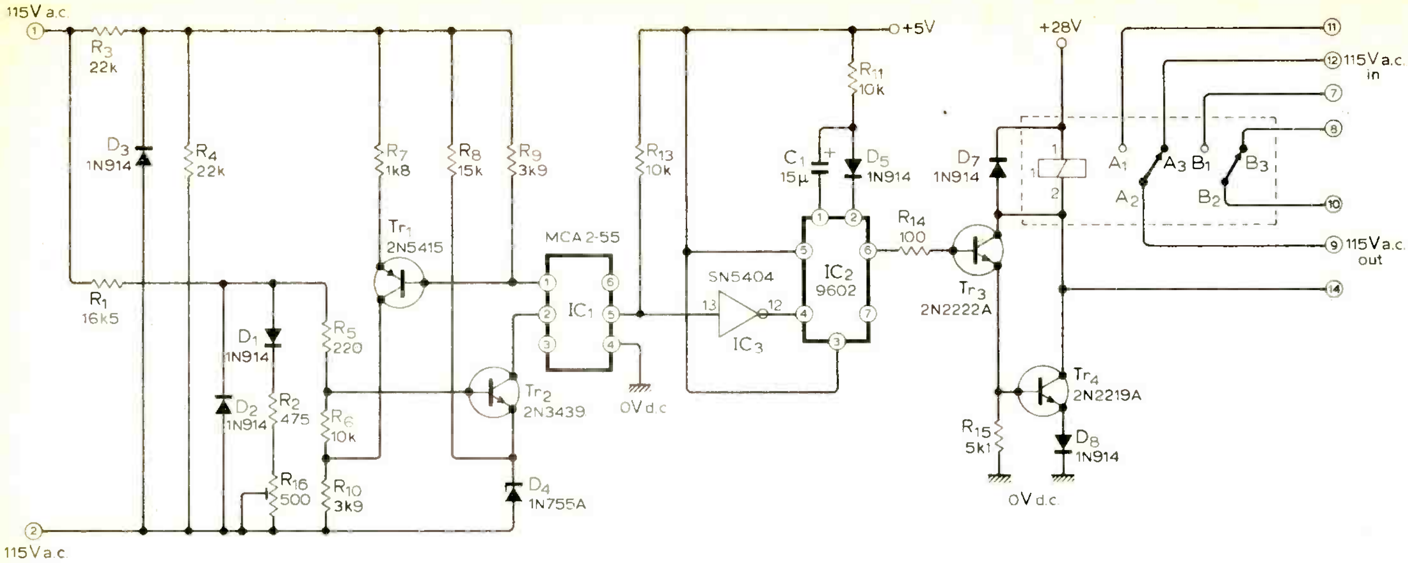


Octal display for microprocessors

The function of this circuit is to display an eight-bit data word in conventional octal form. This is useful in microprocessor prototyping, where it is usual to use the octal representation. Digit and data selection is effected by a three state counter built around synchronously operated JK flip-flops. The two or three bits appropriate to each display are steered to the seven segment decoder by wired AND open-collector gates, and inverters. A segment current of about 3mA was found adequate for most lighting conditions, with a multiplexing oscillator frequency of approximately 2kHz.

Dr R. D. Mount,
Romsey, Hants.



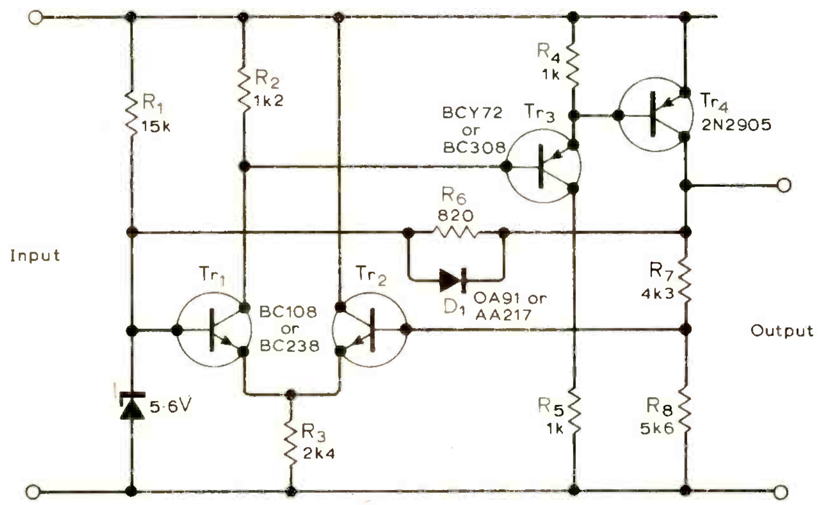


A.c. line sensor

A line sensor is used to protect delicate equipment from sustained over-voltage. This circuit will disconnect the supply if it exceeds a pre-set level.

Transistor Tr_2 senses the input, which can be varied by R_{16}, and turns on if the base voltage exceeds V_{be} + 7.5V. When this occurs the opto-coupler IC conducts and switches Tr_1 on. Positive feedback produces a fast switching action and the circuit remains on until the alternating voltage falls below the pre-set level. The output pulse is shaped by IC_3 and used to trigger the monostable IC_2. As long as the time constant C_1R_{11} is longer than the duration of the pulse, pin 6 is high so the relay is activated which disconnects the alternating supply. When the a.c. falls below the pre-set level the monostable reverts to the stable state and switches on the supply.

F. E. George,
College of Arts, Science and Technology,
Jamaica.



Germanium diode for regulator protection

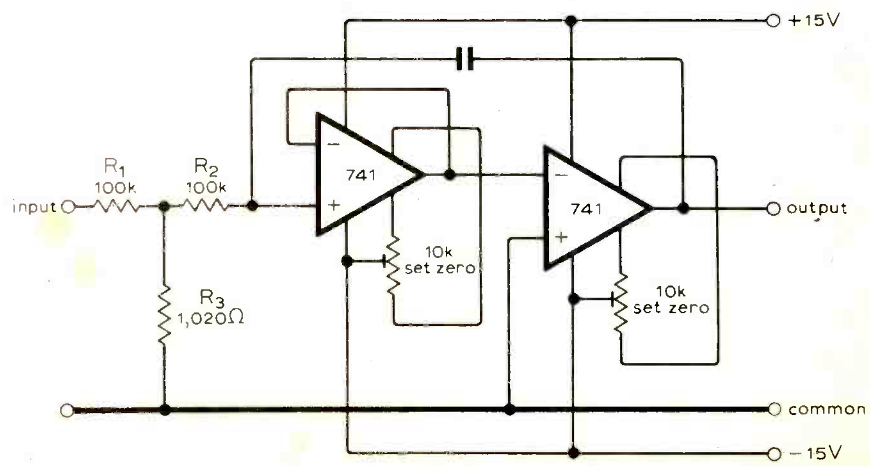
Power regulator protection is a perennial problem and this circuit offers a simple and economical solution. Under normal conditions, D_1 is reverse biased by the voltage across R_6 and does not affect the regulator operation. When the output is shorted, however, D_1 turns on and draws current through R_1 which removes the reference voltage across the zener diode. Because D_1 is a germanium type, Tr_1 is held off which also turns Tr_3 and Tr_4 off. When the short is removed, the circuit recovers and resumes normal operation.

D. E. O'N. Waddington,
St Albans,
Herts.

Op-amp integrator

Two 741 op-amps can be combined as shown to produce a circuit with a selected input resistance of 2 × 10^8 ohms and a drift time, 0 to 10V, of 90 min. Resistor R_3 is equal to $R_1R_2/R_{in}-(R_1 + R_2)$ where R_{in} is the required input resistance. For the values shown R_{in} is $10^7\Omega$.

N. G. Boreham,
Teignmouth,
Devon.



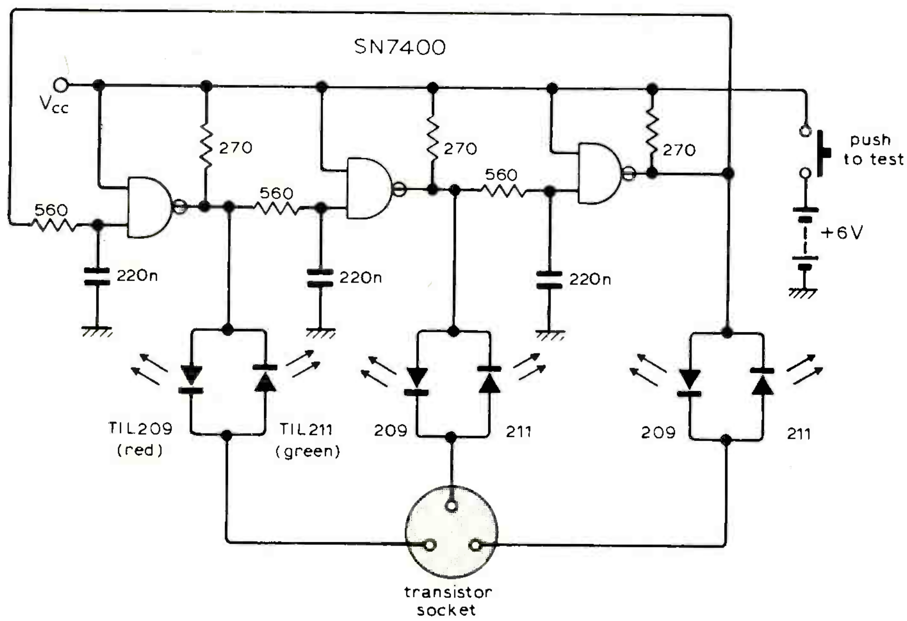
Semiconductor tester

This circuit tests transistors and diodes for polarity, and short/open circuits in one measurement. The same tests using a multimeter would require at least four operations.

A three-phase waveform is derived from the low-frequency ring-of-three oscillator, and applied to the device under test via the l.e.d.s. The oscillator waveform enables each pair of device terminals to be forward, reverse and unbiased for one third of a cycle. Current flowing into the device will turn the appropriate red l.e.d. on and current flowing out will turn on the green l.e.d. Thus, the position of the base lead and the polarity of a transistor may be deduced.

Voltage drop across the l.e.ds and device under test is typically 4.5V. A t.t.l. "1" will not source current at this voltage, so 270Ω resistors have been added to source and limit the diode current. Frequency of operation, defined by the CR network, is not critical, but the resistor should not exceed 1kΩ for reliable operation. Oscillator frequency with the values shown is about 2kHz.

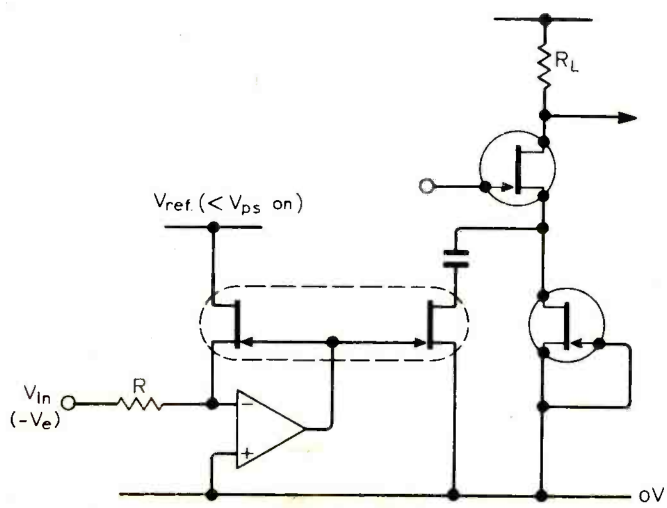
N. E. Thomas,
Balham,
London.



Linear v.c.a.

This circuit is based on dual matched f.e.ts. and can be used in applications such as linear voltage-controlled amplifiers and two-quadrant multipliers. The resistance of the f.e.t. in the feedback loop is adjusted automatically to source the current demanded by V_{in}. This resistance, and therefore the resistance of the other f.e.t., varies inversely with input voltage. The gain of the amplifier stage is given by $R_L/V_{ref}R \times V_{in}$ and is variable over about 80dB.

B. Turner & J. Custo,
Tewkesbury,
Glos.



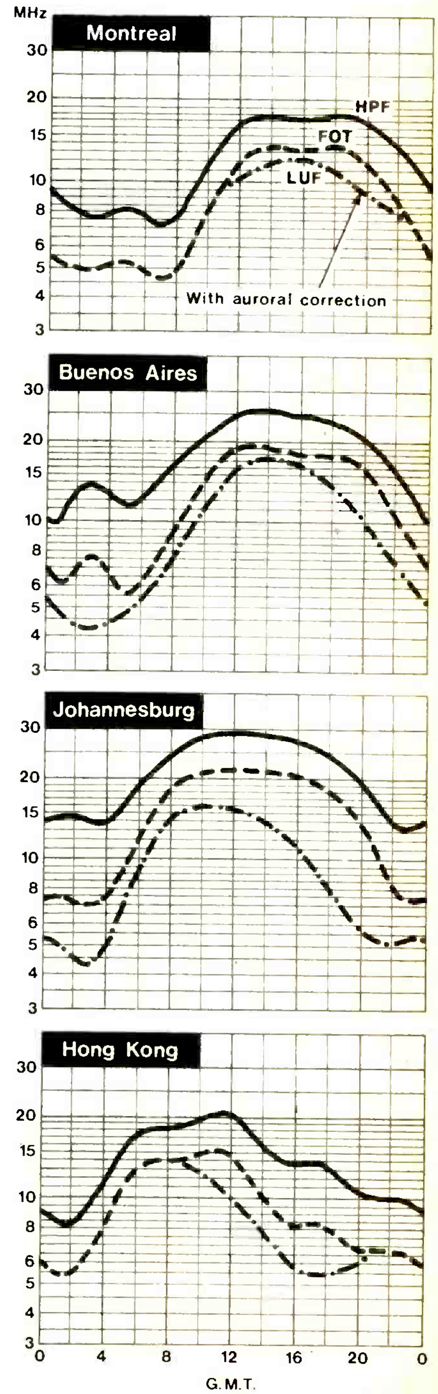
HF predictions

Solar and magnetic activity 1976 from data supplied by the Royal Greenwich Observatory:

	A	B	C	D	E	F
Jan	14	26	9	18	6	0
Feb	18	29	3	11	8	0
Mar	21	34	17	27	6	1
Apr	14	28	16	27	2	0
May	14	34	11	26	6	1
Jun	9	32	11	27	9	4
Jul	11	31	2	31	24	2
Aug	8	34	16	26	1	1
Sep	12	27	13	22	4	7
Oct	10	34	20	19	3	6
Nov	5	14	3	15	10	2
Dec	7	36	14	21	5	5

A, magnetically disturbed days. B, C, highest and mean of daily sunspot numbers. D, number of days that observations possible. E, number of observed days having zero sunspots. F, new cycle spots.

There were 5 large sunspots and only one solar flare during the year.



Interference from amateur stations

An investigation by the Radio Society of Great Britain

by I. Jackson G3OHX

This report, released in 1976, describes a survey carried out by the Radio Society of Great Britain which investigated interferences caused by radio amateurs. The survey was based on questionnaires (see pages 45 and 46) answered by more than a thousand licensed RSGB members. The report also discusses the results of the survey and the recommendations and conclusions made by the society.

Each year the Home Office issue figures about the number of cases of interference to television and radio reception. Various sources of interference are identified, among which are amateur radio transmitters. For several years recorded cases of television interference (t.v.i.) have fluctuated, but have averaged about 1,000 (with a sudden drop of 30 per cent in 1974). These figures represent only those cases dealt with by Home Office officials and no indication is given as to the technical reasons for such interference, neither is any estimation made of the number of cases of interference which never come to the attention of the Home Office.

For a long time it has been obvious in amateur circles that a major cause of interference is the inadequate immunity of domestic electronic entertainment equipment to the strong r.f. fields near amateur radio stations. The expression "electromagnetic compatibility" (e.m.c.) is used to describe the susceptibility of this equipment to such interference.

When interference is cause to television, radio and hi-fi installations with low e.m.c., the cure is not a question of the suppression of radiation on unwanted frequencies by the amateur. Usually the affected equipment must be altered in some way. Amateur equipment, while not completely blameless, has become much less of a cause of interference for the traditional reasons, such as harmonic radiation.

For several years the RSGB Interference Committee has been making approaches to the British Radio Equipment Manufacturers' Association (BREMA) to try to induce a more realistic attitude to the concepts of television, radio and hi-fi design so that e.m.c. might be improved. So far the response has been disappointing. While it might be considered unfair to say that there has been downright resistance to any proposals made, arguments against them indicate that the true interference situation is not appreciated. Despite technical evidence, it is often considered that the amateur is still the real culprit.

Another reason for not making any improvements in domestic equipment design is that the number of cases of interference which occur, when compared with yearly sales, are not considered sufficient to warrant such action. It is felt that it is uneconomical to increase the e.m.c. of all equipment when only a small proportion of it is likely to be used in the inhospitable environs of an amateur radio station. It is thought that it is better to treat on an individual basis those cases of interference which do occur. While this may seem to be a perfectly reasonable compromise solution, it is the experience of the RSGB Interference Committee that such pious intentions sometimes seem to take a lot of putting into practice. In any case, curing interference after it has occurred does not prevent amicable neighbourly relations from becoming strained as a result of the inconvenience and misunderstandings which often arise. The social consequences of interference are numerous and far-reaching.

It would be foolish to argue that amateurs never cause interference in the technical sense. One of the principle reasons for this survey is to try to apportion the blame for such interference, and to make an assessment of the true number of cases which occur each year. In addition, questions are asked to find out the amateur's attitude to interference and its effect on his operating habits. This is likely to influence band occupancy, not only during "sensitive hours" but also at other times of day.

Table 1. Total number of amateurs who answered the questionnaire (see questions 1 and 6 of section 1).

Class	*Non-wired*	*Wired*	*Total*
A	765	64	829
B	228	22	250
"A+B"	132	10	142
Total	1125	96	1221

Table 2. Answers to question 2, section 1 — number of years licence held at present location.

Class	*Total Years*	*Average period*
A	6676	8.05
B	804	3.22
"A+B"	501	3.53
ALL	7981	6.54

The ideas behind the questions

The questions in the Interference Survey were framed so that the answers would be in a form most useful to the Interference Committee. Other surveys containing more or fewer questions were considered, but it was felt that the survey chosen was a reasonable compromise between the need to obtain detailed information and the possibility of reducing the number of returns because the questions were too complicated or lengthy.

Despite careful working, some questions yielded answers which indicated that some amateurs were confused. However, suitable corrections have been made where it is obvious that misinterpretation has occurred.

The questions were asked for the following reasons:

In section 1 the class of licence was asked for in case there was a marked difference in the answers given by the two classes.

The time at the present location was required for various reasons. One was to avoid stretching memories too far. It was felt that this was preferable to asking for periods such as "the last five years", "since you received your licence", etc. To have stipulated limited time periods would have biased the survey towards the newly licensed amateurs.

Question 3 was asked to assess the emotional attitude of the amateur to interference. It was intended that he

RSGB Interference Survey

INTERFERENCE TO TELEVISION, RADIO, AND AUDIO EQUIPMENT

SECTION 1—GENERAL

1. Indicate with a tick the class of licence you hold. If you now hold a Class A but have held a Class B then tick both squares.

A	
B	

2. For how many years have you held a licence *at your present location*?

3. How severely do you *feel* worried by interference problems? For example, do you restrict your operation in any way because you cause interference, or *think* that you might do so? Do you avoid certain frequencies or certain times of the day? Do you transmit knowing full well that interference *is* being caused? Just how do you *feel*? Indicate by using a *number only* as follows: 0—not at all worried; 1—slightly worried; 2—moderately worried; 3—severely worried.

4. Are there any bands (which your transmitting equipment covers) on which you are unable to operate without restrictions, voluntary or enforced, because of known interference problems? These restrictions could be, for example, on time, transmitting mode, power, beam heading etc. Please tick the relevant boxes.

1·8 MHz	3·5 MHz	7 MHz	14 MHz	21 MHz	28 MHz	70 MHz	144 MHz	432 MHz	1296 MHz upwards

5. Are there any bands (which your transmitting equipment covers) on which you have not made a determined effort to operate, because you believe that interference problems will arise? Please tick the relevant boxes.

1·8 MHz	3·5 MHz	7 MHz	14 MHz	21 MHz	28 MHz	70 MHz	144 MHz	432 MHz	1296 MHz upwards

6. State the tv channel numbers normally received in your area. If you do not know the channel numbers please state the name(s) of the transmitting station(s). If "wired" tv is used please tick the relevant box.

VHF					
BBC1			ITV		

Wired

UHF								
BBC1			BBC2			ITV		

SECTION 2—TELEVISION INTERFERENCE

This section covers interference caused to tv sets only, where interference affects vision and/or sound.

1. How many tv sets have suffered from interference due to the operation of your amateur radio station (either when transmitting or receiving)? Indicate the number of sets affected, *not* the number of separate complaints. Include your own tv set if applicable.

2. (a) How many of the tv sets in Question 1 suffered from interference when tuned to a broadcast transmission in VHF Band 1? (See note below).

   (b) How many of the tv sets in Question 1 suffered from interference when tuned to a broadcast transmission in VHF Band 3? (See note below).

   (c) How many of the tv sets in Question 1 suffered from interference when tuned to a broadcast transmission in UHF Bands 4 or 5? (See note below).

3. In how many cases of interference to tv sets in Question 1 were the Post Office called in to investigate? Indicate the number of sets, *not* the number of visits made to carry out tests etc.

4. How many of the tv sets in Question 1 were cured of interference *without* the Post Office being called in to investigate?

5. How many of the tv sets in Question 1 were cured of interference by modifications to your station? Modifications include fitting of filters, screening, re-positioning aerials etc, but do *not* include a change of modulation mode or transmitted power.

6. How many of the tv sets in Question 1 were cured of interference by modifications to the tv installation? Modifications include fitting of filters, screening, re-positioning aerials, repairing faulty joints etc.

7. How many of the tv sets in Question 1 were cured of interference by the fitting of *external devices* to the tv set (eg aerial or mains filters, "braid-breakers", transformers, stubs, traps, earthing braid etc)?

Note (Question 2): In the UK the VHF Bands 1 and 3 are used for 405-line transmissions. Band 1 (Channels 1 to 5) is always BBC1, Band 3 (Channels 6 to 13) is usually ITV, but in certain areas it may carry BBC1 transmissions also. UHF Bands 4 and 5 (Channels 21 to 68) are used for 625-line transmissions (including colour) for all programmes (BBC1, BBC2 and ITV).

SECTION 3—RADIO INTERFERENCE

This section covers interference caused to radio sets only. This includes radio tuners fitted to hi-fi systems, radiograms etc.

1. How many radio sets have suffered from interference due to the operation of your station (either when transmitting or receiving)? Indicate the number of sets affected, *not* the number of separate complaints. Include your own radio set if applicable.

2. (a) How many of the radio sets in Question 1 suffered from interference when tuned to a broadcast transmission on the long and/or medium wavebands?

   (b) How many of the radio sets in Question 1 suffered from interference when tuned to a broadcast transmission on vhf/fm (Band 2)?

3. In how many cases of interference to radio sets in Question 1 were the Post Office called in to investigate? Indicate the number of sets, *not* the number of visits made to carry out tests etc.

4. How many of the radio sets in Question 1 were cured of interference *without* the Post Office being called in to investigate?

5. How many of the radio sets in Question 1 were cured of interference by modifications to your station? Modifications include fitting of filters, screening, re-positioning aerials etc, but do *not* include a change of modulation mode or transmitted power.

6. How many of the radio sets in Question 1 were cured of interference by modifications to the radio installation? Modifications include fitting of filters, screening, re-positioning aerials, repairing faulty joints etc.

7. How many of the radio sets in Question 1 were cured of interference by the fitting of *external devices* to the radio set (eg aerial or mains filters, "braid-breakers", transformers, stubs, traps, earthing braid etc)?

SECTION 4—AUDIO INTERFERENCE

This section covers interference caused to all types of audio equipment such as hi-fi systems, record players, tape recorders, public address systems, electronic organs etc. Note that this section does not *include the audio sections of television or radio receivers.*

1. How many audio installations have suffered from interference due to the operation of your station (either when transmitting or receiving)? Indicate the number of installations affected, *not* the number of separate complaints. Include your own audio installation if applicable.

2. In how many cases of interference to audio installations in Question 1 were the Post Office called in to investigate? Indicate the number of installations, *not* the number of visits made to carry out tests etc.

3. How many of the audio installations in Question 1 were cured of interference *without* the Post Office being called in to investigate?

4. How many of the audio installations in Question 1 were cured of interference by modifications to your station? Modifications include fitting of filters, screening, re-positioning of aerials etc, but do *not* include a change of modulation mode or transmitted power.

5. How many of the audio installations in Question 1 were cured of interference by modifications to the audio installation? Modifications include fitting of filters, screening, re-positioning of interconnecting leads, repairing faulty joints etc.

6. How many of the audio installations in Question 1 were cured of interference by the fitting of *external devices* to the audio installation (eg filters on mains, loudspeaker or other interconnecting leads etc)?

Table 3. Answers to question 3, section 1 — feelings of amateurs worried by interference problems.

Class	Not worried	Slightly worried	Moderately worried	Severely worried %	Average "feel"
A	24.61	37.88	26.73	10.25	1.22
B	32.8	32.00	21.2	9.2	1.02
"A+B"	21.83	35.92	27.46	10.56	1.23
ALL	25.96	36.45	25.75	10.07	1.18

Table 4. Answers to question 4, section 1 — Bands "unworkable" due to interference.

Class	A		B		"A+B"		ALL	
Band (MHz)	Cases	%	Cases	%	Cases	%	Cases	%
1.8	43	5.19			6	4.23	49	5.05
3.5	169	20.39			22	15.59	191	19.67
7	113	13.63			16	11.27	129	13.29
14	176	21.23			30	21.13	206	21.22
21	200	24.13			29	20.42	229	23.59
28	169	20.39			25	17.61	194	19.98
70	61	7.36			9	6.30	70	7.21
144	78	9.41	78	31.2	29	20.42	185	15.15
432	13	1.57	24	9.6	4	2.82	41	3.36
1296	6	0.70	3	1.2	1	0.70	10	0.82

Table 5. Answers to questions 5, section 1 — Bands avoided by amateurs because of interference problems.

Class	A		B		"A+B"		ALL	
Band (MHz)	Cases	%	Cases	%	Cases	%	Cases	%
1.8	18	2.17			4	2.82	22	2.27
3.5	63	7.60			10	7.04	73	7.52
7	43	5.10			7	4.90	50	5.15
14	79	9.50			10	7.04	89	9.17
21	113	13.63			14	9.86	127	13.08
28	95	11.46			10	7.04	105	10.81
70	40	4.83			13	9.15	53	5.46
144	23	2.77	11	4.4	5	3.52	39	3.19
432	7	0.84	13	5.2	4	2.82	24	1.97
1296	2	0.24	3	1.2	1	0.70	6	0.49

Table 6. Television interference — results for section 2, bold figures are the average number of cases (tv sets) per amateur.

	Class	A		B		"A+B"		ALL	
Question	Interference	Cases	%	Cases	%	Cases	%	Cases	%
1	Total number of sets	2257	**2.72**	576	**2.3**	401	**2.83**	3234	**2.65**
2a	To sets in v.h.f. Band 1	1018	45.10	103	17.88	95	23.69	1216	37.6
2b	To sets in v.h.f. Band 3	584	25.88	134	23.26	85	21.19	803	24.83
2c	To sets in u.h.f. Bands	1208	53.52	378	65.63	275	68.58	1861	57.54
3	Cases seen by Post Office	682	30.22	180	31.25	113	28.18	975	30.15
4	Cases cured by amateur — not seen by P.O.	1044	46.26	265	46.01	184	45.89	1493	46.17
5	Cases cured by mods to station	214	9.48	49	8.51	25	6.23	288	8.91
6	Cases cured by mods to tv set	1293	57.29	332	57.64	244	60.85	1869	57.97
7	Cases cured by external mods to tv set	1211	53.66	270	46.88	215	53.62	1696	52.44
	No t.v.i.	133	16.04	60	24.00	19	13.38	212	17.36

Table 7. Radio interference — results for section 3, bold figures are the average number of cases (radio sets) per amateur.

	Class	A		B		"A+B"		ALL	
Question	Interference	Cases	%	Cases	%	Cases	%	Cases	%
	Total number of sets	728	**0.88**	171	**0.68**	147	**1.04**	1046	**0.86**
2a	Sets on l.w. and/or m.w.	423	58.10	60	35.09	85	57.82	568	54.30
2b	Sets on v.h.f. f.m.	347	47.66	119	69.59	82	55.78	548	52.39
3	Cases seen by Post Office	104	14.29	24	14.04	15	10.20	143	13.67
4	Cases cured by amateur — not seen by P.O.	193	26.51	60	35.09	37	25.17	290	27.72
5	Cases cured by mods to station	36	4.95	11	6.43	4	2.72	51	4.88
6	Cases cured by mods to radio set	195	26.79	60	35.09	37	25.17	292	27.92
7	Cases cured by external mods to radio set	98	13.46	20	11.69	16	10.88	134	12.81
	No b.c.i.	458	55.24	159	63.6	62	43.66	679	55.61

should express his feelings, regardless of any actual incidence of interference.

Question 4 was included to find out if any bands (on which the amateur really wanted to operate) were particularly troublesome.

Some amateurs never even try to use certain bands because of fears of interference. Question 5 was required to find out whether the traditionally troublesome bands deserved their reputation (as indicated by the answers to question 4).

Question 6 was asked with the intention of establishing any connection between the tv channels received and operating problems. Wired tv (c.a.t.v., m.a.t.v.), which has no official protection against amateur interference, was included for completeness and to find out if it posed extra problems. No attempt was made to find out the wired tv frequencies, which could be quite different from those received locally "off-air".

Section 2 was worded to be as compatible as possible with sections 3 and 4. A lot had to be left to the discretion of the amateur; for example, the number of cures was asked for. In some cases a "cure" may be effective

Notes on the tabulated results

Most of the figures recorded in the tables are self-explanatory. However, as most of the results are expressed as averages or percentages, the following notes will make it clear how these were arrived at.

Section 1.

Q2. The average period of operation is the total number of years recorded in 1.2 divided by the total of survey forms returned.

Q3. The average "feeling" is the sum of the numbers recorded in 1.3 divided by the total returns. The percentage of amateurs with a particular feeling is the number recording that feeling divided by the total returns.

Q4 & Q5. The percentage of amateurs with restrictions on or avoiding a particular band is the total recording that band divided by the total returns. As Class B licencees cannot use the bands below 144MHz, when relevant, the percentages of questions 4 and 5 in section 1 are calculated using a total of 1125 amateurs (i.e. the number of Class B licencees are deducted).

Section 2.

Q1. The average number of tv sets suffering t.v.i. from each amateur is the total of answers in question 2.1 divided by the total of returns.

Q2 to Q7. The percentages are the totals of answers to the appropriate question divided by the total of answers to 2.1.

Sections 3 and 4.

The averages and percentages calculated for these sections are calculated on the same basis as for section 2.

It must be pointed out that although many of these results are calculated to two decimal places this does not imply that they are accurate to this degree. It merely facilitates the subsequent rounding-off of figures, as necessary.

Table 8. Audio interference — results for section 4, bold figures are the average number of cases (installations) per amateur

	Class	A		B		"A+B"		ALL	
Question	Interference	Cases	%	Cases	%	Cases	%	Cases	%
1	Total number of installations	1026	**1.24**	264	**1.06**	230	**1.62**	1520	**1.24**
2	Cases seen by P.O	139	13.55	34	12.88	28	12.17	201	13.22
3	Cases cured by amateur not seen by P.O	324	31.58	92	34.85	83	36.09	499	32.83
4	Cases cured by mods to station	33	3.22	26	9.85	4	1.74	63	4.14
5	Cured by mods to installation	353	34.41	75	28.41	72	31.30	500	32.89
6	Cured by external mods to installations	210	20.47	30	11.36	36	15.65	276	18.16
	No a.f.i.	273	32.93	97	38.8	32	22.54	402	32.93
	No t.v.i., b.c.i. or a.f.i.	63	7.6	35	14.0	9	6.4	107	8.76

only on some tv channels or for some amateur bands.

The number of tv sets affected was asked for in preference to the number of complaints received. It was felt that this would give more realistic answers. Most of the cases recorded by the Home Office are probably "one set — one complaint", especially if the time period is short.

Question 2 is intended to amplify question 1. It was thought that in most cases the amateur would remember if BBC1, BBC2 or ITV was affected, or which line standard — hence the note at the end of the question.

It was realised that the amateur might not know all the facts of the cases of t.v.i. The Home Office do not always disclose who or what is suffering interference. In some circumstances (e.g., in cases of multiple t.v.i.) the number given in the reply to question 3 may be lower than the true value. It is also possible that, over a period of time, one set could be responsible for several cases being recorded by the Home Office. As a result, it is possible that the number of cases recorded by the Home Office and those reported in question 3 may not agree exactly.

In question 4 the judgment of the amateur is relied upon for what he calls a "cure". However, it enables a ratio of "amateur cures" to the number of times the Home Office is involved to be calculated. Of course, these two events are not totally of the same character as the Home Office may not always effect a cure. In consequence, this ratio does not exaggerate the amateur role in curing t.v.i.

Question 5 tries to discover how often the amateur station is technically responsible for causing t.v.i. "Repositioning of aerials" is included as a modification, but this does not imply that a badly sited transmitting aerial is really a technical fault. However, the RSGB Interference Committee recommends that amateurs should consider the possibility of reducing field strengths by attention to aerial position or design. A change of modulation mode is excluded as this is considered to be avoiding t.v.i. rather than curing it.

When interference is cured by modifying the affected tv installation it is reasonable to conclude that in most cases the amateur is not to blame. In question 6 it is intended that any modification (including those in question 7) should be counted.

Question 7 specifically limits modifications to the usual amateur methods of adding external filters, etc. It was considered important to find out what proportion of the cures of question 6 were achieved without having to resort to difficult modifications, such as internal modifications to the tv set. The Interference Committee recommend against tampering inside neighbours' equipment.

Sections 3 and 4 were worded similarly to section 2 and were chosen for similar reasons.

(To be continued)

Part 2 of this article will discuss the survey results, as tabulated, suggesting possible reasons for the figures obtained.

Editor's note

QST, the official journal of the American Radio Relay League (ARRL), reported in their November 1976 issue: "In the United States, with the recent increase in popularity of c.b. radio and a commensurate increase in the number of privately owned transmitters, the FCC is now receiving interference complaints at a rate of over 100,000 a year. Of the complaints of interference to home-entertainment devices, only seven per cent involve amateur radio operators. Further analysis shows that of these complaints, almost 90 per cent would not have occurred at all if the manufacturers of the home-entertainment devices had provided adequate filtering or shielding in their products. These statistics suffer a severe limitation in that they record only **reported** cases of interference. . . . It is clear that even though amateurs are involved in only a small percentage of all reported interference cases, the overall effect on amateur radio operation is unknown."

EEC DATA-PROCESSING CASH

The EEC Commission is making available 103 million units of account (about £43 million) to help the data-processing industry. The money will go to "joint developments and new products in many areas mainly related to distributed computers," according to Christopher Layton, director for technology in the Commission's Directorate-General for Industrial Policy in Brussels, "or new products in the field of peripherals, terminals, etc." Between 20 and 50% of the cost of collaborative projects would be provided as long as they involved at least three member states. Any new application so funded would involve repayment if successful.

The Commission is concentrating on making stronger the mini- and micro-computer sectors, where large foreign competitors have not yet gained a foothold. Similar proposals to strengthen the telecommunications and electronic component sectors will follow later. The present scheme, a four-year programme, should be in operation by 1978, say the Commission. They are anxious that the European industry should adopt common standards, that the member states should become more aware of one another's products, that public buying in the member states, about 30% of all purchases, should be directed towards helping the native European industry, that agreement should be reached about the privacy of computer data, particularly that crossing frontiers, and that a European users' association be set up.

Previous public support for the data-processing industry has been given on a national basis. In 1971-75 member states spent about £76 million a year. "This enabled the European-based industry to survive but, unless co-ordinated in future, the nationalist bias, the Commission believes, could prove dangerous." Manufacturers have found it difficult to obtain a Europe-wide return on their investments, have been unable to find the resources to attack all sectors of the market, and have wasted the resources they can find in duplicated effort. This is why the Commission's financial help is for collaborative projects put forward by users of at least three member states or industrial companies from at least two.

Earlier attempts to persuade the three largest European computer firms to co-operate in developing and marketing a common range of computers, the Unidata project, have failed, and support for creating a community leasing fund along Japanese lines, managed by the European Investment Bank and provided with an initial 100 million units of account (£40 million) has not met enough support to be included in the four-year programme.

Television pattern generator

Simple design providing crosshatch / dot matrix, colour bars and grey scale

by R. A. Owen, M.Sc. and D. Brenkley, B.Sc., *University of Essex*

The unit generates the waveforms corresponding to the standard test patterns using inexpensive, readily available, t.t.l. integrated circuits. Line synchronization is necessary, ideally using line blanking pulses, and output buffering circuitry may be needed, depending on the required amplitude, d.c. level and isolation of the output signal(s). Component values are for use with the 625-line system.

Waveforms

The crosshatch/dot-matrix waveform is composed of two sets of pulses, producing the vertical and horizontal components of the pattern. The vertical component pulses are some 200ns wide and of period approximately 3μs, while the 52μs horizontal component pulses recur every twenty-five lines. The colour-bar waveforms are square-wave pulses providing the separate RGB drives and weighted summing of these three drive signals forms the grey scale waveform. Gating during the line blanking period ensures that the pulse sets exist only during the active line time, preventing serious foldover. Provision is made for adjustment of the vertical line/bar spacing of the patterns.

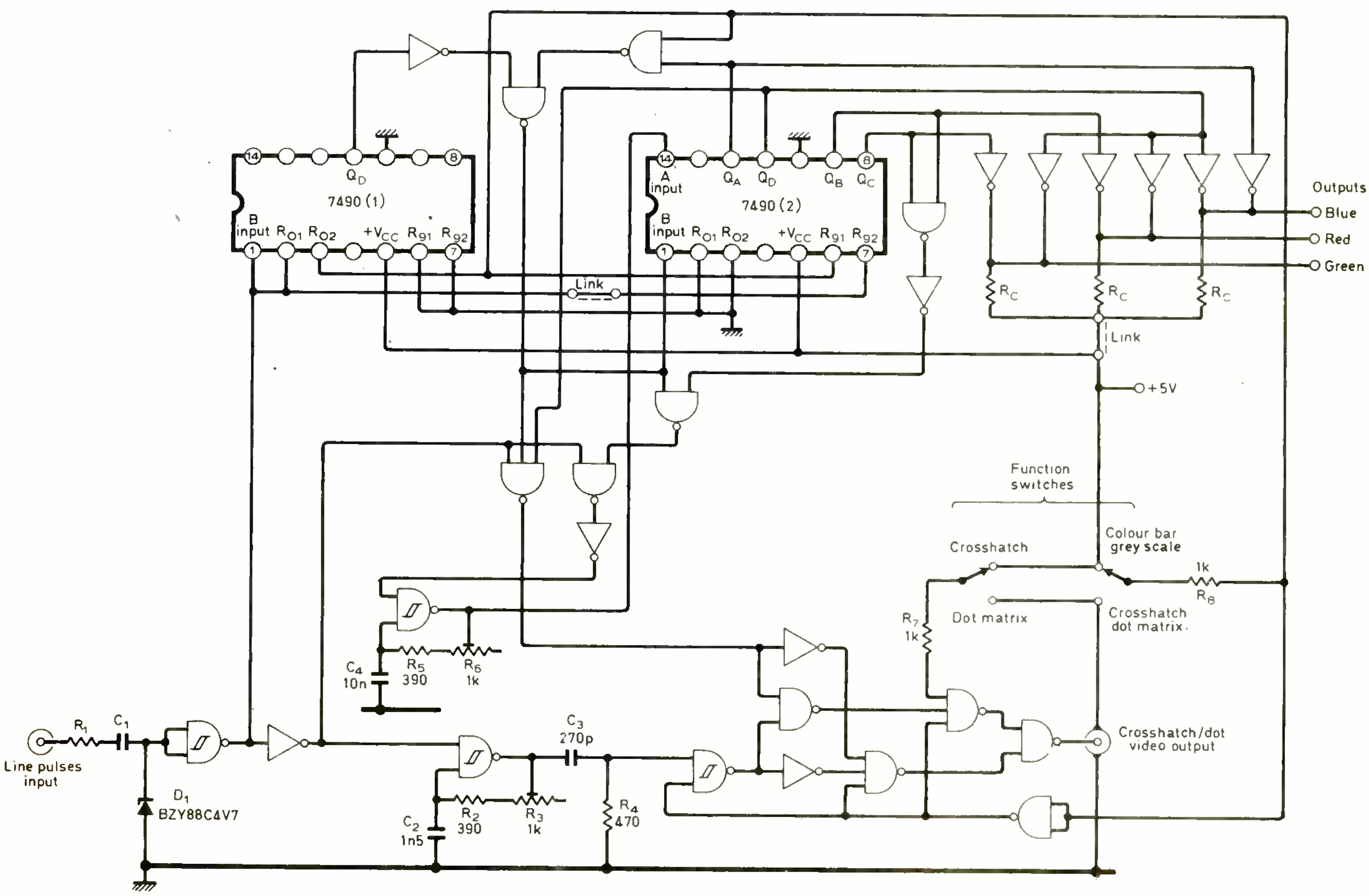
Input pulse shaper

In the circuit diagram of Fig. 1, R_1, C_1, D_1 limit the amplitude of the negative-going line input pulses applied to the two-input schmitt-trigger NAND gate, whose input/output hysteresis helps to provide jitter-free operation with slow rise-time inputs. The cleaned-up pulses then provide synchronization and gating.

Crosshatch

A second two-input schmitt-trigger NAND gate serves as a gated RC astable multivibrator, in which R_3 alters the frequency of oscillation. The output

Fig. 1. Main circuit diagram. The output inverters are a 7406, the other inverters a 7404, the three-input gates part of a 7400, two-input gates are two 7400s and the Schmitt two-input gates are a 74132. The link in the second 7490 reset line is in place of the circuit of Fig. 4.



waveform, a rectangular pulse train of 2:1 duty cycle, is differentiated by C_3, R_4 and shaped by a schmitt-trigger NAND gate. The internal input diode of the NAND gate limits the negative excursion of the differentiated waveform. The width of the negative-going output pulses for the vertical cross hatch component are related to the time constant C_3, R_4. To reduce pick-up, the differentiated output is gated off in the colour bar mode. For the horizontal component of the crosshatch, the two 7490 decade counters function as a divide-by-25 counter, as in Fig. 2(a) the reset functions being inhibited. The negative-going pulses of one active line length (52μs) are fed from a three-input NAND gate to the output gating circuitry.

Essentially, an OR type function is employed for crosshatch and an AND type function for dot matrix in the output circuitry, with a switchable interchange between the two.

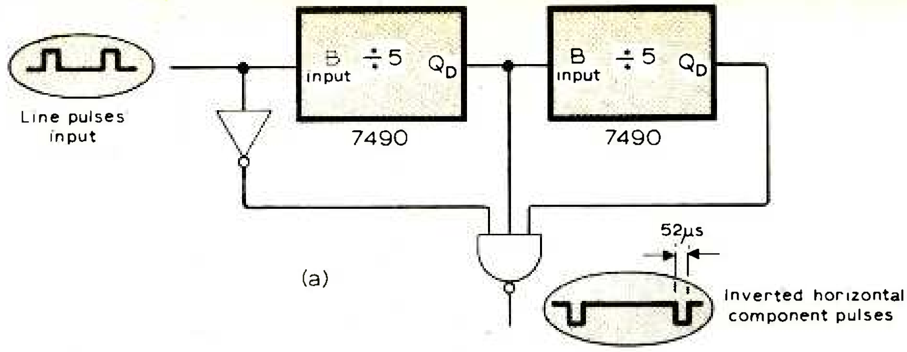
Colour bar/grey scale

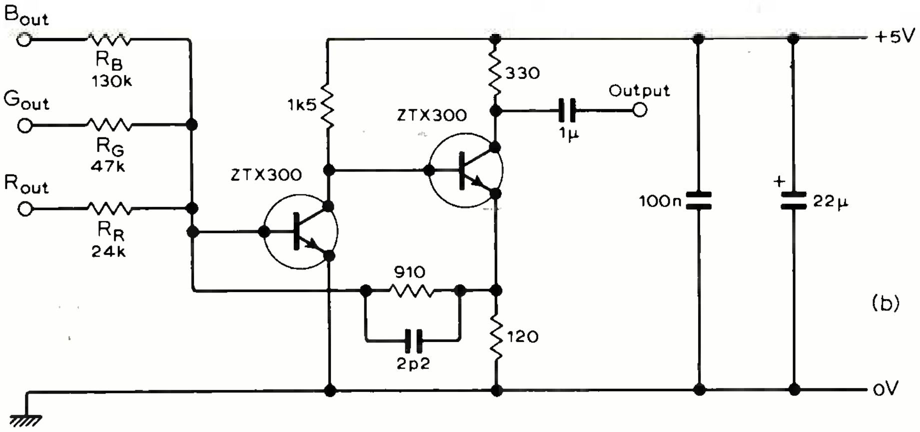
R_5, R_6, C_4 and the associated schmitt-trigger NAND gate form the colour bar astable oscillator. R_6 alters the oscillation frequency, and when optimally adjusted produces an oscillation period of 6.5μs. Subsequent division by 2, 4 and 8 produces inverted drive waveforms, available at the A, B, C outputs of the second 7490 counter, which are inverted to provide positive-going video signals. Buffer circuitry may be added externally if the t.t.l. outputs are incompatible. Weighted summing of the drive signals, as in Fig. 2(b) provides the eight-level grey scale in Fig. 2(c), sequentially from peak white to black. A simple resistor summing network can be used as a compromise as in Fig. 2(d). Summing resistors are selected to give a 100% amplitude, 100% saturation waveform, the amplifier output being a grey scale of about 1V p-p.

Gating

In the crosshatch mode, the three-stage binary counters of the 7490's in Fig. 1, for which the count cycle length is divided by five, are used and the resets are inhibited.

In the colour bar mode, the second 7490 functions as a 0 to 7 counter with the appropriate external gating, set to a count of nine in the line blanking period. The Q_D output of the first 7490 assumes a static logical 0 in this mode, since the counter is reset every line. The colour bar oscillator is gated off by the line blanking pulses or by the output of a NAND gate structure responding to a logical 111 presented from the outputs Q_A, Q_B, Q_C of the second 7490 (corresponding to a count of seven). So, the second 7490 counts, generating the bar waveforms, to 0111, inhibiting the oscillator. The line blanking pulse then continues to gate off the oscillator and sets the counter outputs to a logical 1001 (a count of nine). By virtue of the





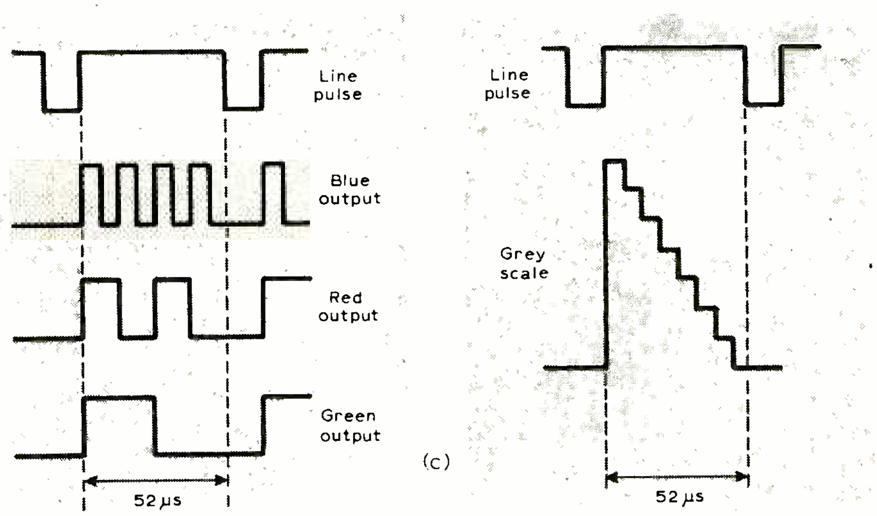
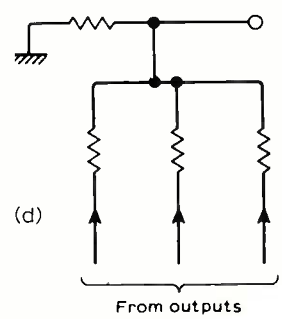
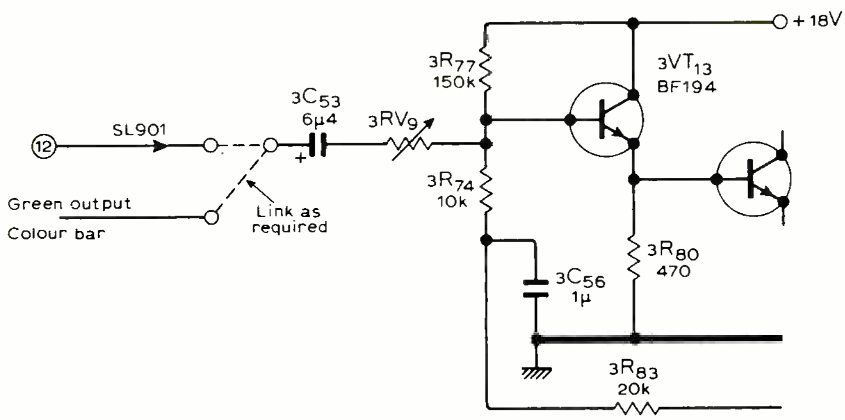


Fig. 2(a). The configuration of 7490s required to divide by 25. The summing circuit for the grey scale is shown at (b) and the waveforms involved at (c). The simple resistor network at (d) can be used as a compromise.

INVERT — AND nature of the open collector outputs, Q_D maintains black level during the line blanking period. On completion of the blanking pulse, the counter and oscillator are enabled and the colour bar oscillator follows rapidly with a negative-going edge, which effects a count increment to 0000.

After completion of a blanking pulse, the difference in propagation delays,





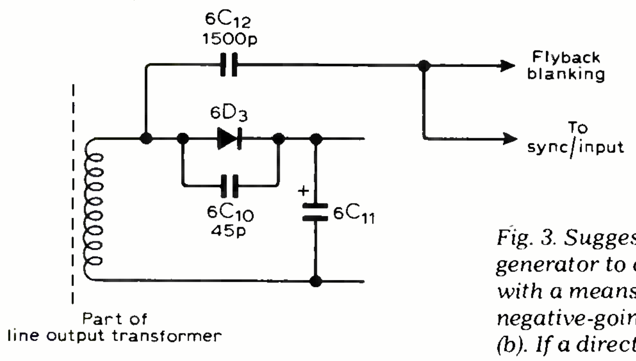


Fig. 3. Suggested circuit to connect the generator to a Bush CTV 184S is at (a), with a means of obtaining the negative-going flyback pulses shown in (b). If a direct connexion is not available, 3-4 turns of very well-insulated cable near the line output transformer should suffice.

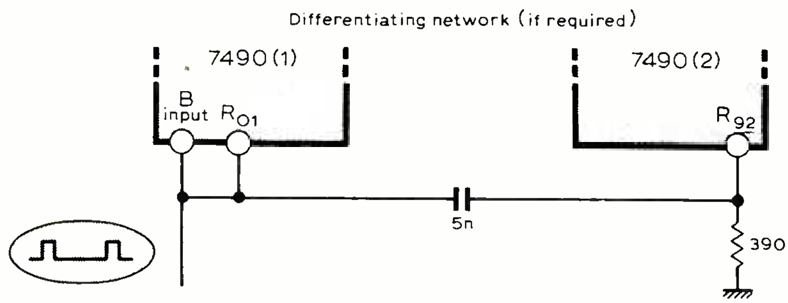


Fig. 4. Differentiating circuit, which may be needed to avoid blanks at the beginning of the line scan.

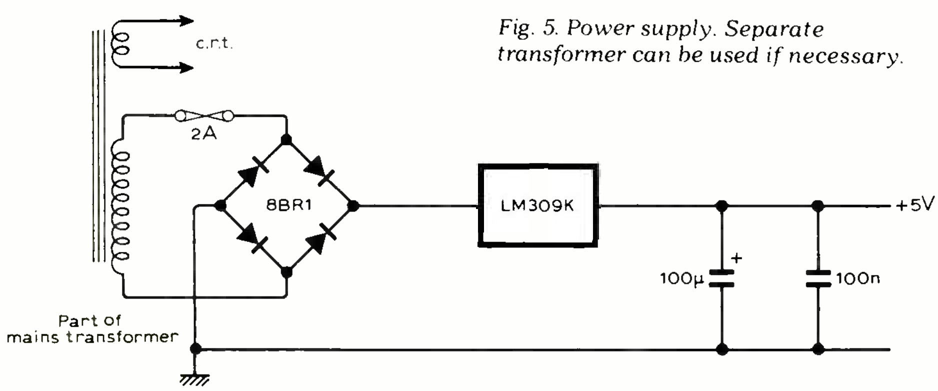


Fig. 5. Power supply. Separate transformer can be used if necessary.

between the counter being enabled and the colour bar oscillator providing the first negative-going edge is some 20ns. If tolerances in propagation delays cause a black bar to be produced first in the line scan, then a differentiating network shown in Fig. 4, can be interposed between R_{92} of the second 7490 and the blanking pulse line. This ensures that the counter is enabled before the end of the blanking pulse. The output gating is removed and peak white is the first bar. The count cycle is repeated.

In using open-collector gates, high-voltage output types, such as the 7406, provide a measure of protection against overvoltage. The inputs of gates requiring a static logical 1 are connected via 1kΩ resistors to +5V, to protect their inputs from supply transients.

Additional circuitry and interfacing

Because of the wide range of conditions and applications, no one interface or buffer circuit is sufficient for general application. An example of connection to a single standard set type CTV 184S is shown in Fig. 3(a): further interfaces were discussed in *Wireless World*, May 1976, pp.64-67.

Construction and test

A prototype was constructed using Veroboard, and with minimal lead lengths no spurious operation was found. A double-sided printed circuit board was later used, with few wired linkages.

The +5V supply should be well decoupled close to the integrated circuit packages. R_1, C_1 must be adjusted in accordance with the amplitude of the available source of line-blanking/flyback pulses, ensuring that D_1 operates within its ratings. For example, with blanking/flyback pulses of −80V amplitude, R_1, C_1 were chosen to be 10-kΩ 0.1-μF. The hex buffer output collector resistors are connected via a link to +5V, provision thereby being made for a secondary supply to be used. Assuming that a suitable +5V supply and output circuitry have been added, then the output signal(s) may be fed into the relevant positive-going amplifier stage(s). Preset resistor, R_3, is adjusted for a suitable number of vertical lines in the crosshatch pattern and preset, R_6, such that the eight bar pattern accurately fits the screen. The control range of R_6 allows a compressed grey scale or expanded partial grey scale to be produced at the extremes.

A printed board for this design will be made available by Mike Sagin, one of our assistant editors. A note will be published when it is ready – Editor.

Viewdata

2 — Applications of the system

by S. Fedida, B.Sc.(Eng.), M.Sc., F.I.E.E., A.C.G.I.
Post Office Research Centre

Before dealing with the possible applications of Viewdata I will conclude the discussion started last month (February issue) on the problem of ensuring adequate communication between the user and the computer – what I have called the computer dialogue.

While the index principle is clearly adequate for the information service as such, a fuller dialogue is needed to cater for the very wide range of services provided by Viewdata, in particular a message facility, calculation and games facilities and a range of interactive services such as requests for advertising literature or other documentation and bookings of holidays and hotels.

The design of the computer dialogue is very important. Information put out by the computer to guide the user must be simple to understand, it must not be ambiguous and must not appear to demand more than one reply at a time. Furthermore the action to be taken by the user following the display of a frame of information must be clearly indicated, i.e. the prompt must always be inserted to ensure that the user does not lack guidance regarding the next step.

An example of part of a dialogue in the message service is shown in Fig. 1. It gives the flavour of the requirement and indicates some of the pitfalls.

A third aspect of the communications arrangements between user and computer concerns the general purpose set of non-indexed or dialogue instructions which may be needed by the user in the course of a session. The object of these instructions, which are only five in number, is to assist the user to recover from errors real or imagined and thus enable him to maintain control of the situation whatever happens.

The set of instructions selected for Viewdata for recovery from errors and more generally for coping with unforeseen problems is as follows:

1. To return to the top of the selection tree: *#
This instruction is mainly used at the completion of one enquiry, when it is desired to start a new one. Alternatively if the user finds himself perhaps on the wrong track, or cannot interpret the dialogue, he uses this to make a fresh start. In other words, it provides a fall back option for all unexpected situations.

2. To recall the previous page: *01
The purpose of this instruction is to enable the user to check the contents of the previous page, in case of miskeying errors, real or imaginary.

3. To recall the current page: *00
The purpose of this instruction is to cause the computer to retransmit the current page, in case some of the information has been corrupted. Interestingly enough, little evidence has been seen so far of serious data corruption during transmission.

4. To jump to a known page (number N): *N#
The purpose of this instruction is to enable the user to jump straight to the required page, if he knows its number, thus by-passing the step by step approach.

5. To correct a miskeying error: **
If an entry is in error it may be erased by keying ** and a fresh start made.

These instructions are normally engraved on the keypad associated with Viewdata, thus providing a constant reminder of what action is needed to cope with the unforeseen.

Office version of a Viewdata terminal, known as Viewdataphone. Note the integral keypad and telephone handset.

Applications of Viewdata

The range of applications of Viewdata is theoretically unlimited. In practice it will be determined primarily by the market – what users want and what they are prepared to pay for. There are six distinct service areas, each with its own specific requirements and each using the interactive capability of the system to some degree:

- general information services
- message communications
- education
- calculation
- personal services
- in-house and private systems.

Information. The largest area capable of immediate development is the information service area. It has a number of subdivisions, with differing characteristics and treatments, e.g.: topical information; reference information, divided into general and professional; classified advertisements; and shopping aids.

The range of topical information itself covers a number of different items, such as news, sports results and weather information, each item in turn comprising a very wide spectrum such as local news, national and international events, business news, items of interest to the domestic viewer, to the business viewer, etc. This section of the information data base is the one most closely related to that of teletext. The major difference is that whereas in teletext the information is more likely to be in abbreviated or headline form because of the obvious limitation of the restricted total amount of information available, in Viewdata the information is in much more detailed form and of course has a considerably greater scope and variety.

Reference information is a large field which could cover items such as train and bus time tables, and perhaps air time tables, telephone directories and "Yellow pages" of local and national interest. It could also cover information on leisure activities such as games, hobbies and sports, do-it-yourself and gardening information, recipes and holiday and tourist information. Other topics of interest could be money matters and savings, tax information, jobs and careers information, and a wealth of specialist reference information for the businessman and professional user.

Classified advertisements are potentially a very important sector of the information spectrum, since, given adequate coverage, classified advertisements may be available in everybody's home at the touch of a button when required, with an immediacy unrivalled by any other medium. By the same token items no longer available may be removed instantly from the data base, thus avoiding unnecessary enquiries and potential frustration. A major benefit of the classified advertisement is that it could provide a useful revenue which, as in the case of newspapers, could be used to counterbalance a proportion of the expenses.

The interactive capability of Viewdata adds an important dimension to the scope of the information services. It could be used, for example, to request further details about a product advertised or discussed, and in certain cases to actually place a purchase order. Potentially it is possible to do this without the need to place an additional telephone call.

Message communication. Viewdata is clearly not only an information medium, but also a message communication medium, indeed a "store and forward" system, for use by the general public. The message, once entered in the computer, would be transmitted as soon as communication to the intended recipient can be established.

The simple message facility so far experimented with provides a number of options. In the simplest option the user may select one or more out of a number of standard messages, mainly greetings messages, but clearly many others are possible. After message selection the user needs to supply the Viewdata number of the intended addresses. Thereafter the action of the system is entirely automatic.

The message is now automatically routed to the local Viewdata computer which places a telephone call to the addressee. If the telephone number is engaged the computer tries again; the number of tries may be specified by the sender. If the number is not engaged but no reply is obtained to the call, after a short ringing interval, a red light fitted to the Viewdata receiver is switched on to indicate that "somebody has called." Indeed arrangements may be made for the local computer to attempt a call several times, and for the visual indica-

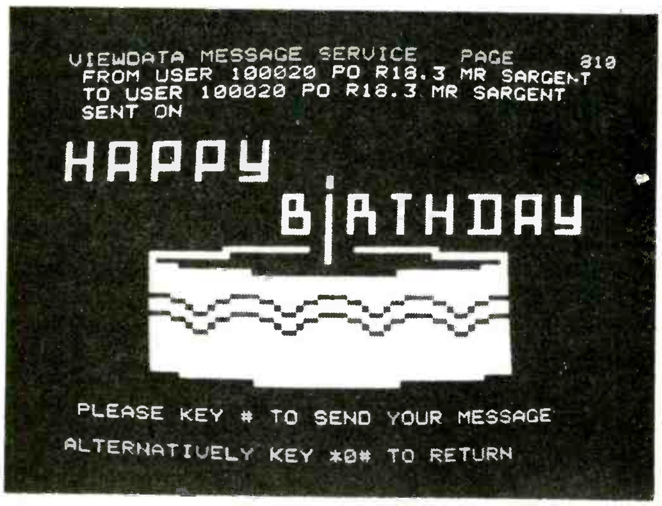


Fig. 1. Example of part of a dialogue in the message services provided by Viewdata.

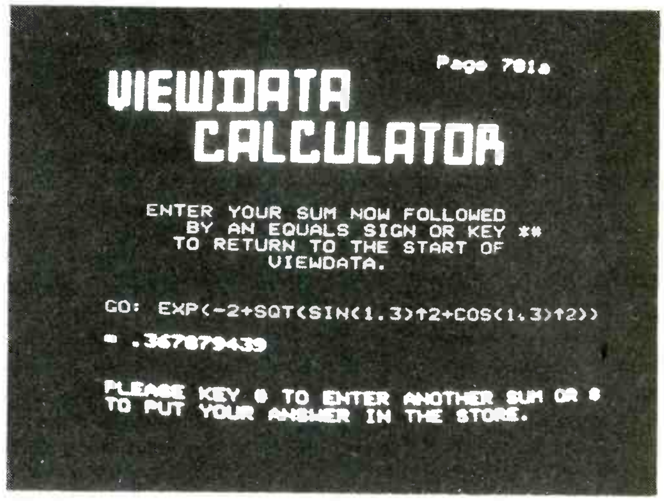


Fig. 3. Example of facilities offered by the calculator service.

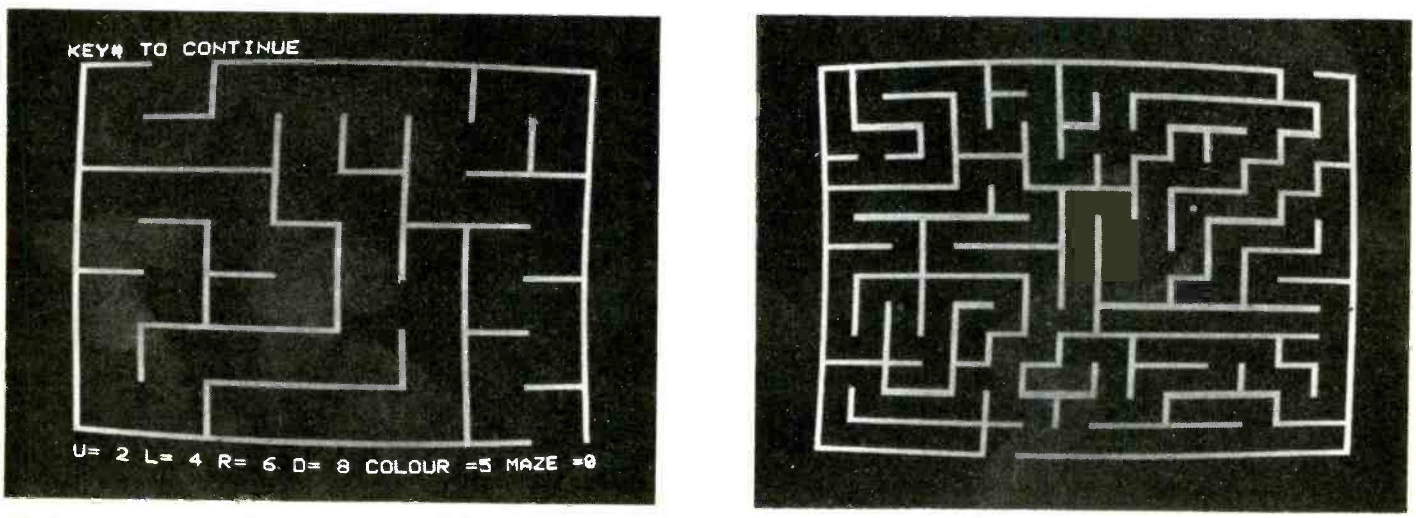


Fig. 2. A maze game which can be played through the system: two mazes of differing complexity.

tor on the Viewdata set to give a count of the unanswered calls.

When the call is answered, the computer places a high pitched tone on the line (1300 Hz), which indicates to the user that the Viewdata computer is calling. Pushing the data button on the telephone set causes the computer to send the message frame preceded by introductory frames to ascertain user number, etc.

A similar procedure applies when the addressee, on returning to his Viewdata set, finds the "somebody has called" light on. On dialling Viewdata and after entering his user number the message is delivered.

Another message option provides the user with the facility of inserting in the standard text one or more words, numeric or alphanumeric, e.g. times of arrival in a "I shall be arriving on the .... train" message.

Finally, users who have the alphabetic keypad may be able to compose their own messages.

All these message options use the same method of delivery illustrated above and all provide the facility for sending one or more messages to one or more addressees, in a single transaction, thus saving the user a very considerable amount of time, particularly when the same message has to be sent to several people.

A simple extension of the message facility is the interconnection with telex[1]. Viewdata benefits in the enhancement of its communication facilities by its interconnection with an extensive telex network with an international coverage. Telex benefits in three ways: it acquires a powerful store and forward capability; it acquires an additional number of customers, not normally on the telex network; and it could relieve congestion in the telex room at peak hours by repeating a telex message direct to an executive's Viewdataphone on his desk.

A further potential extension of the Viewdata message service is in the case of business mail. This could provide a useful load to the Viewdata computer network, during the night, for example, when its facilities are mostly unused.

Finally because Viewdata displays messages visually on the domestic tv receiver, it could provide a cheap and convenient way for deaf people to communicate at a distance, among themselves and with other people.

Education. Viewdata may be applied to the education field in three areas. The first is the conventional information services providing details of educational facilities, e.g. what courses are available and where, details of qualifications required, and who to apply to. This service could be structured under a number of different headings, such as subject titles and local facilities, and the usual method of access would be applied.

The other areas are the more exciting possibilities of using Viewdata to assist in the learning process. Many attempts have been made recently, particularly in the United States, to introduce this system of learning (computer assisted learning), which has many obvious advantages. It could relieve very considerably the day to day pressure on teachers and lecturers, who would then be able to devote more of their time to the individual requirements and difficulties of their pupils. The potential of this education medium for home-learning is also of great importance.

Unlike conventional methods of learning, Viewdata, by taking advantage of interactive working, can provide the student with assistance when required and a method of self-monitoring and self-testing which could greatly increase the speed of learning and provide the necessary intellectual stimulus to the student.

Viewdata in education could also be invaluable to parents in enabling them to follow the educational progress of their children and thus possibly enable them to help and encourage them more effectively.

A related aspect of education is the games facility where again the interactive capability of the computer is called for. The field for educational games is vast and so far two programmes have been experimented with. One is MOO, which is an exercise in logical thinking, wherein the user has to guess a four digit number selected at random by the computer. The guessing or deduction is made as a result of clues given by the computer in response to a "guess". The other is a maze game, increasing in complexity from the very simple to the more complex, which is a good example of pattern recognition (see Fig. 2).

Calculations. The primary purpose of Viewdata is not to provide a calculations service, but as illustrated earlier an information and message service. Nevertheless the availability of a number of distributed computers a local call distance away suggests that for very little extra cost a useful calculation service could be provided to students, small businesses and indeed all who might need its fairly limited but potentially very useful facilities.

Little would be gained if the calculator facilities were limited to those provided by the small mass-produced calculators. Such a service would be hopelessly uncompetitive. Neither would a great deal be gained by providing the sophisticated facilities of the now well established computer bureaux. The professional user of extensive computational facilities is already well catered for.

Rather it is intended to fill the gap between the two, some of which is at present covered by the more expensive hand or desk calculator. Unlike these more complex and powerful machines, however, the Viewdata approach is to eschew all manuals and complicated instructions and so to organise the dialogue that users may, without any specialised training whatever, carry out the calculations they desire. Instructions for entering requirements are given by the system as and when they are needed and the dialogue is so arranged that errors may be caught quite simply as they occur (Fig. 3).

An additional feature of the calculation programme is a curve or histogram plotting facility related to the computations carried out.

Personal services. We have seen that Viewdata users are able to enter information into the system for example for message purposes. This clearly could be extended by arranging that this information is only accessible to the user or to one or more other persons nominated by him.

We now enter a fairly sensitive area of security (or privacy) of information. Much study will need to be done to ensure that information thus entered is indeed reasonably well protected. Initially, however, the studies are concentrated on information which, in the individual's opinion is not too sensitive. A user may enter perhaps reminders to himself of meetings, dates, telephone numbers, data for his own private use and the like. A typical one may be a reminder to send flowers to the wife on her birthday! Even in such fairly innocuous cases, passwords are provided to ensure that accidental disclosure of private information does not occur.

In house and private data banks. An extension of the personal information service is the use of the Viewdata network to store and provide access to information of interest to closed user groups on certain specific topics, e.g. employees of a business house. Also a minimum degree of privacy will need to be provided, although absolute privacy is not an objective of the system, at least in the initial stages.

In the case of closed user groups, information and data might be collected for the benefit of groups having similar interests. For example the source of supply of certain commodities used in certain categories of business, e.g. building supplies with current prices, availability etc.

Clearly the range of potential services of this nature is open ended. Development will no doubt take place in this area as the capability of this new medium becomes apparent through usage and experimentation.

The next article will deal with the operation of the Viewdata system in detail

Reference

1. S. Fedida — Development of Computer-based Information Media for the General Public. Paper presented at 2nd International Symposium on Subscriber Loops and Services 3-7 May, 1976. The Institution of Electrical Engineers. London.

Logic design — 3

Event-driven circuits

by B. Holdsworth* and D. Zissos†

A four-step procedure based on the sequential equations, for the design and implementation of event-driven logic circuits is described in this article. Realistic circuit constraints are automatically taken into account by the design process.

The principal factors to be considered in the design of event-driven circuits are:

- Circuit reliability. The circuit must operate correctly and reliably.
- Gate fan-in and fan-out restrictions. These must be observed.
- Speed tolerances. Gate speed tolerances of ± 33⅓ per cent are automatically accommodated by the design process used.

Generally speaking, the solutions obtained do not necessarily use a minimum number of gates, but the design requires minimum effort. The design steps are easy to apply and require no specialist knowledge.

State diagrams

State diagrams can be used to describe both the external and internal operations of event-driven sequential circuits. In a state diagram, states can be represented by squares, rectangles or circles and lines linking the states represent transitions between states. The direction of a transition is indicated by an arrow pointing in the direction of the destination state, and the signal condition that initiates the transition is indicated by its Boolean function inserted either above or below the line. For example the part of a state diagram shown in Fig. 1 indicates that the circuit moves from state S_0 to S_1 when $X\bar{Y} = 1$, i.e. when $X = 1$ and $Y = 0$.

The external and internal-state diagrams of a circuit in which the activation of a switch X in Fig. 2(a) operates, in turn, two lights L_1 and L_2 are shown in Figs. 2(b) and 2c) respectively. Variables X_n and X_{n+1} are used to indicate the n^{th} and $(n+1)^{th}$ activation of the switch. The external-state diagram closely resembles a flow chart, which can be drawn with very little regard to circuit implementation.

There are no hard-and-fast rules for developing internal-state diagrams. Since such diagrams describe the internal operation of a circuit, the designer usually makes arbitrary choices depending on past experience, his understanding of the problem and availability of components, which can lead to different but equivalent results.

The following example is used to illustrate typical variations in the internal-state diagrams of the relatively simple light circuit shown in Fig. 3(a). The function of the circuit is to turn lamp L_1 on when the two switches X and Y are made in that order, and lamp L_2 on when the switches are made in the reverse order. Two different but correct versions of the internal operation of the circuit are shown in Figs. 3(b) and 3 (c).

Most persons attempting this problem would probably derive internal-state diagram 3(b) which uses five internal states. State S_1 is used to record that switch X has been made and state S_3 that switch Y only has been made. In both cases there is no change in the circuit output, although clearly there is a change in the internal-state of the circuit. Very few designers, if any, would arrive at Fig. 3(c) the first time round.

As might be expected the circuit implementation of the state diagram of Fig. 3(c) is the simplest. This state diagram can be obtained by constructing a state table from the state diagram shown in Fig. 3(b), the state table then being reduced by the application of Caldwell's merger procedure. This technique will be described later in this article.

State variables

Each state of an event-driven logic circuit is defined by a unique combination of logic signals called state variables or secondary signals. Clearly one state variable A, defines two states, one by $A = 0$ and the other by $A = 1$. Two state variable define four circuit states each state corresponding to a combination of their values, i.e. 00, 01, 11, and 10. In general, n variables will define 2^n circuit states. As an example of state allocation, the states S_0, S_1, S_2 and S_3 in Fig. 2(c) can be defined by the state variables AB = 00, 01, 11, 10. In allocating state variables to states in event-driven circuits it is necessary to ensure that each circuit transition involves a change in the value of a single variable only. The reasons for

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† Dept of Computing Science, University of Calgary, Canada

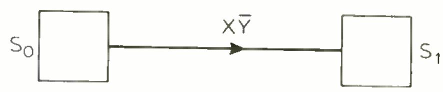


Fig. 1. Elements of a state diagram.

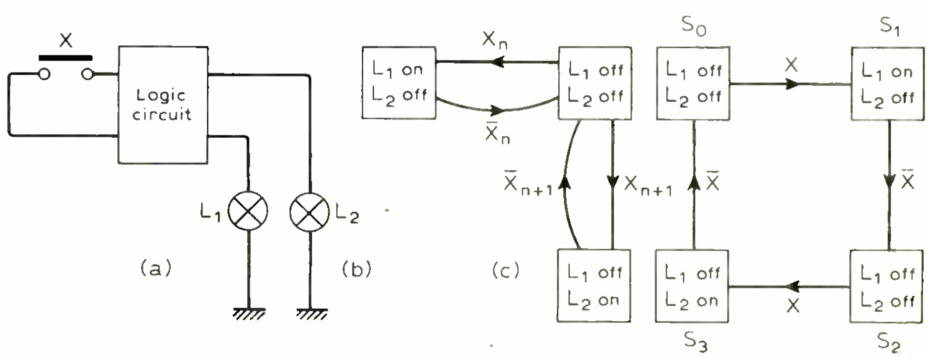


Fig. 2. Internal and external state diagrams of a logic circuit.

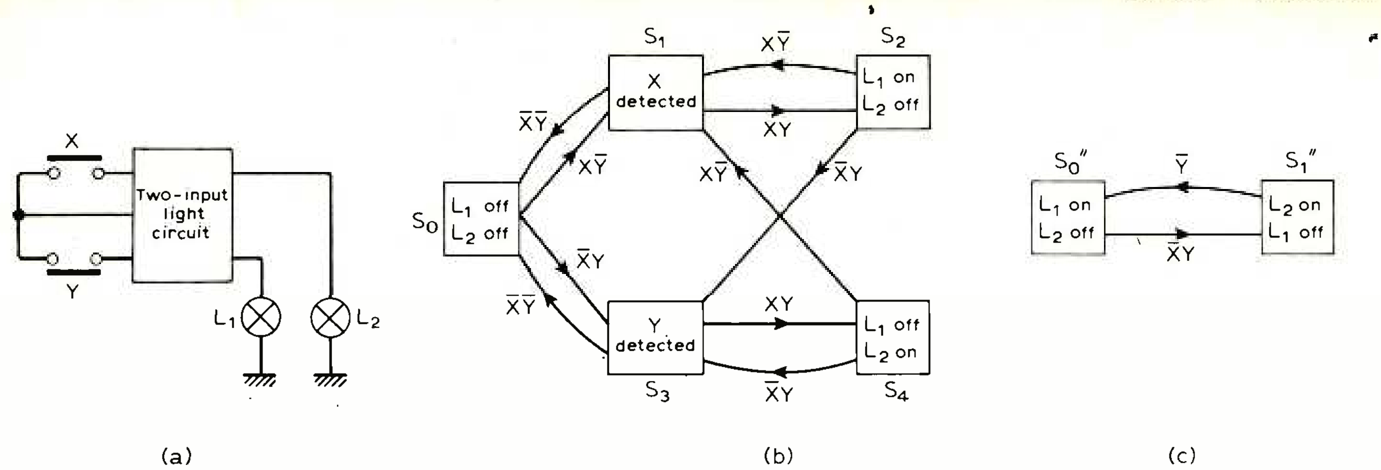


Fig. 3. Internal state diagrams of a two-switch logic circuit.

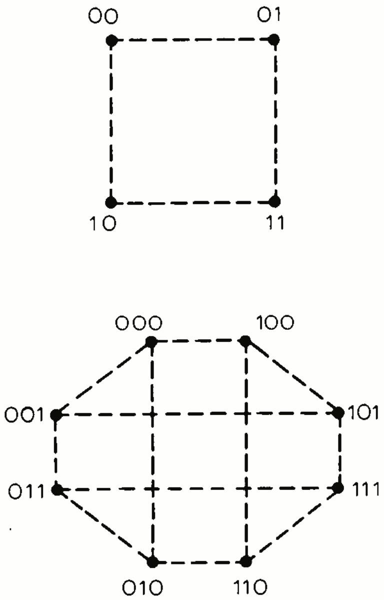


Fig. 4. Race-free diagrams for two and three variables.

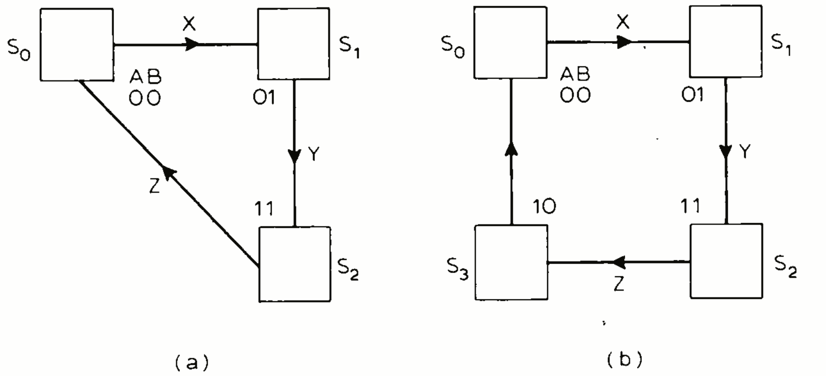


Fig. 5. Use of a dummy state (S_3) avoids simultaneous two-variable change from S_2 to S_0.

doing this is to ensure that races between state variables or secondary signals are automatically avoided.

A race-free assignment of states can be achieved with the aid of a race-free diagram. This is a two-deminsional diagram containing 2^n coded nodes, where all nodes whose codes differ in one variable only are joined by interrupted lines. Hence, races between secondary signals are automatically avoided if each circuit transition lies on a race-free line. Race-free diagrams for two and three variables are shown in Fig. 4.

Dummy states

There are certain patterns of internal-state diagrams that cannot be assigned race-free codes. Such a pattern is shown in Fig. 5(a). If the state codes for S_0, S_1, and S_2 are AB = 00, 01, and 11 respectively the direct transition from state S_2 to S_0 cannot be implemented as this would involve the simultaneous change of two variables. In this case the link between S_2 and S_0 can be turned into a race-free link by interposing a fourth state S_3 between S_2 and S_0, coded A = 1 and B = 0. This is called a dummy state and replaces line S_2–S_0 with race-free links S_2–S_3 and S_3–S_0, as shown in Fig. 5(b). The S_3–S_0 transition is unconditional and once the circuit assumes state S_3 it moves automatically to S_0. In terms of state variables this ensures that signal B is turned off first and this automatically turns signal A off.

Unused states.

If the number of states to be implemented is N, where $2^{n-1}<N<2^n$, there will be 2^n-N unused or redundant states. For example, in the case of the three-state diagram shown in Fig. 5(a) there will be one unused state. It can never be assumed in practice that a circuit will not move into an unused state either when switching the circuit on or due to the interference of a noise signal. For example, when in state $S_0=00$, a noise signal may turn A on and the circuit enters the unused state $S_3=10$. The circuit may be operating in conjunction with other circuits and moving into state $S_3=10$ may result in the incorrect behaviour of the overall system.

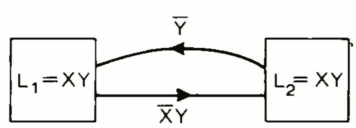
The designer is therefore strongly advised to take such a possibility into account at the design level and take the necessary action. For example, if the misoperation of the above circuit can result in the jamming of a production

XY	00	01	11	10
S_0	S_0	S_3		S_1
S_1	S_0		S_2	S_1
S_2		S_3	S_2 $L_1=1$	S_1
S_3	S_0	S_3	S_4	
S_4		S_3	S_4 $L_2=1$	S_1

(a)

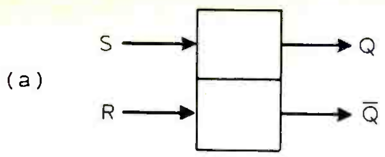
XY	00	01	11	10
S_{012}	S_{012}	S_{34}	S_{012} $L_1=1$	S_{012}
S_{34}	S_{012}	S_{34}	S_{34} $L_2=1$	S_{012}

(b)



(c)

Fig. 6. State-table reduction.



(b)

	S^t	R^t	Q^t	$Q^{t+\delta t}$
1	0	0	0	0
2	0	0	1	1
3	0	1	0	0
4	0	1	1	0
5	1	0	0	1
6	1	0	1	1
7	1	1	0	Forbidden combinations
8	1	1	1	

Fig. 7. SR flip-flop and its truth table.

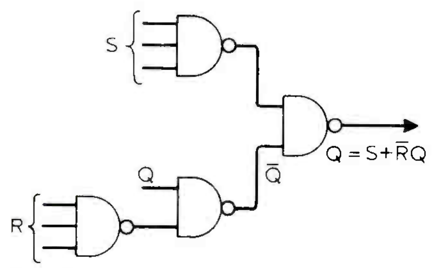


Fig. 8. Implementation of the NAND sequential equation for S and R primary signals.

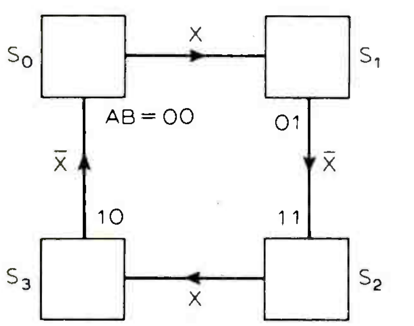


Fig. 9. Determination of turn-on and turn-off sets.

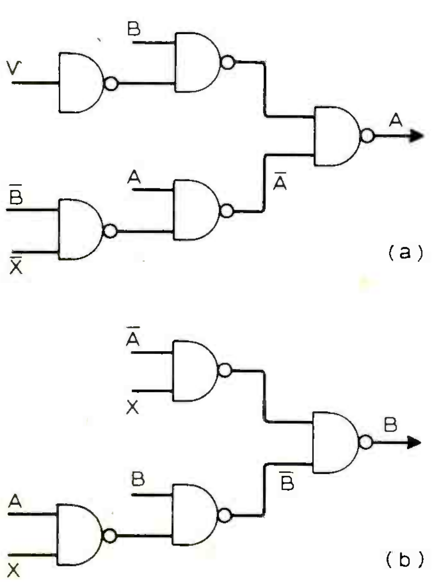


Fig. 10. Implementation of NAND sequential equations for turn-on and turn-off sets obtained from state diagram of, for example, Fig. 9.

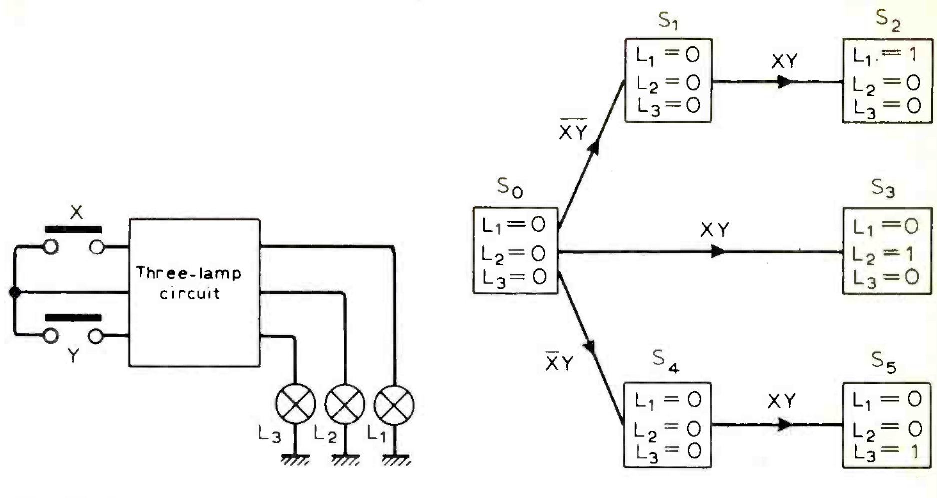


Fig. 11. Three-lamp circuit and its state diagram.

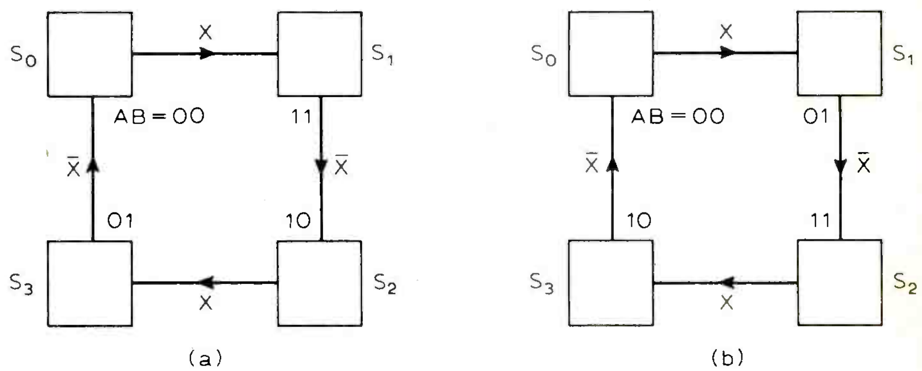


Fig. 12. Elimination of races between secondary signals.

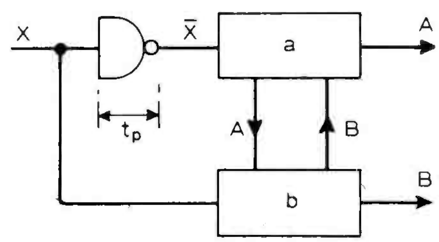


Fig. 13. Races between primary and secondary signals.

line, a possible action would be to use the signal A$\bar{B}$, which defines the unused state, to turn off all machines and raise an alarm.

Frequently, such states are referred to as "don't-care" states. Boolean expressions defining the "don't care" conditions are used as optional products to reduce the circuit equations and hence the complexity of the circuit. This is based on the assumption that a "don't care" condition does not arise in practice, which is only valid for normal operation. Since one cannot exclude the possibility of circuit misoperation, the designer is strongly advised not to leave undefined the response of the circuit under such conditions. In other words the designer "cares" about all circuit conditions.

Summarizing, no state diagram containing other than 2^n states should be implemented. Referring to the light circuit of Fig. 3, only the state diagram in Fig. 3(c) can be implemented. The implementation of the state diagrams in Fig. 3(b) would require the addition of three states. Additionally the reader is strongly advised against the mathematically convenient use of "don't care" states for circuit simplification.

State tables

The design restriction of always implementing 2^n states can be met either by introducing dummy states or by reducing the number of internal states. State reduction is carried out by using Caldwell's merging procedure which is based on the state table. Such a table has a row for every state of the circuit and a column for every combination of the input signals. The rows and columns are headed by labels representing the corresponding states and inputs. In each cell the circuit destination is entered, i.e. the next state assumed by the circuit when it is in a state corresponding to the row heading, and it receives input signals defined by the column heading. If the designer does not wish to specify the next state the entry in the appropriate cell is left blank. A second entry is made in each cell which specifies the circuit output,

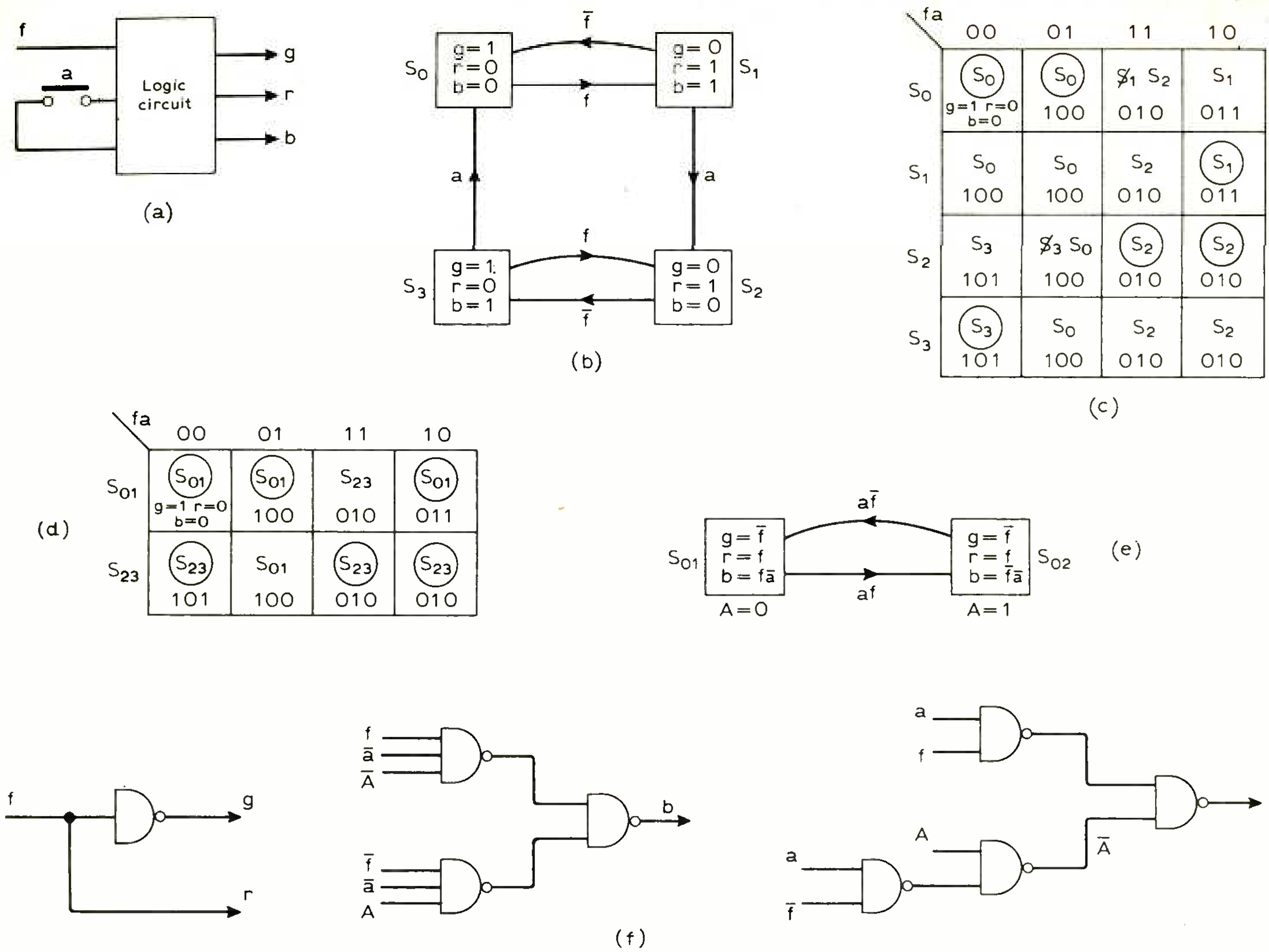


Fig. 14. Function to be realized in Example 1 is at (a) and its state diagram is at (b), while the state table is shown in (c) and in merged form at (d). Initial state diagram based on (d) is shown at (e) and realization of the circuit is (f).

unless it is a blank cell. If the circuit destination is the same as its current state, the circuit is stable and the entry is encircled. The state table corresponding to Fig. 3(b) is shown in Fig. 6(a).

State reduction

The process of combining the rows of a state table is made in accordance with Caldwell's merging rules.

Two rows may be merged if the state numbers and the circuit outputs appearing in corresponding columns of each row are alike, or if the entry in one or both of the rows is blank.

When circled and uncircled entries of the same state number are to be combined, the resulting entry is circled. Thus the two rows

	3	5		
	3	5	6	8
combine into	3	5	6	8

A change of state from 5 to 8 now involves a change of the input state only.

When a row S_m is combined with row S_n the new row is marked S_{mn}.

Examination of Fig. 6(a) indicates that rows S_0, S_1, and S_2 can be merged to give a new row S_{012} and also that rows S_3 and S_4 can be merged to give a new row S_{34}. The reduced state table is shown in Fig. 6(b) with its corresponding state diagram in Fig. 6(c), and this is identical to the state diagram of Fig. 3(c).

Sequential equations

The sequential equations, allow a state diagram to be translated directly into a circuit, as a consequence, lead to a much simpler solution of event-driven circuit problems. These equations can be obtained directly from a consideration of the logical behaviour of an SR flip-flop.

The SR flip-flop is shown symbolically in Fig. 7(a), the set and reset inputs being labelled S and R respectively, whilst the complementary outputs are labelled Q and $\bar{Q}$. The truth table for the flip-flop is shown in Fig. 7(b).

In the first three columns of this table, all combinations of the present states of S, R, and Q, i.e. their states at time t, are tabulated. In the fourth column the next state of the flip-flop, i.e. its state at time $t + \delta t$, is tabulated.

Examination of this table shows that a change of flip-flop state occurs in rows 4 and 5 only. In row 4 the flip-flop is being reset, i.e. its state is being changed from 1 to 0, by the application of inputs $S=0$ and $R=1$. In row 5 the flip-flop is being set, i.e. its state is being changed from 0 to 1, by the application of inputs $S=1$ and $R=0$. The reader should also notice that with this type of flip-flop it is inadmissible for S and R both to be logical 1 simultaneously. This restriction can be expressed algebraically as $SR=0$.

One form of the sequential equations is obtained by taking the logical sum of the combinations in the truth table for which $Q^{t+\delta t}=1$ and adding in the product $SR=0$. This does not affect the value of $Q^{t+\delta t}$ but leads to a simpler equation for it.

Hence:

$Q^{t+\delta t}=(\bar{S}\bar{R}Q+S\bar{R}\bar{Q}+S\bar{R}Q+SR)^t$.

Minimizing:

$Q^{t+\delta t}=(S+\bar{R}Q)^t$.

The second form of the sequential equations is obtained by excluding the product SR from the equation for $Q^{t+\delta t}$ so that

$Q^{t+\delta t}=(\bar{S}\bar{R}Q+S\bar{R}\bar{Q}+S\bar{R}Q)^t$.

Minimizing:

$Q^{t+\delta t}=[(S+Q)\bar{R}]^t$.

Time is inferred in these equations and they are written

$$Q=S+\bar{R}Q$$

and $$Q=(S+Q)\bar{R}$$

where S is referred to as the turn-on set of Q and R is referred to as the turn-off set of Q.

The most general form of the equations is:

$Q = \Sigma$ turn-on sets of $Q + Q(\overline{\Sigma \text{ turn-off sets of } Q})$

and $Q = (\Sigma$ turn-on sets of $Q + Q)$ $(\overline{\Sigma \text{ turn-off sets of } Q})$

The first of these two equations is used when the design is to be implemented with NAND gates and the second equation when NORs are to be used.

The implementation of the NAND sequential equation, $Q = S + \bar{R}Q$, is shown in Fig. 8. In this circuit S and R, the turn-on and turn-off signals respectively, are the primary signals, whilst Q is the secondary signals which is turned either on or off by the primary signals. When designing an event-driven logic circuit the turn-on and turn-off sets are derived directly from the state diagram; for example, by reference to Fig. 9.

Turn-on set of $A = B\bar{X}$
Turn-off set of $A = \bar{B}\bar{X}$
Turn-on set of $B = \bar{A}X$
Turn-off set of $B = AX$

Substituting these values in the NAND equations

$A = B\bar{X} + A(B + X)$
$B = \bar{A}X + B(\bar{A} + \bar{X})$

and the implementation of these equations is shown in Fig. 10.

Causes of misoperation

Circuit misoperation is said to occur when a circuit assumes an internal state other than the one intended. For example, if on leaving state S_1 in Fig. 11, with $X = 1$ and $Y = 1$ it assumes a state other than S_2, circuit misoperation occurs. Excluding component failure, the causes of circuit misoperation in event-driven circuits are races between primary signals, secondary signals or both. The above three causes will be examined in turn and solutions suggested in the next article.

Letters to the Editor

CIRCULAR INSERT GENERATOR

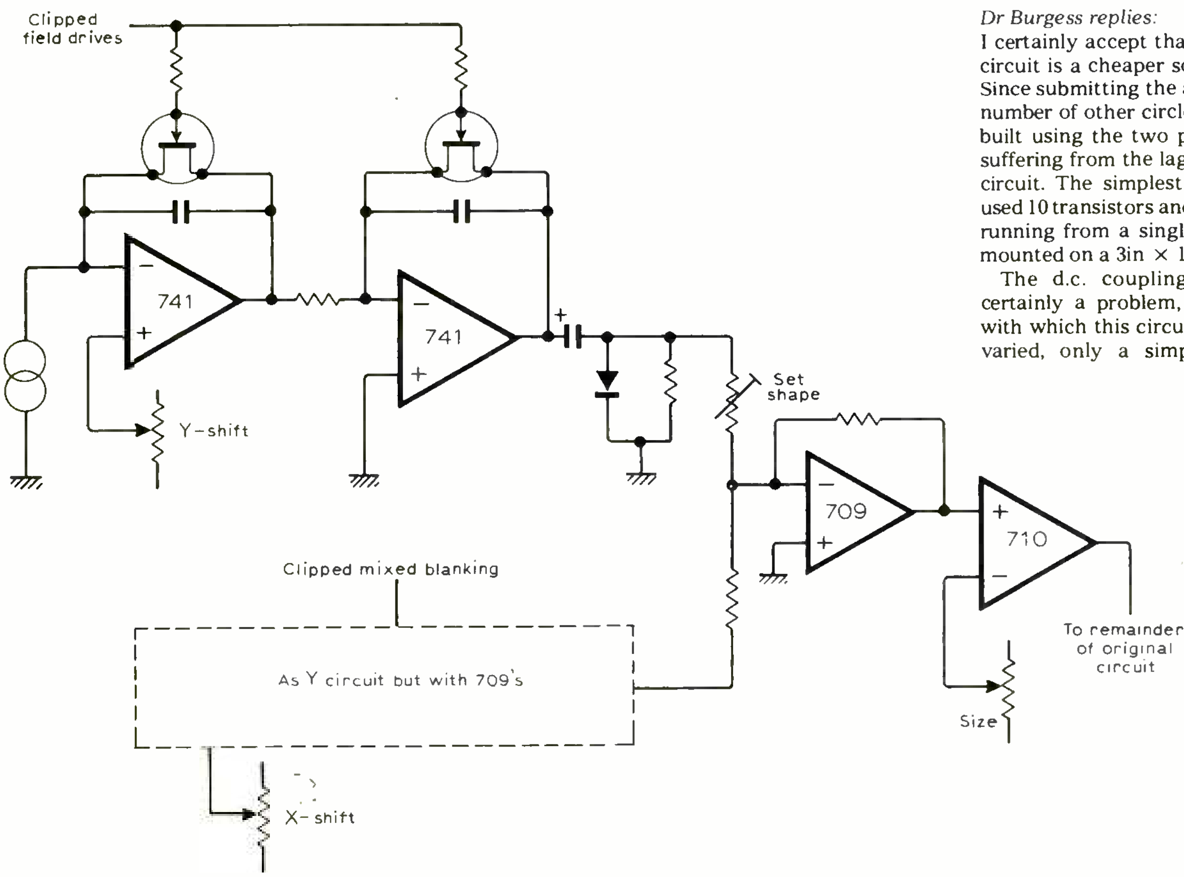
I read the article by D. E. Burgess in your January issue, entitled "Circular insert generator for television" with interest but feel that the use of two multiplier/divider circuits is rather extravagant.

The circuit of Fig. 1 outlines a cheaper and simpler solution, eliminating the multipliers and using a single rather than a dual comparator. The circuit generates the functions $(x-a)^2$ and $(y-b)^2$ by integrating the sawtooth waveforms of the original design and d.c.-restoring the resultant parabolae to prevent the shape of the circle varying as its position is adjusted. The parabolae are added and compared to a constant giving the circular area $(x-a)^2 + (y-b)^2 \leq c^2$.

There is a possible disadvantage in that the field rate d.c.-restorer will cause slight lag on the action of the Y shift control. In most applications this would not be serious.

I also note that the video input signals are d.c.-coupled. Unless the black levels of both have been fixed (e.g. by clamping) immediately prior to the unit the black level of the circular insert will be uncontrollable and will depend on the average levels of the two input signals. This problem is commonly found on inexpensive commercial units and is extremely frustrating when producing tv programmes.

J. Borin,
Student Television of Imperial College,
London, SW7.



Dr Burgess replies:

I certainly accept that Mr Borin's suggested circuit is a cheaper solution to the problem. Since submitting the article for publication a number of other circle generators have been built using the two parabolas idea, but not suffering from the lag problem of Mr Borin's circuit. The simplest solution found so far used 10 transistors and a 709 as a comparator, running from a single 9-volt power supply, mounted on a 3in × 1½in p.c.b.

The d.c. coupling of video signals is certainly a problem, but since equipments with which this circuit might be used are so varied, only a simple video circuit was described, to be used as a guide for potential users.

Could I point out an omission from the circuit diagram, as published? The junction of R_{15}, R_{45} and R_{46} should be connected to earth.

Mr Canning's article in the December issue of *Wireless World* draws attention to one of the more scandalous aspects of modern scientific-engineering but I wonder why he limits his comments to the resuscitation of forgotten ideas? Many have innocently made reputations and money from re-invention right alongside the originals.

Perhaps the best example of this is the super cathode-follower which, worldwide, operates happily in the same equipment as its prototype the stabilized power supply.

But we are all fallible and Mr Canning falls into his own trap of non-recognition when he talks of two-terminal negative-resistance tube oscillators. A basic proposition of oscillator theory is that any frequency-selective device can oscillate when its losses are zero. Electronic oscillators consist of a frequency-selective circuit (which, in practical form, has losses) and an active device which provides an effective negative resistance to cancel those losses. The circuit configuration is irrelevant to an oscillator except that, in the completed device, it determines the desired performance characteristics.

K. H. Green,
Tintagel,
Cornwall.

SHORTWAVE BAND CONGESTION

In his article "Congestion in the shortwave bands" in your November 1976 issue Mr Vastenhoud has forgotten to mention the United Kingdom. The BBC External Services have been using "out of band" broadcasting frequencies such as 15.070MHz, 12.095MHz and 9.410MHz for a long time.

G. Davydov (ex U1VB),
Moscow,
USSR.

The BBC confirms that, because of overcrowding in the international short-wave bands, External Services has, for many years, used a number of frequencies which are outside the agreed band limits. The frequencies have been used with the agreement of the UK regulatory authority for English and foreign language transmissions – Ed.

THE INVENTORS

As a postscript to your very interesting article, "The inventors" (August, 1976), it might interest you to know that Great Britain lost another invention, which not only now has a yearly turnover of approximately \$1,000m (it was already \$500m in 1967), but which Britain could have had for nothing. I refer to inertial navigation.

After conceiving the "U-Plane" — a submarine craft which could outmanoeuvre and outspeed all existing ships or submarines during the mid-thirties, I was searching for a means of automatic position indication which was not only independent of radio, but also jam-proof, and found it in the principle now known as Inertial Navigation—"IN" for short.

When World War 2 was approaching, I decided to offer the design to the Government. I was at the time in Palestine, and discussed the matter with Mr M. Offner, the engineer in charge of the Palestine Broadcasting Service, who agreed with my thoughts, that this was too revolutionary to offer as such, might fall into the wrong hands, or be not appreciated. I therefore decided, as a trial balloon, to first offer a similar position indication by means of a light point on a moving transparent map (other versions had crossed light lines on a transparent map which changed automatically when the indicated position reached its sides), but instead of "IN" used radio as the input and thus was more conventional, the intention being, to update it to the "IN" version when in England, and when sure its military value would be appreciated.

Thus, in 1939, when employed by the Meteorological Service, I submitted the design to the Director of Civil Aviation, Mr D. W. Gumbley, who decided to pass it on to London. While waiting for a reply, I constructed a simplified "IN" system for eventual demonstration purposes.

A quarter year later, my boss, the Director of C.A., received a letter from Marconi's in London, stating that they were not interested in the invention, as the need to make the light sources moveable for adjustment under a map when changing station and/or map would render the whole apparatus too elaborate and expensive. I was never given a chance to reply and point out that maps could in fact be projected without this need; and, furthermore, had indicated other solutions. I was not even considered worthy of a direct reply, nor of course was I invited to London.

I therefore concluded, that most people will rather die, live in misery, or see their cities destroyed, than make a rational assessment of advanced technology when presented by an individual person and give credit where it is due.

H. Lipschutz,
Rhoose,
Glamorgan.

ADVANCED PREAMPLIFIER DESIGN

The advanced preamplifier design featured in the November 1976 issue showed many useful design techniques for reducing distortion. However, the use of capacitors in the feedback loops for equalization and tone control must introduce some measure of transient distortion and I wonder if Mr Self has made any evaluation of this distortion.

I have recently compared some RIAA stage designs by listening tests and I have observed that taking the treble de-emphasis out of the feedback look and substituting a passive network gives a better sound quality in terms of definition of voices in choral works for example, and better stability and location of stereo images.

It is necessary, in making such comparisons to have high quality equipment and I used power amplifier modules designed by Crimson Electrik (designed for low transient distortion and comparing very favourably with some better-known commercial designs), an Empire 2000 E III cartridge and Monitor Audio MA3 loudspeakers.

I have since designed and built the preamp shown here. I have not been able to test whether taking the bass equalization out of the feedback loop makes any further improvement, though I would expect it to be less of an improvement than initially taking the treble equalization out of the feedback. This design does have the drawback that the overload margin is reduced, but the overall sound quality is certainly better than conventional RIAA stages.

I feel that this is an area of design which merits further attention and it is my impression that hardly anyone who designs amplifiers is aware of it.

Graham Nalty,
Borrowash,
Derby.

Mr Self replies:
I cannot see why Mr Nalty feels that the use of capacitors in equalization and tone-control feedback loops should generate transient distortion. While it is now largely accepted that an amplifier with a poor open-loop bandwidth and a low slew rate will generate transient intermodulation distortion when presented with high-frequency signals of large amplitude, despite the fact that a high negative-feedback factor has apparently greatly improved its performance, this shortcoming is due to the open-loop characteristics of the amplifier itself, and not the feedback network.

I am puzzled as to why Mr Nalty feels that executing the RIAA treble roll-off outside the negative-feedback loop gives superior subjective sound quality, since if the time-constant is correctly chosen the amplitude/frequency and phase/frequency responses will be identical in both cases. Furthermore, as he admits, the overload margin at high frequencies is greatly reduced (for example by about 12dB at 10kHz) and since the highest recorded velocities tend to occur at these frequencies, overloading of the stage becomes very much more likely, with an inevitable deterioration of quality. Another drawback is that the first amplifying stage now handles a signal with a much greater high frequency content. Hence the harmonic distortion is likely to be higher, and unless the maximum slew rate is very high, any transient distortion will be a great deal worse.

I can see no benefit in using a passive bass-boost configuration; one inevitable result will be a severe reduction in the overload margin available at mid-frequencies.

LOGIC DESIGN

The method of Boolean reduction presented by Holdsworth and Zissos is needlessly complex at one point (*Wireless World*, Jan. 1977). This complexity originates in an insufficiently general "race hazard" rule. I should like to offer a simpler method.

A *tautology* is any function that receives the value true (1) whatever values are assigned to its component variables. $A+\bar{A}+B$ is a tautology, as is $AB+\bar{A}B+A\bar{B}+\bar{A}\bar{B}$, since whatever we assign to A and B at least one term in the "sum" (disjunction) is true, and so the whole sum is.

Two rules are used which I term *introduction* and *elimination*. The elimination rule is just redundancy: "If a term in a sum is part of another term, eliminate the larger." Introduction is based on the following theorem: *Let the sum* $A_1 + \ldots + A_n$ *be a tautology. Then the sum* $A_1B_1 + \ldots + A_nB_n$ *is equivalent to the sum* $A_1B_1 + \ldots + A_nB_n + B_1 \ldots B_n$

Proof. If the first sum is true then some term A_1B_1 is true, and this term occurring in the second sum, that is true too. If the second sum is true then if (i) some term A_1B_1 is true this occurs in the first sum which is therefore true. If (ii) the term $B_1 \ldots B_n$ is true then each B_1 must be true. Since $A_1 + \ldots + A_n$ is a tautology some A_1 must be true. Hence A_1B_1 is true and so the first sum is true. The two sums thus always have the same value and are equivalent.

The two rules may be applied mechanically as follows: (1) Locate a largest tautology. (2) Introduce the resulting term ("optional product"). (3) Eliminate original terms using the introduced term. To illustrate with the example given: Reduce: (1) $A + \bar{A}B + BC + \bar{A}\bar{B}D$. The largest tautology is $A + \bar{A} + BC + \bar{A}\bar{B}D$. So introduction gives (1) = (2). (2) $A + \bar{A}B + BC + \bar{A}\bar{B}D + B$ and then elimination of terms containing B gives (2) = (3). (3) $A + \bar{A}\bar{B}D + B$. A largest tautology is $A + \bar{A} + B$. So introduction gives (3) = (4). (4) $A + \bar{A}\bar{B}D + B + \bar{B}D$ and then elimination of terms containing $\bar{B}D$ gives (4) = (5). (5) $A + B + \bar{B}D$. The largest tautology here is $A + B + \bar{B}$ so introduction gives (5) = (6). (6) $A + B + \bar{B}D + D$ and then elimination of terms containing D gives (6) = (7). (7) $A + B + D$

There is thus no need for the concepts of "parent-product" and "non-parent product," nor indeed for any theorems. Rules are emphasised, since transformations are the only concern and we achieve this emphasis by relying exclusively on truth tables (the theorem is of course a statement about these).

Peter Mott,
Department of Philosophy,
University of Lancaster.

WAS BAIRD FOOLING THE PUBLIC

F. H. Haynes comments at length on J. L. Baird on page 52 of the December, 1976 issue. Mr Haynes states that Baird's April 1925 television equipment, used at Selfridge's store in London, was not synchronized and did not have a light sensitive cell. How could Mr Haynes possibly know of these details if the equipment was completely "boxed in"? Baird is also accused of not giving out details on his recently-patented apparatus; he obviously couldn't divulge this information for the simple and obvious reason that he would not have been granted patents for previously having disclosed the same information. Of course, Mr Haynes is quite wrong in both of his statements. Baird's equipment was seen "unboxed" at Selfridges and some details were reported[1]. In reference 1 the photograph is of Baird's equipment at 22 Frith Street, not Selfridges. Various other people reported on Baird's equipment at this period [2], [3] and [4]. References 1 to 4 all state quite clearly that the equipment was synchronized and used light-sensitive cells. Mr Haynes will see a photograph of Baird's synchronized, eight-line receiver at 22 Frith Street, March 1925, in a recent article of my own in *New Scientist* [5]. Reference 4 gives details of Baird's phasing arrangements, his provisional patent for which dates to 1924, which indicates that he was capable of phase control of the image in April 1925. References from late 1926 onwards indicate that the British government had requested that Baird disclose no details of his photocell, since he had just given demonstrations of long range infra-red and reflected radio-wave location of objects to the armed services of several countries. Any person wishing more information from Baird could have read his patents or made suitable business arrangements to purchase the same, i.e. normal business procedure. Since all the television pioneers were very secretive, it is unfair to single out Baird.

Mr Haynes' comment on Dr Burn's letter of October, 1976, that to cite experienced senior officials (who all praised Baird's efforts) is not appropriate, is a nonsense. If Baird was "fooling the public", how can Mr Haynes explain Baird's long friendships with Sir J. A. Fleming (diode valve inventor and scientific adviser to Marconi's), Sir Oliver Lodge (radio pioneer before Marconi, scientific adviser to Marconi's), Sir Edward Appleton (Nobel Prize winner, pioneer of modern radar), George Bernard Shaw, A. Russell (President of I.E.E.), Professor W. Bragg (President, Royal Institution) and many others who had reputations to preserve. As Mr Haynes says, so much was published (true) yet so little is known of essentials (not true), that one must find and read the published information before passing any comments.

Regarding Vector's comments on Baird, in the December 1976 issue, the following points should be noted. Baird was engaged in television and sound film research from 1912. His commercial exploits were to raise money for his experiments. Regarding diamond manufacture, Baird in fact was copying Sir Charles Parsons' many experiments in which he was occasionally helped by A. A. Campbell Swinton. In trying to make diamonds in Glasgow, Baird displayed a higher level of intelligence than Swinton who was actively destroying diamonds [7]. Concerning Baird's Trinidad jam factory, this was no abysmal failure as was suggested. After trial and error, Baird produced mosquito-free jam, returning to London in September 1920 to establish trade outlets for the factory. From private letters of Baird it transpires that his factory manager absconded to America with all of Baird's money, leaving him destitute and broken hearted in London, hence the exploits with Baird's "Speedy Cleaner" to raise more money. Baird was also no "unqualified crank"; his Associateship of the Royal Technical College in Glasgow (the world's first technical college and technical university) was an excellent technical qualification for its day and with Baird's final track record of achievement he was most certainly no "crank". He was "unqualified" in television engineering I agree, but perhaps Vector could inform me of anyone who was so qualified in 1924/25?

In surveying the comments on Baird to date in *Wireless World*, excluding Dr Burn's letter which I thoroughly enjoyed for its objectiveness and immaculate referencing of the facts, it could yet prove to be the case that it is not Baird who "is on trial" but anyone who comments on J. L. Baird and has not first checked their facts.

P. Waddell,
East Kilbride,
Glasgow.

This correspondence is now closed.—Editor.

1. Bird, P. R. "Wireless Television, a Review of the Baird System", *Popular Wireless and Wireless Review*, May 23, 1925 P662-623.
2. Russell, A. *Nature*, 115 No 2892, April 4, 1925, P305.
3. Baird, J. L. "Wireless Television", *Engineering*, CXIX, 1 May 29, 1925, P661/2.
4. Dinsdale, A. "The Problem of Synchronisation in Television". *Radio News (USA)*, January 1928, P750-1.
5. Waddell, P. "Seeing by Wireless". *New Scientist*, 72, 1026. November 11, 1976, P342-4
6. Kaempfert, W. "How Baird sees Through Space by Radio". *New York Times*, Sunday, March 6, 1927, PXX-5.
7. Parsons, C. A. and Campbell-Swinton, A. A. "The Conversion of Diamond into Coke in High Vacuum by Kathode Rays". *Proc. Royal Soc. A, 80*. 1908, P184.

ADVANCED RADIO MONITORING

In the article Advanced Radio Monitoring in your November 1976 issue reference was made to computer-controlled receivers. From inquiries we have received it appears that confusion has arisen in the minds of some of your readers concerning the manufacture of these receivers.

To clarify the situation, I would like to emphasise that these are RA1780 series receivers, manufactured by Racal Communications Limited of Bracknell.

E. A. Carey,
The Racal Electronics Group,
Wokingham,
Berks.

CITIZENS' BAND IN THE UK?

We read with interest your editorial and the article by Mr Dwyer on the question of a Citizens' band in the UK in the future.

We feel it might be of interest to you to know that the EEA have recently set up a working party on Citizens' band with the object of making an industry recommendation on the introduction of such a service. This will involve a careful study of the present use in other countries of equipment operating in the 27MHz band and the advantages to be gained by employing a higher frequency part of the spectrum.

The industry is anxious to see that any introduction of such a service should be undertaken with due regard to the needs of the citizen, the effect upon other users of the spectrum, and the implementation of a "sensible" degree of control by the Home Office.

M. S. Ollivant,
Director,
Electronic Engineering Association.

WAVEFORMS IN QUADRATURE

The issue of *Wireless World* for December 1976, p.43, Fig. 2 contains a circuit to produce wave forms in quadrature. This circuit suffers from lead/lag ambiguity. This can be prevented if the D input to one of the flip-flops is connected not to its own $\bar{Q}$ output but to the $\bar{Q}$ output of the other flip-flop.

C. Rashbass,
Institute of Psychiatry,
Denmark Hill,
London.

Can oscillators be "common"?

Does it make sense to classify them in the same way as amplifier circuits?

by "Cathode Ray"

I want to make clear from the start that the above title has no reference to social status. If it hadn't been abbreviated it would have been too long for a title – in the electronic though perhaps not in the theatrical world. In full it would have had to be something like this: You know how one of the first things you learn about transistor circuits (and used to learn about valve circuits) is that they come in three kinds, common-emitter, common-base and common-collector (common cathode, common-grid and common-anode)? Well, does it make sense to classify oscillator circuits in this way?

So much for the title. Before going on to the subject itself, may I first be allowed to dispose of those who talk about "grounded-base", etc, Genuine Americans are entitled to use the word "grounded" because what we call "earth" they have always called "ground." So fair enough. But to accept "earth" like a true Briton and yet to say "grounded" instead of "earthed" is just silly. Much more important than this nationalistic consideration, however, is the fact that both "grounded" and "earthed" and any other words there may be that mean the same thing are wrong in this particular context, because earthing has nothing necessarily to do with it.

The context referred to is amplification. Every amplifier has (in principle), a pair of input terminals and a pair of output terminals. That makes four terminals altogether. So if the amplifier is drawn as a box, we get Fig. 1. Let us suppose that this amplifier has only one stage, or that it is a single stage of a larger amplifier. Then the essential thing that the box contains is a transistor (or a valve), which has three terminals, so is known as a triode. Therefore one of the three terminals must be connected to both input and output. In a word, it is *common* to both input and output. Obviously it mustn't be common to both input or to both output terminals, because that would short-circuit them. Another point: the triode's common terminal is still effectively common even when there is a constant potential between it and the input or output or both. For example, Fig. 2 (a) shows a perfectly typical amplifier stage. If you take away all the components that are required simply to maintain the electrodes at the correct steady potentials for proper working, you are left with (b). This is a signals-only circuit diagram, which helps us to see that the lower input and output terminals are connected to one another and to the emitter, so it is a common-emitter circuit. Even in the form of Fig 2 (a) it is not very hard to identify as a common-emitter circuit, especially if the component values are given, because the capacitance of C would be large enough to tell us that it is practically a short-circuit to signals.

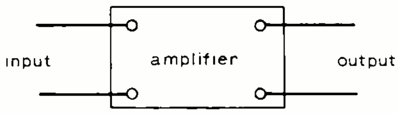


Fig. 1. Any amplifier has a pair of input terminals and a pair of output terminals, even if they consist only of positions on the wiring.

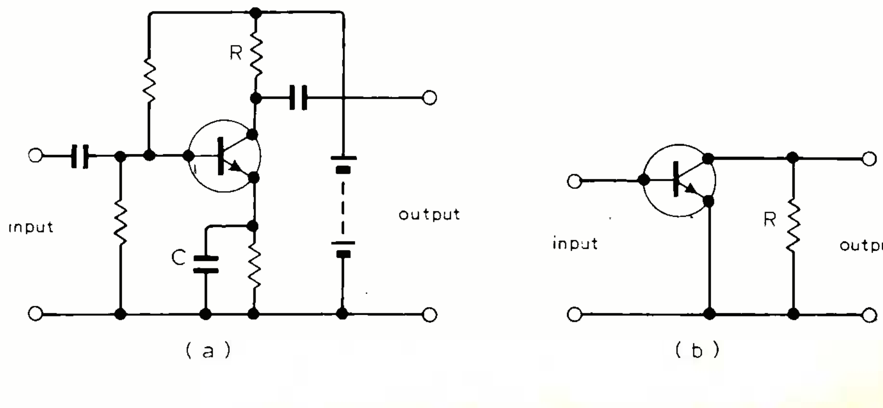


Fig. 2 (a) is a typical complete circuit diagram of a one-stage amplifier, and (b) shows the same circuit after all components concerned only with d.c. have been removed.

This amplifier stage might well be part of some small portable equipment in which case there would be no earth connection and the term "earthed (or "grounded") would be altogether inappropriate. It is true that if the circuit was earthed anywhere it would most likely be at the common input/output point. But it would make no difference in principle if somebody decided, just to be different or for some better reason, to earth the collector. It would still be a common-emitter circuit. One would be perfectly correct, but exceedingly misleading, to describe it as an earthed-collector circuit.

Common, then; not earthed or grounded.

What about oscillators? Perhaps the clearest way of explaining them to people who already know what amplifiers are is to tell them to tap off a fraction of an amplifier output, equal to the input, and arrange the circuit so that this reduced output is exactly in phase with the input. It is then a perfect copy of the input and can be substituted for it, giving a circuit that generates its own signal continuously; in a word, an oscillator. This conversion is shown in Fig. 3. Usually the magnitude and phase of the output fed back will be correct at only one frequency; that, then, will be the frequency of oscillation.

The only snag I can think of about this neat introduction to oscillators is that on the basis of what has gone before it is almost bound to lead one to suppose that if (for example) the amplifier is of the common-emitter variety the resulting oscillator will also be common-emitter. But this is a fallacy.

Why? Fig. 3 presumably has one input and one output terminal common, and if they are connected to the emitter then surely it is a common-emitter oscillator circuit?

The three different configurations work as amplifiers in different ways: the common-emitter gives both voltage and current gain, with phase inversion; the common-base gives voltage gain and current loss, without phase inversion; and the common-collector gives voltage loss and current gain, also without phase inversion. Surely one can tell which is which in an oscillator as well as an amplifier?

Plausible, but it won't stand examination. We have been making too many assumptions about the parts of the circuit needed to make the output equal to the input in magnitude and phase. We shall have to draw the whole circuit, including what is inside the box in Fig. 3. But, as we saw in Fig. 2, there is no need to include the d.c. feeds which just confuse us when we are concerned only with signals. Fig. 4 shows the best-known of all oscillator circuits, the Hartley. Which is the common electrode?

After a pause for deep thought, the verdict must be that of the Dodo at the end of the caucus race: all have won, so all must have prizes.

Having so far had in mind chiefly the popular common-emitter configuration, we may perhaps try to get Fig. 4 into the Fig. 3 form in such a way as to show that it is a common-emitter circuit. Very well, then; Fig. 5 is exactly the same circuit as Fig. 4, and it is clearly a common-emitter circuit.

But before the common-emitter supporters cheer themselves hoarse let them take a look at Fig. 6. This too is exactly the same circuit as Fig. 4 (and Fig. 5) and it is clearly a common-collector circuit. Similarly the same circuit can be drawn as in Fig. 7, proving that it is a common-base circuit. But in case common-base enthusiasts try to get one up on the others by pointing out that Fig. 7 is the only one that really looks like Fig. 3, we must tell them that Fig. 3 could have been drawn to favour either of the other two.

So, going back to Fig. 4, we can say that any of the three electrodes has just as much and just as little right to be called the common one as either of the others. In other words, the question as to which of the three this oscillator circuit is should not be asked, for it has no useful meaning. And that this is true of the Hartley circuit can be shown to be true of any other oscillator circuit. Showing this is more difficult for the RC oscillator, but it can be done.

Before we leave the subject let us look again at Fig. 4, and regarding each electrode in turn as the common one see how the circuit fulfils the conditions required by that configuration. First the emitter. The common-emitter amplifier circuit is the only one of the three that inverts the phase, so as an oscillator circuit it must include means for inverting it again. Fig. 4 (and Fig. 5) show how the tuning coil serves as an auto-transformer to do just that. If the transistor gives a considerable voltage gain, as it can well do in the common-emitter configuration, the correct tapping point is quite near the base end of the coil. But even if it were used at such a high frequency that there was no voltage gain at all, the output being no more than equal to the input, it could still be made to work as an oscillator by tapping at the centre of the coil.

Next the common-collector. This gives a voltage loss and no phase inversion, and Fig. 4 (and Fig. 6) show that the coil now appears as a voltage step-up autotransformer with no phase inversion. Lastly, if Fig. 4 (and Fig. 7) are regarded as common-base circuits, we see that the coil is again a non-inverting autotransformer, but this time with a step-down in proportion to the voltage gain, thus compensating for the current loss in a common-base amplifier.

Was S. W. Amos therefore wrong in stating* that one of the two essential requirements of an oscillator was signal inversion? Not if one looks at the maintaining amplifier part of the complete oscillator circuit as a common-emitter type as he did and was entitled to do. But he or we are entitled alternatively to look at the same complete oscillator circuit from a different point of view, embodying a common-base or common-collector amplifier, in which cases inversion is not a requirement.

So it is all a matter of point of view. And different points of view make no difference to the actual oscillator circuit or its working.

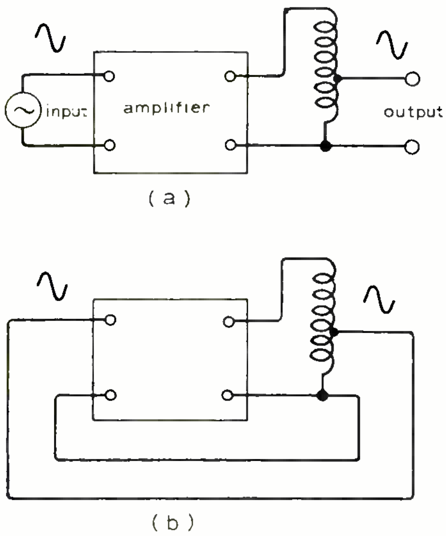


Fig. 3 (a) is the same as Fig. 1 plus a device for making the final output signal equal in magnitude and phase to the input. So this output can be substituted for the input signal generator, as at (b) to make an oscillator.

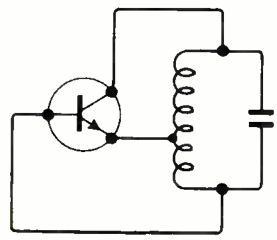


Fig. 4. The familiar Hartley oscillator circuit in the signals-only form.

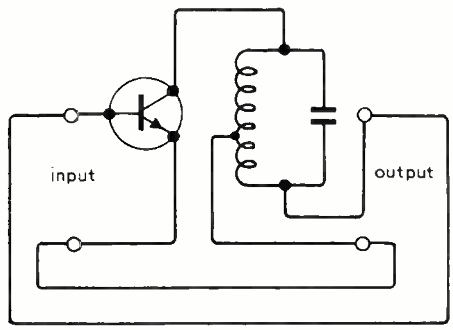


Fig. 5. The same circuit as Fig. 4, redrawn in the form of Fig. 3 (b) to look like a common-emitter circuit.

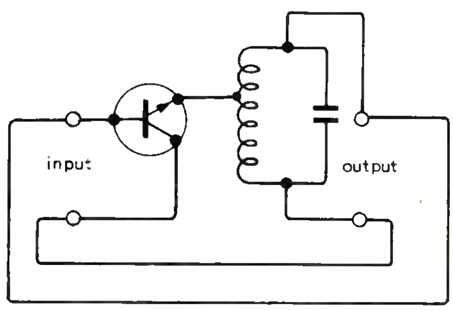


Fig. 6. Looks like a common-collector circuit, but is actually identical with Figs. 4 and 5.

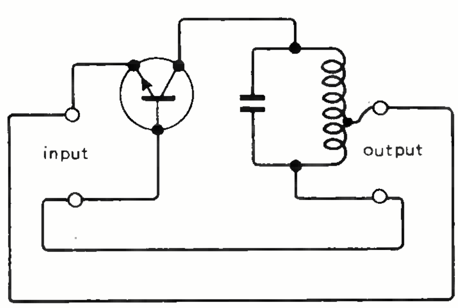


Fig. 7. Again the same as Figs. 4, 5 and 6, though looking like a common-base circuit.

*"Antiphase or 180° phase shift?", WW, June 1976, p.47.

Identifying European television — 2

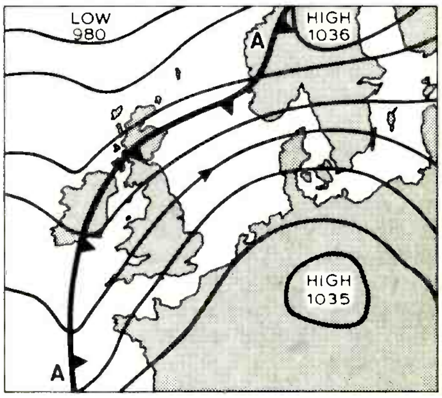
A further selection of test cards and identification captions

by G. Smith and K. Hamer

The reception of European television signals is generally dependent upon the prevailing weather conditions. One of the best methods is reception by sporadic E between mid-May and late August when the earth's E layer is ionized by the sun. This ionized layer refracts television signals back to earth and the duration of reception can range from a few minutes to several hours.

If a British television receiver is used, simple modifications are necessary. The vision detector diode should be reversed because the British system "A" has positive vision modulation and the receiver must be adapted for negative-going signals. A reduction in cathode bias on the video amplifier is necessary as a result of this. The line oscillator may run up from 405 to 625 lines without further modification, but it may be necessary to reduce the value of the series resistor to the line hold control. If any modifications are undertaken it must be remembered that the chassis is live. These modifications are not necessary if the signals are received on u.h.f. Sporadic "E" signals can also be fed through a v.h.f./u.h.f. converter which enables an unmodified u.h.f. receiver to be used.

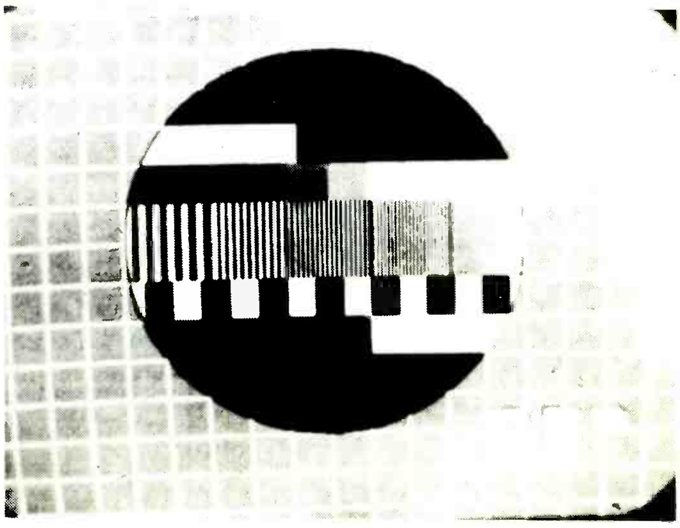
There is another method of signal propagation which affects u.h.f. and band III transmissions from Europe. This is known as Tropospheric Propagation. The troposphere extends from the Earth's surface to about 20,000 feet. If an anticyclonic system develops, also called a high-pressure system, and remains centred over Scandinavia for a few days, it is likely that enhanced u.h.f. reception will occur provided that a cold front stretching from Norway to England is present. The cold front will cause a temperature inversion to take place which will tend to duct the signals. Unlike Sporadic "E", Tropospheric Propagation does not occur annually but can be a source of reception at any time. Normally, distances involved during tropospheric conditions are shorter than for Sp.E, usually up to 1000 miles. During good conditions, transmissions can be received in colour



except for France, Monaco and certain eastern European services which use SECAM.

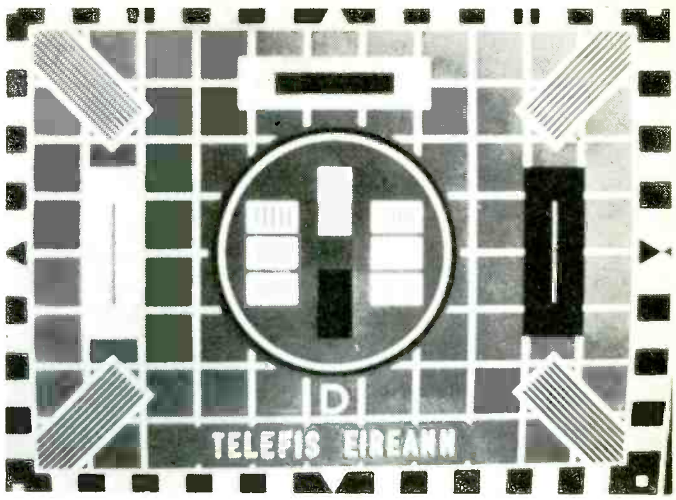
A typical weather chart for enhanced tropospheric reception is shown with the pressure indicated in millibars. The extent of the high-pressure system is shown by the isobars which indicate equal points of pressure. Line AA shows the cold front.

Algeria RTA (B) — The EBU bar is used by many members of the European Broadcasting Union.

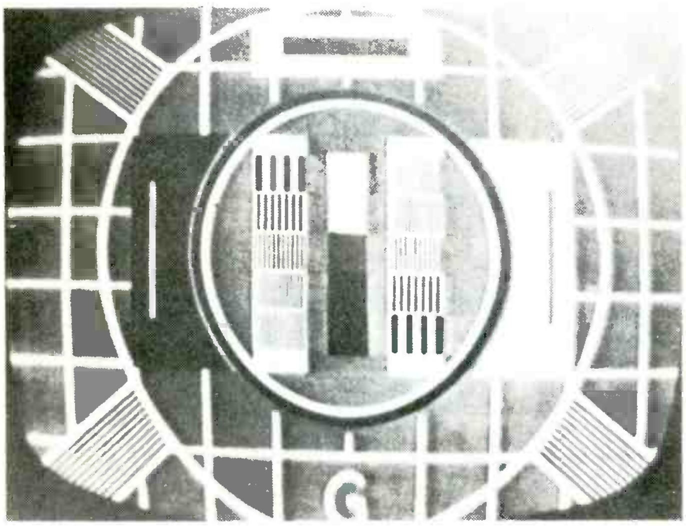


West Germany DBP (G) PAL colour — An electronically generated test card.

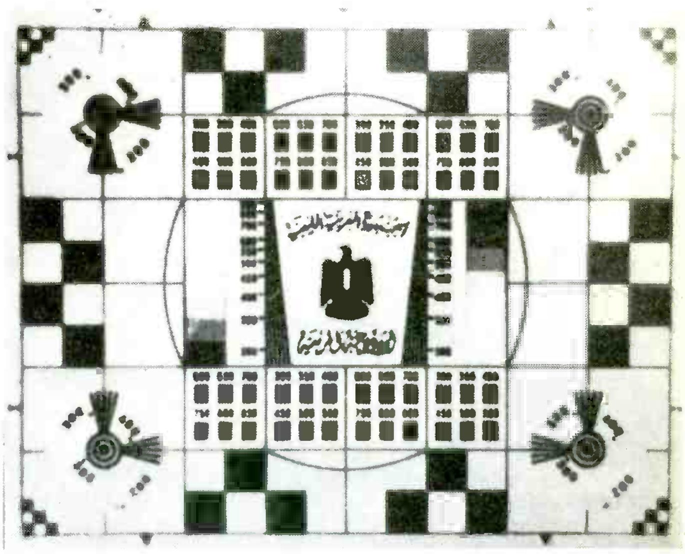
West Germany A.R.D. (B, G) PAL colour — Bayerischer Rundfunk operate three high-powered Band I transmitters.



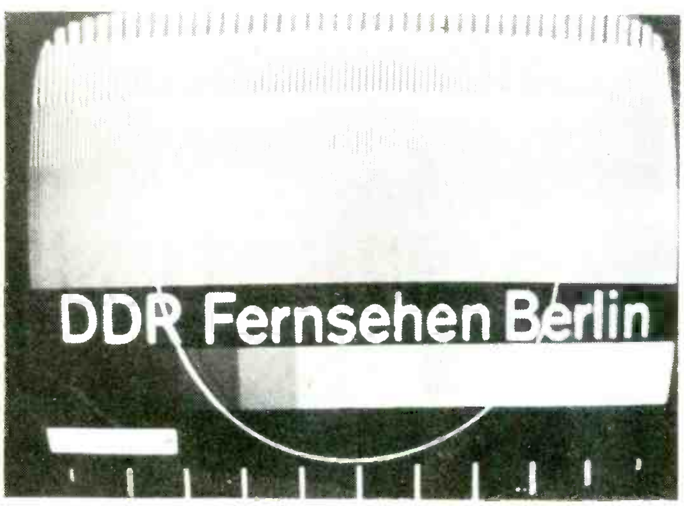
Eire RTE (A, I) PAL colour — Radio Telefis Eireann now use the Philips PM5544 electronic test card.



Bulgaria B.T. (D) — Test card "G" as radiated from B.T's low-powered transmitters. This is an off-air photograph.

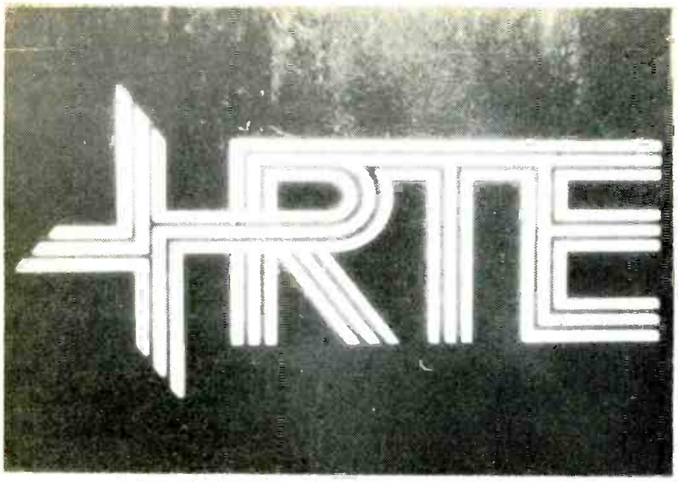


Libya PRB (B) — This type of test card is usually referred to as being an "ORTF-type" after the name of the old French service which first introduced it.



East Germany DDR-F (B, G) SECAM colour — There are several different identifications used with this electronic test card.

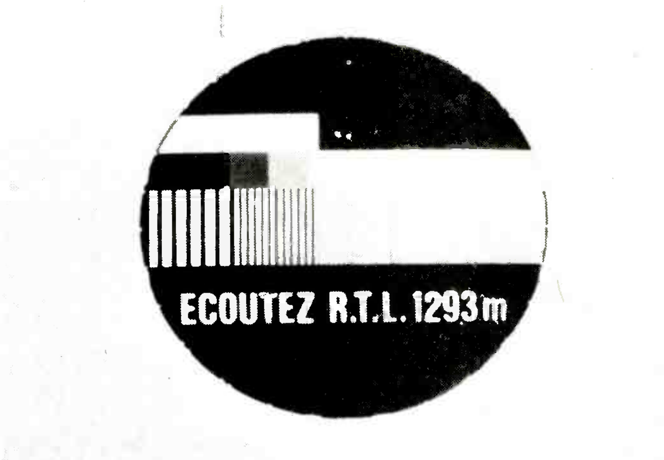
West Germany DBP (G) PAL colour — The DBP transmit identification captions, or "Senderdias", at regular intervals during test transmissions.



Eire RTE (A, I) PAL colour — Identification caption as used by Radio Telefis Eireann.

Jordan JTC (B) — The Jordan Television Corporation operates a 100kW transmitter in Band I which has been received in the U.K.

East Germany (B, G) — Radio programmes are relayed with this electronic test card.



Luxembourg RTL (L) PAL (Band III) & SECAM (u.h.f.) colour — Radio-Tele-Luxembourg also uses the FUBK electronic test card with the identification "ECOUTEZ RTL."

East Germany DDR-F (B, G) SECAM colour — The clock caption as used by Deutscher Fernsehfunk.

East Germany DDR-F (B, G) SECAM colour—The Second Network on u.h.f. is occasionally received in the United Kingdom.

Weather-satellite picture facsimile machine — 4

Setting up procedures and operation

by G. R. Kennedy

Setting up procedures for the weather-satellite picture facsimile machine are as follows:

The v.c.o. and the input level to the **clock-rate detector** are set to obtain a steady clock rate from the satellite signal with full picture modulation.

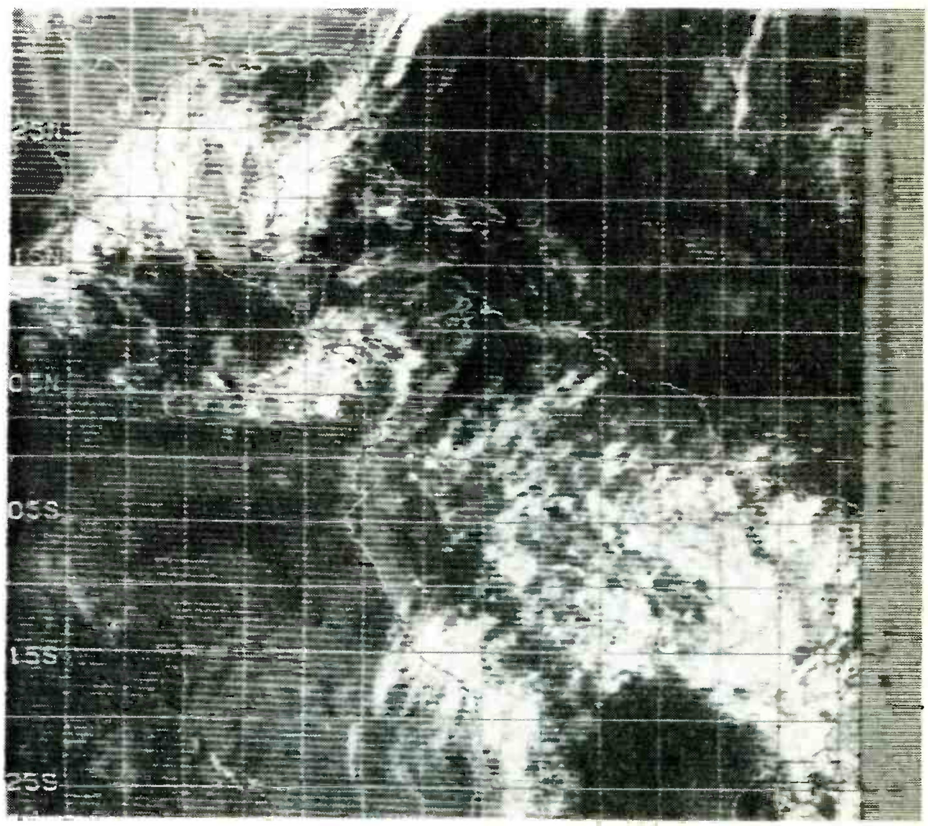
Motor drive (Fig. 12). C_{27} is set as previously explained. S_4 is left open and a d.c. ammeter, on the 400mA, or 1A range, is placed across it. RV_{11} is increased so that 200V r.m.s. is obtained across the motor. The drive at C_{24} is then removed and RV_{11} is backed off until the standing current on the meter is not more than 50% of that with drive applied.

Sample pulse generator (Fig. 8). A satellite signal is fed into the machine and a few cycles of the demodulated signal monitored on one beam of an oscilloscope. This is triggered from the clock rate signal. The sample pulse is then applied to the second beam of the oscilloscope and RV_9 is adjusted to give a pulse width of approximately 2% of the demodulated subcarrier period. RV_8 is adjusted so that each sample pulse coincides with each positive peak of the signal. Note that if the phase-lock-loop v.c.o. is adjusted the phase of the clock signal will alter and RV_8 will have to be reset.

Signal detector and light source driver (Fig. 7). First set RV_7 to maximum. Set RV_5 (the brightness preset) to minimum, i.e. the wiper to the R_{23} end. This is the normal running setting of RV_5 and it will only need altering for special purpose pictures. RV_6 is adjusted to give a peak-white to peak-black excursion of 36 to 40V at Tr_8 base/Tr_7 collector. Reduce RV_7 while monitoring Tr_9 emitter waveform across R_{37} with the input subcarrier signal on the second beam, until distortion and drop-out of long white sections occurs. Then increase RV_7 slightly to remedy this.

Strobe generator (Fig. 14). An accurate oscilloscope or a digital time/frequency meter are the best instruments to use, if available, to set up the strobe generator. Trigger the start of the oscilloscope timebase or the digital counter from the negative leading edge of the 0.8Hz input pulse into C_{34}. Set S_{3b} to 1/5th line division. Adjust RV_{15} to give the trailing (positive going) edge of the pulse at IC_{22} pin 1 ($\bar{Q}$ output) 250ms after the start. Switch to 1/4 line and adjust RV_{14} for a pulse length of 312.5ms. Switch to 1/3rd line and adjust RV_{13} for a pulse length of 416.6ms. These pulses set the writing period for SR pictures; they are exactly as long as one drum revolution. If set too short, the picture will be too narrow, and if too long, overlap and double imaging will occur. If accurate equipment is not available, the strobe pulses may be viewed together on an oscilloscope and the appropriate pot (RV_{13}-RV_{15}) adjusted for coincidence.

Drum position sensor. Mark the drum with white painted lines or similar to indicate precisely the position of the sticky tape which holds the paper around the drum, so that the strip can be freshly applied when required to exactly the same place. It is assumed that the picture wrap-around — and hence the edge — will be halfway across the strip. Temporarily, stick a small piece of "rubber magnet" to the edge of the drum near the position sensor (tape head) with a small piece of the sticky tape. Rotate the drum in the normal direction and print a rough picture sufficient to show the picture borders. Mark the correct magnet position and cement it firmly in place. The process can be speeded a little by monitoring the picture and the drum pulse on an oscilloscope, but before cementing the magnet a picture should be printed so that the borders are in exactly the right position. Adjust RV_{12} (Fig. 13) to give sufficient pulse height for Z-modulating the beam of an oscilloscope. If double pulses are produced, the sensor is too near the drum magnet and must be moved slightly further away.



ATS-3 satellite picture, *2nd March 1975 at 09.00z. Computer processed infra-red data from NOAA-4 satellite, showing South America and the U.S.A. The dark marks in the edge band indicate that the received signal was marginal and that picture data was being lost as the satellite rotated. Note the cloud typical of the hot jungle around the Amazon Basin.*

Picture slip oscillator (Fig. 11). Monitor the picture line signal at the input or at the crater-tube monitor socket and trigger the oscilloscope from the drum rotation pulse. Switch the picture slip switch on and adjust RV_{10} to give a slip rate which is comfortable for setting the edge position, but not too slow. A good starting rate is a slip of one line in five seconds.

Picture contrast adjustment (Fig. 7). Initially RV_6 should be set for 5mA crater tube current on the meter with a peak white signal, and the contrast potentiometer preceeding the expander should be adjusted to give 35mA or so (dark grey). When the satellite signal is to be printed these controls should be balanced against each other to give an undistorted demodulated signal at the crater-tube monitor socket, with peak black and white just beginning to clip. For special emphasis of, say, cloud or land the balance between expander input and total crater-tube excursion can be varied. These settings can be critical, and multi-turn pots with turns-counting dials should be used and the settings noted. Once a standardized level of reception and/or recording is carried out, printing of the pictures should not require much adjustment of the contrast and gain controls, and familiarity will lead to consistent results.

Routine operation

The machine does not run hot and should not need a warm-up period. For normal pictures the expander will be set at a minimum (direct) for APT and WEFAX and at a maximum for SR pictures. Set up the machine in a dark room with a red safe light and developing dishes etc, to hand. *Remember to keep the machine, which runs at mains voltages, away from any liquids. Ensure that the machine is well earthed with its mains lead in good condition and do not operate with wet hands.*

Set the traverse to the start position and place the paper on to the roller by wrapping it tightly around the drum and sticking both ends to the strip of tape. Start the drum and then switch on and monitor the signal using a one beam oscilloscope. To do this the drum pulse is applied to the Z-axis of the oscilloscope to give a bright blip on the trace. The picture slip switch is then operated until the edge of the picture line and blip coincide. Switch on the crater tube and traverse so that a picture is produced. At the end, switch off the crater tube, peel off the paper and develop the picture.

Should it be necessary to produce reversed pictures, such as transparencies, the drum motor connections can be reversed and the drum will rotate in the opposite direction giving pictures transposed left to right.

Scanning radiometer pictures

If SR pictures are to be printed the second beam of the oscilloscope must show the SR strobe pulse and the phase lock loop must be slipped until the correct portion of the SR line (VIS or IR) is in the strobe period. Edge setting can be carried out before or after this since the process is independent of the relative phase relationship of clock and picture.

If the whole width of the IR or VIS channel is to be printed, the line division switch should be set to 1/3rd line. The resultant picture will show 'milk-bottle' distortion due to the rotation of the satellite scanning radiometer, and the scene at the left and right hand edges will be distorted and will appear to run off to infinity. However, the pictures obtained will have close line spacings and will appear to be of reasonable contrast. Also, with the drum dimensions given, a complete NOAA-4 pass (for example) can be produced on the one print. At the other extreme, if 1/5th line division is selected, the picture can be arranged so that only the relatively non-distorted part is shown. In this case the line spacing is very wide, being four times wider for example than that for the APT of ESSA-8 at the same expansion, since the lines are strobed (switched on) one in every five of the corresponding ESSA-8 lines. Due to the newsprint effect, no matter how black the inscribed line, the overall effect is of a grey and white as opposed to 'soot and whitewash'. Generally, the 1/5th line SR pictures are rather insipid viewed close-to, and are only really useful for viewing from a distance, such as in lecturing. SR pictures on v.h.f. are essentially low definition, with a sub-point discrimination not finer than 7.4km. With a real-time scan of only 48 revolutions per minute, the 1/3rd line division pictures probably give the best all round results for meteorological work.

Further developments

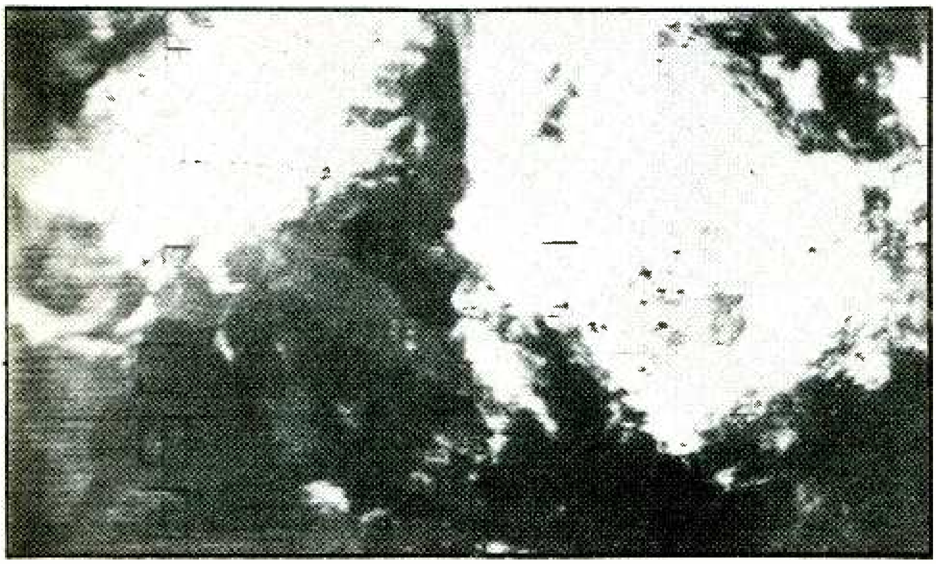
As the machine stands, operator skill is required to set the picture edge and to select the required SR portion to be printed. Since a clock signal is available and the operations are signal time dependent, it should be possible to make the major part of the picture writing process automatic. The setting of picture contrast could no doubt be done with a type of a.g.c. system, but is probably best left for operator control.

The SR signal strobing and the traverse movement could be co-ordinated and improved by using a stepping motor for traverse drive. In this case, reset could be effected by applying a high frequency reversed phase supply to the motor.

Applications

The machine may be used for the production of routine cloud cover pictures from the satellites mentioned earlier. As the input is a demodulated signal, the original radio frequency is immaterial and the WEFAX transmissions from the S-band SMS/GOES satellites can be printed[12]. The ATS and SMS/GOES TBUS prediction messages, which comprise orbital parameters in words and figures, can be produced as well as Mercator and polar projection world maps.

Lastly, the machine can be used to produce pictures and written data from any source providing it can be amplitude modulated on to a 2.4kHz carrier and presented to the machine in real time or from a tape recording.



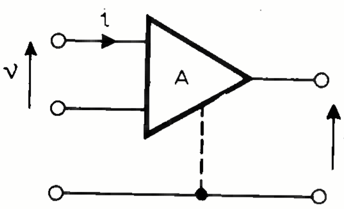
ESSA-8 satellite picture, *3rd May 1975, revolution 29247. This picture was produced when the satellite optics were already mis-aligned and five months before the satellite finally failed. It is a tv-type APT visible-light image and shows Italy in the centre of the picture.*

Editor's note. *Following articles will describe modifications to the basic design of the weather-satellite facsimile machine so that it may be used specifically for meteorological purposes. The modifications will enable both weather satellite and radio facsimile broadcasts to be printed.*

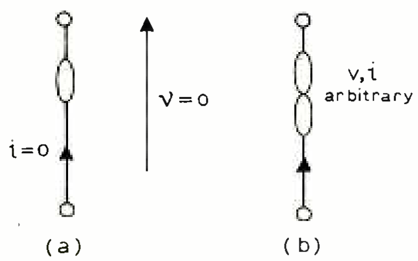
Special-purpose amplifiers

Using norators and nullators to classify the balanced, push-pull and bridge amplifiers described in set 33 of Circards

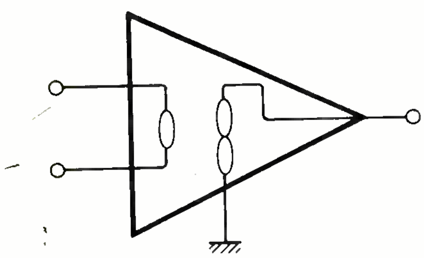
by J. Carruthers, J. H. Evans, J. Kinsler and P. Williams,
Paisley College of Technology



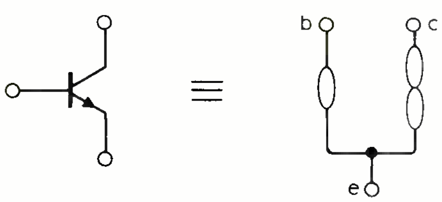
1. For an operational amplifier, as $A \rightarrow \infty$ then $vi \rightarrow 0$ for any finite v_0. One terminal of the output port is common to the supply.



2. Two one-ports have been proposed: the nullator having siultaneously zero voltage and current; the norator sustaining arbitrary voltage and current. Neither has a real separate existence.



3. Infinite gain operational amplifier can be represented by a nullor the combination of a nullator and a norator.



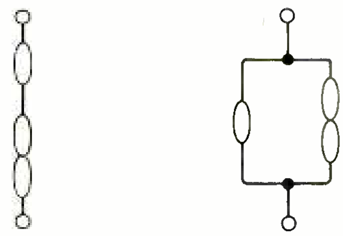
4. High-gain transistor can also be represented by a nullor; the constraint is a common point between nullator and norator.

It might seem that amplifiers are too familiar to need further investigation. Straightforward amplifier design is well understood; the budding circuit designer happily gurgles 'voltage follower' almost in the same breath as he (or in this enlightened age, she) first says 'Dada'. Feedback configurations follow naturally on from the 'four-times tables', soon to be abandoned in favour of programmable calculators anyway.

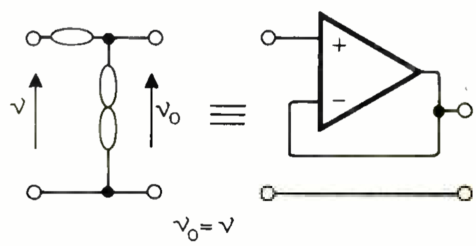
But one area with unquestioned answers as well as unanswered questions is that of special-purpose amplifiers. An inadequate description, this, to cover a multiplicity of functions. When the inputs and outputs are in voltage form no problem arises; if either or both are currents, if either or both are floating balanced or differential the problems start. If more than one of these conditions are imposed the solutions become even more devious. To steer a way through these problems, we offer a technique we have found helpful in the accompanying diagrams. It has been widely used in active filter design, but is surprisingly useful in relating these often confusing alternatives. As to the practical solutions, Set 33 of Circards contains some standard circuits re-evaluated, recently published ideas, and some suggestions of our own.

Topics in set 33

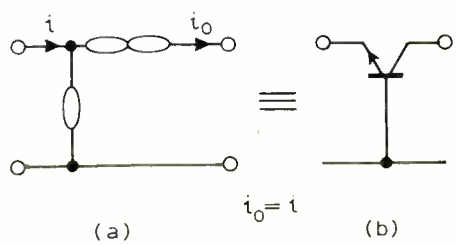
- Differential amplifiers
- Differential input/single-ended output amplifiers
- Differential input/balanced output
- Current amplifiers
- Floating amplifier/increasing c.m.r.r.
- Bridge amplifiers
- Broken/floating bridge
- Offset/drift cancellation
- Feedforward/feedback compensation
- Lowdrift wideband amplifiers



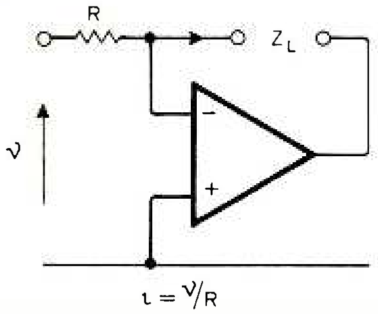
5. Nullator and norator in series sustain arbitrary voltage while drawing no current; the parallel combination has the opposite characteristics. They are equivalent to an open-circuit and a short circuit respectively.



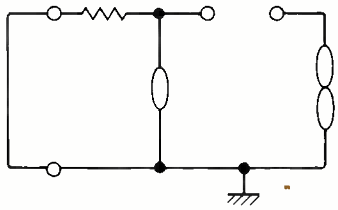
6. Voltage follower is equivalent to a nullor with no additional resistors. An emitter follower is a less accurate approximation in that the input current may be significant.



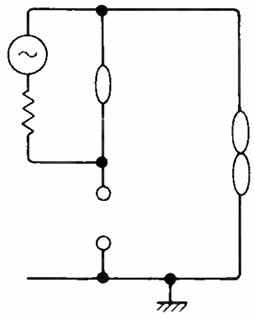
7(a). Dual of the voltage follower, the current follower, requires a norator with no ground connection.
7(b). Common-base stage approximates to this ideal of unity current-gain with negligible input voltage and very high output impedance.

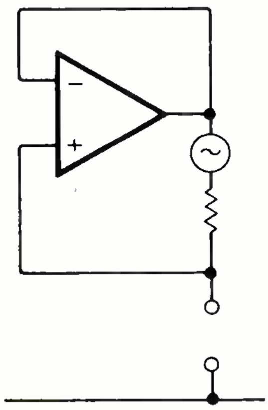


8. Usual circuit for converting an input voltage into a proprtional output current, again has a floating load.

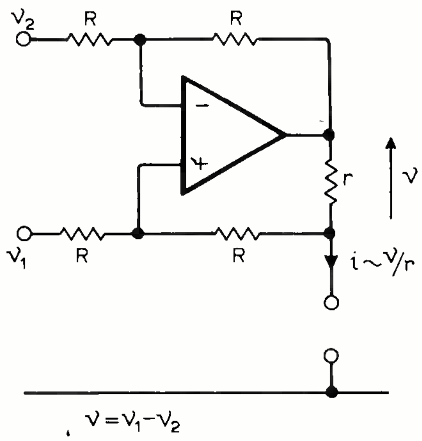


9. Drawing the circuit in nullor form and shifting the ground point to the other side of the norator leads to an unfamiliar form of the circuit.

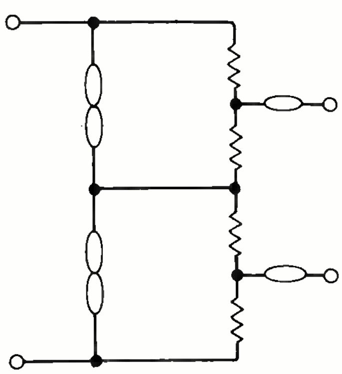




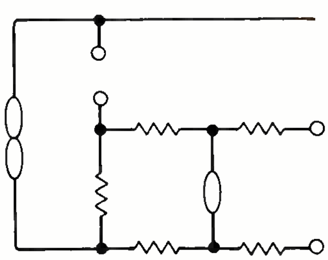
10. This leads to simple and obvious conclusion – one which may even be correct! For a voltage-current or transconductance circuit of this form source nullor and load are in series around a loop. Only one point can be grounded. If the nullor is so constrained then either the load or the source must be ungrounded.



11. Novel way of injecting a voltage across a resistor so as to define the current in a grounded load. This is indicative of the flexibility of the bridge of resistors in its many forms.



12. Nullor form of the circuit. While Figs 10 & 11 have visual similarity, each redrawing can reveal new modifications even though (or perhaps because) the new form in unfamiliar. Figs 9 and 12 are related in the same way but are more difficult to relate visually.



13. When two or more amplifiers are used, the inputs may be in a single-ended, balanced or differential form. Similarly the output may be single-ended voltage or current, push-pull etc. Nullors are just one of a number of techniques for devising new variants and of understanding the inter-relationships of known circuits.

Issue no. 35 will be the last in the present series of Circards, the final two sets covering analogue gate circuits. A wide range of subjects in electronics communication and control have now been covered in Circards by Peter Williams and colleagues Jack Carruthers, John Evans and Joe Kinsler (all of Paisley College of Technology) who have selected hundreds of circuits – sifted out of many thousands – tested them and presented the results, together with circuit modifications, in Circards.

The first 20 sets of the award-winning scheme are now reprinted in book form, though some individual sets are still available, together with background articles and additional circuitry (Circuit Designs 1 & 2).

The books are obtainable through booksellers or, in case of difficulty, from IPC Electrical-Electronic Press Ltd, General Sales Dept (Room 11), Dorset House, Stamford Street, London SE1 9LU, for £10.40 vol. 1 and £12.50 vol. 2 post included, from which individual sets can also be obtained for £2 post included.

Circard subjects

1 active filters
2 switching circuits (comparator and Schmitt circuits)
3 waveform generators
4 a.c. measurement
5 audio circuits (equalizers, etc.)
6 constant-current circuits
7 power amplifiers (classes A, B, C, D)
8 astable multivibrator circuits
9 optoelectronics: devices and uses
10 micropower circuits
11 basic logic gates
12 wideband amplifiers
13 alarm circuits
14 digital counters
15 pulse modulators
16 current-differencing amplifiers – signal processing
17 c.d.as – signal generation
18 c.d.as – measurement and detection
19 monostable circuits
20 transistor pairs
21 voltage to frequency converters
22 amplitude modulators
23 reference circuits
24 voltage regulators
25 RC oscillators-1
26 RC oscillators-2
27 linear c.m.o.s.-1
28 linear c.m.o.s.-2
29 analogue multipliers
30 non-linear functions
31 digital multiplers
32 transistor arrays
33* special-purpose amplifiers
34* analogue gate applications — 1
35* analogue gate applications — 2

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Mobile radio communication — 3

Range, interference and a comparison of a.m. and f.m. systems

by D. A. S. Drybrough, B.Sc., M.I.E.E., *Drybrough Communication Services Ltd*

The following factors govern the range of effective communication between two stations in the v.h.f. and u.h.f. mobile services.

Frequency. The frequency affects the propagation loss between aerials, transmission-line losses, receiver noise factor, ambient noise and interference, the effect of movement and of mistuning. An increase in operating frequency increases the losses, the noise factor and the effects of movement and mistuning but decreases noise and interference.

Modulation. The type of modulation has an effect on the signal/noise ratio at the input to the receiver for the required communication quality. Theoretical studies of the relationship between the commonly used modulation types, a.m. and f.m., show the latter to have a good margin of superiority over the former for all but very low signal/noise ratios. Field trials have not entirely confirmed such a clearcut advantage, probably due to the different behaviour of the two types of modulated signals when they fluctuate at low average levels. This discussion is limited to amplitude modulation and frequency modulation, using speech or sinewave modulating signals.

Depth of modulation. For a sinewave signal, it is easy to define a 100% modulation level in an a.m. system or to set an agreed maximum deviation in an f.m. system. Modulation depth for speech, with its high and indeterminate peak/mean ratio, is not so easy to set but, by experiment and experience, it has been found that peaks can be clipped or compressed to within 6 dB of the mean without excessive distortion or loss of naturalness in the voice. A.g.c. circuits can be used to keep the mean level of speech from all operators constant to within a few decibels at the transmitter modulator stage. Excessive distortion in the audio circuits of transmitters and receivers degrades intelligibility and, hence, the communication range.

Effective radiated power. Systems models assume, in most cases, that

Low-power a.m. mobile unit (GEC-Marconi)

half-wavelength dipoles are used as aerials. It is possible to concentrate more power in a given direction by using a directional aerial or, when omnidirectional propagation is essential, by stacking aerials to reduce the vertical beamwidth of the aerial. Such gains over a dipole must be taken into account when calculating the effective radiated power. Although r.f. losses in aerial elements are low, feeder, filter and changeover relays reduce the effective radiated power (e.r.p). Typical values in the mobile services are 25 W for high-power mobile and base stations, 5 W for low-power sets and 0.5 W for portables.

Effective transmitting-aerial height. This parameter is a difficult one to settle in any given location because it depends to a large extent on the path profile between the transmitting and receiving aerials as well as the height above local ground level. CCIR recommend that this height be taken as that above the average height of the ground along the path towards the receiver between 3 and 15 km from the transmitting aerial.

Propagation loss. CCIR give curves for field strengths for a radiated power of 1 kW and various aerial heights and paths, and from these the propagation loss can be calculated. These curves are drawn for 50% of locations and varying time percentages. Corrections are given for path roughness and for different percentages of locations. Height/gain corrections are also discussed by CCIR. These curves are averages and should not be relied on for high accuracies, especially when ground constants differ from the average values they assume.

Effective receiving aerial height. CCIR recommend that this be taken as the actual height above local ground.

Receiving-aerial gain. As with the transmitting aerial, the receiving aerial can be more directional than a dipole. If this directivity is in the vertical plane, it may also result in higher noise pickup. The usual quarter-wavelength whip for 'low' band v.h.f. mobiles has a small loss compared with a half-wavelength dipole, but aerials with gain relative to a dipole may be used for the higher frequencies.

Receiver sensitivity. CCIR recommended a minimum ratio of 15 dB as output signal/noise ratio, measured by means of a volume-unit (v.u.) meter, for a speech signal set to give an average modulation depth (amplitude modulation) of 6 dB below peak at the source transmitter. The signal/noise ratio for 100% modulation is thus 21 dB. For a.m. receivers this is the i.f. signal/noise ratio required at the detector. For frequency modulation, the required i.f. signal/noise ratio depends on the relative bandwidths of the i.f. and a.f. sections and, for low ratios, on the peak deviation also when, as is necessary, so great an allowance has to be made for frequency inaccuracies due to temperature changes and mistuning that the deviation does not fill the whole channel. For 25 kHz channels the average crystal filter in the i.f. stages has a bandwidth of about ±8 kHz and the peak deviation is ±5 kHz, with an audio bandwidth of about 2800 Hz. For 12.5 kHz channels, the figures are ±3.75 kHz, ±2.5 kHz and about 2400 Hz, respectively. No correction for unused bandwidth is necessary above an output signal/noise ratio of about 20 dB for these figures (a.m. and f.m.). The input signal/noise ratio is determined by the level of the wanted signal field around the aerial, the aerial gain, the losses between the aerial and the receiver, the noise factor of the receiver and the ambient noise and interference picked up by the aerial within the passband and spurious response bands of the receiver. Good mobile receivers of recent design have noise factors of about 2.5 (4 dB) and losses between aerial and set as low as 1-2 dB, usually rising with frequency.

Table 3. Typical ranges in mobile radio systems

Band	Receiver noise figure, dB	Mobile aerial gain, dB	Range in kilometres for ambient noise: low, a.m.	low, f.m.	low, f.m. with flutter	medium, a.m.	medium, f.m.	medium, f.m. with flutter	high, a.m.	high, f.m.	high, f.m. with flutter
Low v.h.f.	5	—	37	55	45	33	46	39	**20**	30.5	**25**
	12	—	36	52	43	32	45	38	19.5	30	25
Mid v.h.f.	5	—	38	53	34	**31.5**	44	**26.5**	23	34	19.5
	12	—	34	49	29.5	30	42	25.5	22.5	33	19
High v.h.f.	5	—	39	60	34	33	47	27.5	24	35	19.5
	12	—	32	46	27	30	42	24.5	23.5	34.5	19
	5	3	45	68	37	**37**	54	**31.5**	27	39	22.5
	12	3	36	53	31	33	48	28	28	38	22
u.h.f.	5	—	26	41.5	29	24	38	28	17.5	29	20
	12	—	19	32	21.5	18	30.5	20.5	16	28	18.5
	5	6	33	53	**38**	32	49.5	35	24	38	26.5
	12	6	26	42	29	25	39.5	28.5	22	35	25

Note: Flutter allowances are −4dB for v.h.f. and −8dB for u.h.f.

Ambient noise varies widely and has not been quantified recently for all conditions of service of mobile radio units. Generally, it reduces with increasing frequency and is almost negligible at u.h.f. There may be several paths between transmitting and receiving aerials and losses and phase angles in each path may change as the mobile changes position and therefore the resultant signal to the receiver input also varies. Such changes are large in urban areas where no direct line-of-sight path exists. The effect of large obstructions is not allowed for in CCIR data but smaller irregularities are covered by alteration of a terrain factor. Losses caused by large obstructions can be estimated using a parameter related to their height in wavelengths above an unobstructed datum. In a.m. sets, the output signal/noise ratio follows closely the fluctuations in input signal level but, in f.m. sets, there is a threshold below which the output signal/noise ratio deteriorates rapidly, more rapidly as the deviation ratio* increases. The average output signal/noise ratio therefore falls below that for a notional average in the absence of fluctuation at these low levels, and degradations of some 8dB for 25 kHz u.h.f. channels and 4 dB for 12.5 kHz v.h.f. channels may be caused by this effect.

Effect of tuning inaccuracies. A.m. systems are more tolerant to detuning than f.m. systems in which the result is harmonic distortion rather than the amplitude distortion of the a.m. systems. Noise also increases more rapidly with detuning in f.m. systems because of the resulting asymmetry of the noise sidebands with respect to the centre frequency of the i.f. and discriminator circuits.

Using the CCIR data and assigning typical figures to the various parameters, typical ranges when using the four main frequency bands are given in *Table 3*. Ranges with and without the flutter allowance discussed above are shown and the most likely conditions for urban systems are shown in bold type. Results are given for a.m. in the u.h.f. band although this type of modulation is not used in that band.

The beneficial effect of aerials with gain at the mobile for the higher bands is evident. The small effect of a substantial degradation in noise figure in mobile low-band receivers can also be seen. If the flutter allowances are not applied, the ranges for f.m. are considerably greater than for a.m. but the flutter allowance brings them more towards equality, in line with field results.

Interference problems

All present-day mobile radio transmitters, using crystals as frequency-determining elements, are constrained by the availability of crystals and the need to avoid large power gains at the output frequency to use multiplying stages to obtain the final frequency from a lower crystal frequency. A wide range of harmonics of that crystal frequency are generated and all but the wanted one have to be filtered out before the signal reaches the aerial. The limit specified in the UK is 2.5μW (11.2mV across 50 ohms) which is about 70dB below the wanted output level in a high power set. Even this level of unwanted harmonics, if fed to a resonant aerial, could cause trouble to, or open the mute of, a receiver at a distance of up to about 3km.

In other types of transmitter using synthesizer drive, spurious emissions and noise can be derived from the side chains or frequency-correcting and stabilising circuits. Noise or signals on supply lines may also modulate the wanted output and good filtering is again necessary. Other unwanted signals can be produced in the output stages of transmitters, spaced at multiples of the spacings between the various signals present. Such spurious signals are especially likely in multiple transmitter installations and can severely restrict the choice of operating frequency for new additions.

As mixing is a feature of all receivers used at present in mobile radio services, the existence of spurious responses is unavoidable. Other unwanted outputs can be produced in a receiver which is overloaded or has insufficient selectivity. Receivers can generate interfering signals at harmonics of the crystal frequency and also at the i.f. Spurious responses can be reduced in number by using the highest practicable injection frequency for the first and only mixer — using more than one mixer adds to their number. The required spurious response ratio with respect to the wanted signal is about 70dB and this can be attained with relatively inexpensive and efficient r.f. tuned circuits for r.f. to i.f. ratios up to about 25. There is therefore a case for a higher i.f. than the conventional 10.7MHz for the u.h.f. band or for the use of double superhets with a much higher first i.f.

Reductions in the overload spurious responses, intermodulation, cross modulation and blocking, are difficult to achieve as they depend on the linearity of the r.f. amplifier and mixer stages unless extremely selective circuits, such as crystal filters, are fitted in the r.f. section. Co-channel signals also cause a great deal of interference and are more likely to cause difficulties in data systems than in those employing speech when they can, to some extent, be ignored. In a.m. receivers, a protection ratio of about 17dB for interfering a.m. signals and 8 to 17dB for f.m.

signals may be necessary for good reception while in f.m. receivers the ratios may be about 10dB and 8dB respectively.

Noise can be generated in transmitters, where it appears as sidebands accompanying the carrier. Noise generated in the crystal stage or subsequent phase modulator in f.m. sets is usually preponderant because of the high following power gain but other sources may be the power lines or the audio circuits which can pick up hum or converter noise. External devices, such as the ignition system, regulator, horn, windscreen wiper and even brakes originate unwanted noise and can usually be made innocuous by suitable decoupling, screening or earthing. In duplex systems, any poor electrical contact between sizable metal parts will produce noise when the transmitter is in use and extensive bonding of all such parts is advisable. In receivers, noise originates mainly in the input stage and aerial, though some may again be fed into audio circuits from noisy supply lines or be picked up by direct radiation from the noisy devices listed above. External noise, not originating in the set or vehicle, is picked up by the aerial and varies widely with frequency and location. Some American measurements of the effects of noise and flutter, in terms of the increase in signal level necessary to restore a specified communication quality, are given in *Table 4*. The degradations tend to a minimum at 470MHz and above showing the reduction of ignition noise with frequency and the residual allowance for flutter.

Table 4. Degradation of mobile signals by noise and flutter

Signal increase necessary to restore communication quality (dB above 0.7 μV).

Band	Grade	Mobile stationary in noisy area	Mobile moving in noisy area	Mobile moving in low noise
Low	4	25	18.5	11.5
Mid	4	21	15.5	11
High	4	17.5	13.5	10.6
U.h.f.	4	11	10.5	10
Low	5	18	15	8
Mid	5	13	11.5	7
High	5	10	9	6.5
U.h.f.	5	6.5	5.5	5.5

Notes: Grade 4 is for noticeable interference, Grade 5 is for annoying interference.

Avoiding interference

When only a few stations are sparsely scattered over a given area the main precautions to be taken in choosing frequencies and setting up stations are the avoidance of spurious emission or response frequencies and the reduction of noise. In single frequency systems it may not be possible to operate transmitters and receivers from the same site when more than one channel is involved and they may have to be spaced apart by a few kilometres. Frequency selection becomes more and more difficult as the numbers of closely-sited stations increase because the numbers of third, fifth and higher odd-order intermodulation frequencies increase rapidly with the numbers of stations involved.

If one base station transmitter is shared by a number of small users the channel can be more fully used and fewer base stations are then needed in a given area. This has the obvious limitation that one channel is incapable of serving more than about 60 mobile units using normal procedures. In shared systems, each group of mobile units is selectively-called, individually or as a group, and time limitations are set for base station transmissions to ensure fair sharing of air time.

Where the source of an interfering signal is known, a direction aerial can be fitted as a base station with a null in that critical direction. Such minima are usually sharper than the maxima and so the sacrifice of coverage in the direction of the unwanted signal can be small. Conversely, the gain aerial can be used to override an unwanted signal at a mobile from a transmitter located outside the normal coverage area but this method should be used with caution to avoid increasing interference in the neighbouring area.

When sufficient frequency spacing exists between the wanted and the interfering signals, filters can be used to give additional selectivity. Bandpass filters, based on cavity resonators or similar devices offering very high working Q factors, will yield losses of about 30 dB at 2% off centre frequency with an insertion loss of about 1 dB. More complex filters, designed according to conventional techniques, can be built up from such elements for both bandpass and band-stop functions. In all cases, attention is required to the effect of temperature changes to avoid tuning drifts.

Comparison of modulation systems

Amplitude modulation has stood the test of time in the UK as a system of modulation which gives good practical results. The process of modulation and detection are readily visualized by servicemen and can be checked with an oscilloscope when desired, making for simple servicing. The use of peak limiters in transmitters has increased the mean level of speech modulation, giving longer ranges or improved signal/noise ratios. Some tailoring of the responses or microphones and audio amplifiers has cut out unnecessary bass, without entirely removing individuality from the operator's voice.

Frequency modulation is still used exclusively in some services and is coming into increasing use in the land-mobile services, owing partly to its exclusive adoption in the u.h.f. band. The usual modulation characteristic is neither pure frequency modulation nor pure phase modulation, but a hybrid whose proportions vary with the degree of limiting imposed in the transmitter audio circuits. In theory, the present 12.5 kHz channel widths are inadequate for faithful transmission of frequency modulation with the full permitted deviation of ±2.5 kHz, but the distortion in properly tuned sets resulting from any loss in sidebands has been found, in practice, to be small. Frequency modulation has a considerably wider spread of significant sidebands than amplitude modulation when modulated by a sinewave but, for speech modulation, set to the same peak, the sideband levels are lower for both types of modulation and distortion adds to both, so that the difference between the two is less marked, as shown in Figs. 6 and 7.

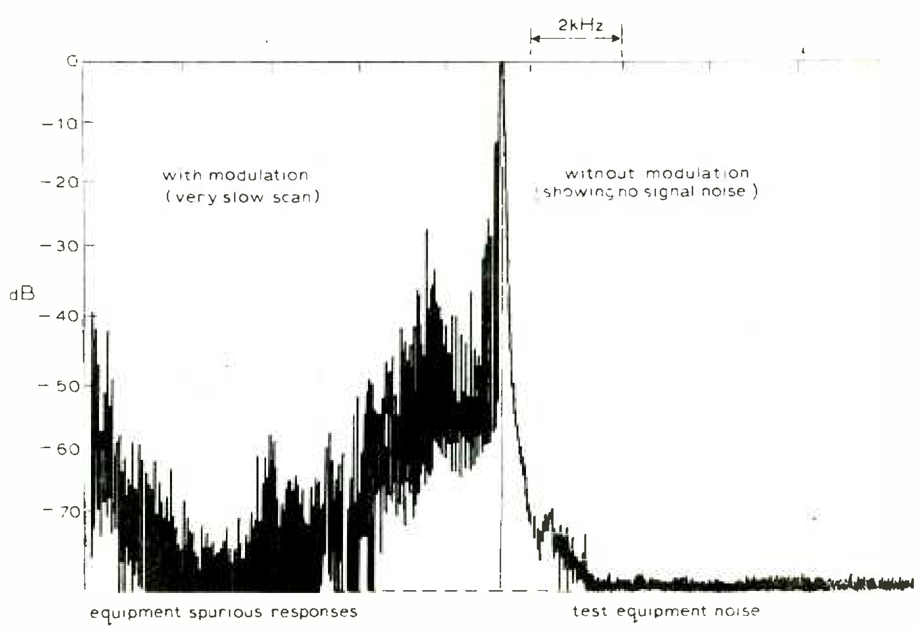


Fig. 6. Typical integrated sideband plot for an a.m. transmitter.

In f.m. receivers, an improvement is obtained in output signal/noise ratio above a certain threshold input signal level when compared with an equivalent a.m. receiver but, in practice, flutter and man-made noise mask this effect in mobile service. In point-to-point links, the superior signal/noise ratio in f.m. systems, operating at the higher and more constant signal levels and in the wider channels generally available, makes frequency modulation the usual choice. Fig. 8 shows a typical low-power f.m. mobile unit.

Noise limiters have been developed effective in reducing the nuisance value of impulsive noise in mobiles. In f.m. sets, the width of the i.f. passband limits the height of impulses passed to the audio amplifier after demodulation, but, as the i.f. bandwidth must include some allowance for drift in frequency, these impluse peaks can exceed the peak of the wanted modulation envelope, whereas, for a.m. sets, the peak limiter can be set to clip down to 50% modulation or less without distortion of speech. F.m. limiting is therefore not as effective as a.m. limiting, and suffers more from mistuning. So far, attempts to design an f.m. limiter on the same basis as the a.m. type have not yet yielded sufficient improvement to merit their inclusion in standard mobiles.

F.m. transmitters make better use of an available r.f. output device than an a.m. transmitter. In the last-mentioned, allowance must be made for the upward swing of the modulating voltage and the increased power dissipation under modulated conditions, whereas the f.m. output stage works permanently under steady carrier conditions. The difference in the low-power transmitters used in the mobile radio services is not very significant however, being less than 2.5 dB in most cases. Power conversion efficiency is also slightly better for f.m. transmitters in this power range, the need for more multipliers or modulators off-setting the absence of the high-level modulator stage. Care is necessary in the design of the supply circuits to the modulated stages in an a.m. transmitter, to ensure that parasitic oscillations cannot occur at any point in the modulation cycle owing to parametric effects in the collector capacitances.

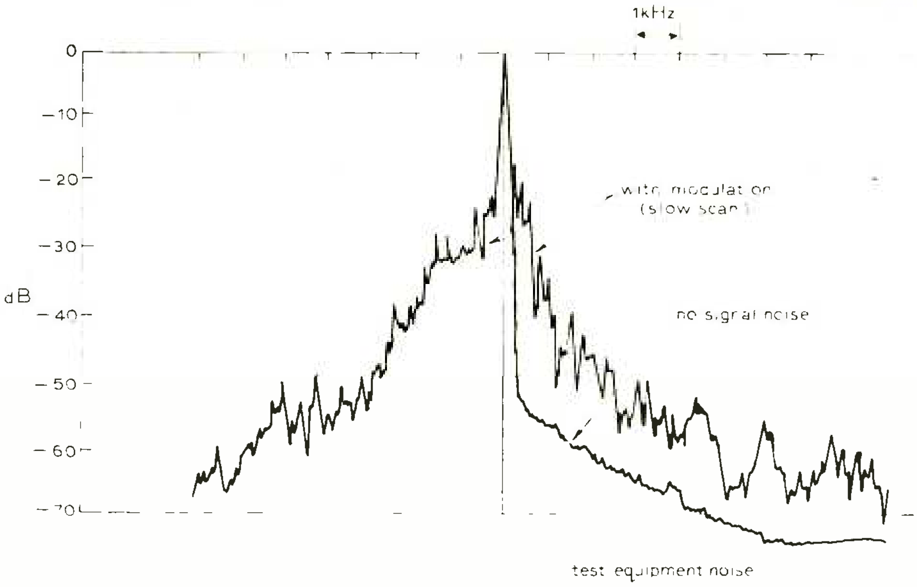


Fig. 7. Typical integrated sideband plot for an f.m. transmitter.

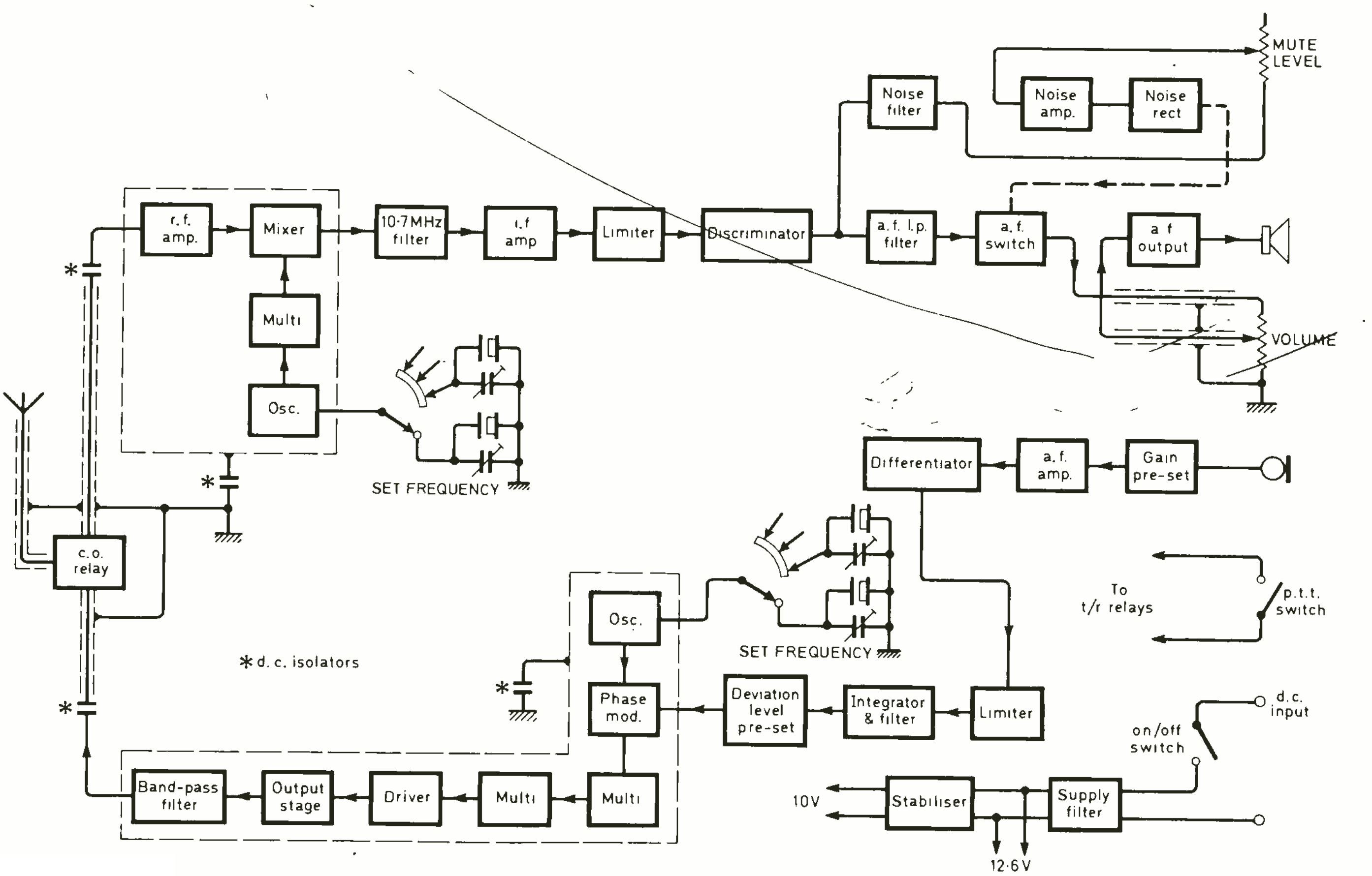


Fig. 8. Block diagram of typical low-power f.m. mobile transceiver.

Single sideband (s.s.b.) operation has been largely ignored in the UK for mobile radio in the v.h.f. and u.h.f. bands, although its use has grown very rapidly in similar bands used by radio amateurs. Reports of trials in the USA in the 1960s were not encouraging and, in particular, revealed poor performance in s.s.b. receivers in the presence of even modest levels of impulsive noise. More recently, it has become apparent that one of the possible advantages of single sideband, that of narrower bandwidth, is not as real as might be supposed, because of the limited rejection of the unwanted sideband achieved in practical transmitters, especially when modulated by speech. Rejections of 40-50 dB are not adequate to free the adjacent channel for use in the same location, and so the number of available channels would not increase in proportion to the nominal reduction in occupied bandwidth. Nevertheless, channel famine may have grown to such an extent that s.s.b. will have to be reconsidered.

In recent years double-sideband suppressed-carrier (d.s.b.s.c.) and double-sideband diminished-carrier (d.s.b.d.c.) systems have been investigated in depth by the University of Swansea on behalf of the UK Home Office in pursuit of a system which would allow area coverage in narrower channels than the present 25 kHz ones, and which would increase the range of the power-conversion efficiency of portable sets. Theoretical and bench studies showed that the original idea of using d.s.b.s.c. was not very practicable, because of difficulties in reinserting the carrier, especially when two signals of comparable strength were being received, and in providing effective a.g.c. It was found that a diminished carrier, set about 16 dB below the equivalent a.m. carrier, would greatly reduce these problems without losing the benefits of beat reduction and transmitter d.c.-to-r.f. efficiency coupled to a degree of secrecy, achieved in the d.s.b.s.c. system.

Double side-band diminished-carrier was preferred to s.s.b., despite its apparent increase in occupied bandwidth, because it did not suffer to the same degree from impulsive noise, being a balanced system, or from a.g.c. problems in receivers, and it can be introduced into an a.m. system with fewer changeover difficulties. Receivers are phase-locked to transmitters, reducing the overall frequency drift to that of the base transmitter, which can be made very stable at little expense. The required channel width can be reduced to about 25/3, or 8.33 kHz. It is expected that d.s.b.d.c. systems will accept data signals readily, but full confirmation of this and other aspects await the results of a large-scale field trial now in progress.

Whereas this system may be suitable for the police and fire service, with their special problems of wide-area coverage with centralised control, the advantages do not seem to outweigh the disadvantages of initial higher costs and integration difficulties for established commercial systems using amplitude modulation or frequency modulation. In particular, the cautious claim that the channel width could be reduced to 8.3 kHz would not be very attractive in the v.h.f. bands, where channel widths are already 12.5 kHz and the next division in the same tradition as previous splits would be to 6.25 kHz. Such a channel width might be usable by a.m. d.s.b. systems, using phase-locking techniques and the referencing of mobile transmitters to the base station frequency to remove all differential drift, but the chances of a competitive f.m. system seem to be bleak, although the same was once said of the 12.5 kHz system now in general and successful use.

At present, there are no practical alternative systems on offer in which direct speech modulation is replaced by some form of speech coding. It is possible that some such arrangement can be devised which will still further compress the bandwidth required for intelligible speech or which will multiplex many conversations into one channel of present width, allowing present frequency allocations to remain untouched.

The successive reductions in bandwidths over the years have resulted in a worsening in the quality of communication in individual systems, and this has generated a certain amount of dissatisfaction in users taking over new equipment, operating in narrower channels, after having experienced using wider channels. The overall problem, however, is still one of accommodating the large number of users in a limited radio spectrum and so, as in many other fields, quality of communication has to be sacrificed to some degree for quantity.

Testing and test equipment

Normal routine testing in the field is usually carried out using simple, specialized meters to check important voltages and currents, discriminator operation, when relevant r.f. output and similar parameters. In these days of integrated circuits, first-line servicing can be carried out by interchanging plug-in boards and so a full set of test equipment is needed only at the base workshop. Such equipment must, however, be of a high standard if full scale tests are to yield results related to the performance of the set rather than to the test gear itself.

When the number of sets to be serviced is high, automatic test equipment is sometimes used. Special jigs are necessary to connect the equipment to the sets unless, as is becoming a feature in some sets, a special connector is provided externally for this purpose.

Acceptance testing is carried out by the licensing authority on prototype units, representative of the subsequent production run. These tests are very exhaustive and are carried out over a range of temperature and supply voltage and demand test gear of a very high standard, especially in respect of adjacent channel noise and frequency stability.

**deviation ratio = ratio between half the i.f. bandwidth and the a.f. bandwidth.*

Printed-circuit boards

An increasing number of construction designs published in *Wireless World* require the use of printed-circuit boards. Since we are not entirely a constructors' journal, we have not made official arrangements for the supply of boards for our designs. However, we do realize that this leaves many would-be constructors in difficulties and one member of our staff, Mike Sagin, has felt so strongly about this that, entirely independently he has arranged a supply of certain boards himself. To assist him in this work, which is considerable, we would now ask that all enquiries should be sent to this office marked "PCB", whereupon they will be passed to him immediately.

WW index and binding

The Wireless World index for Volume 82 (1976) has been published separately and is now available, price 50p including postage, from the *General Sales Department, IPC Electrical-Electronic Press Ltd, Room 11, Dorset House, Stamford Street, London SE1 9LU.*

Binding. Volumes of Wireless World including the appropriate index can be bound by our publishers. Send the copies to *Press Binders Ltd, 4-4a Iliffe Yard, Crampton Street, Walworth, London SE17,* with your name and address enclosed. Confirm your order and send it with the remittance (£6.05 including index for each volume) to the *General Sales Department, IPC Electrical-Electronic Press Ltd, Room 11, Dorset House, Stamford Street, London SE1 9LU.*

In both cases, cheques should be made payable to IPC Business Press Ltd.

World of Amateur Radio

US prepares for 1979 WARC

Although the United States, like all other countries, will have only one vote at the 1979 World Administrative Radio Conference which may (or may not) rewrite the entire ITU Table of Frequency Allocations, there is little doubt that the proposals of the US delegation will carry considerable weight. Some idea of the attitudes likely to be taken by US delegates on allocations for amateur radio has been revealed recently, although these may not prove to be the final proposals.

Two entirely new allocations for amateurs are suggested: a low-frequency band of 160 to 190 kHz (the United States has no "long-wave" broadcasting); and a u.h.f. band from 902 to 938 MHz.

No entirely new bands are suggested for h.f. (this will disappoint those seeking support for new bands at 10.1, 18.1 and 24 MHz) but existing bands would be extended downwards to: 1750kHz (instead of 1800kHz); 6950kHz (instead of 7000kHz); 13,950kHz (instead of 14,000kHz); and 20,700kHz (instead of 21,000) but the following frequencies would be lost to amateurs: 1920 to 2000kHz and 21,200 ro 21,450 kHz. The 220MHz band of Region 2 would be shared with "land mobile" thus opening the way to its use also for Class E Citizens' Band operation.

Miniaturizing h.f. beams

With so many British amateurs now using factory-built transmitters, receivers and transceivers, one of the remaining areas where a good deal of individual experimentation and home projects continue is that of aerials, where the home product still vies in popularity with the commercial triband yagi beams and multiband verticals. At h.f. few amateurs are in a position to put up beam arrays for bands below 14MHz and even on 14MHz the full-sized arrays based on elements up to 34ft long are often too large to fit the average surburban garden or the urban rooftop.

Several years ago Leslie Moxon, G6XN, showed that for h.f. operation most amateurs come firmly up against a "gain barrier" of about 6dB (reference dipole), even assuming a three-element yagi or two-element cubical quad, correctly adjusted for optimum performance.

Over many years amateurs have tried to reduce the size, or at least the turning radius of h.f. beams, though most "mini-beam" designs have proved of limited value and not easy to reproduce successfully. Most amateurs thus believe that "mini-beams" are at best a compromise that leaves much to be desired in terms of gain or operational bandwidth or both. Many designs have depended on loading coils which, with a low radiation resistance, are lossy components.

A few years ago a design for an easy-to-construct triband "X" beam using wire elements with a turning radius of 12ft was evolved by Fred Caton, VK2ABQ (formerly G30NC), and more recently he has shown that this can be miniaturised for an 8ft turning radius. Forward gain is about 3dB.

Leslie Moxon, G6XN, believes strongly that miniature beams could become competitive with full-sized units and should be capable of achieving 4dB gain (plus in many cases additional "height gain" since their size and weight should allow them to be raised higher than full-size units without undue difficulty). He has in fact recently been developing a modified form of the VK2ABQ "X" beam using neutralising capacitors to achieve correct balance of currents and phasing in the two elements, and preliminary results are highly promising.

The development of compact high-performance mini-beams that could be built and erected quite easily would represent an important incentive for h.f. long-distance operation among the considerable number of amateurs who are at present discouraged by feeling that they have little hope of consistent success when competing for dx contacts with stations using full-sized arrays.

Secret listening

Looking through the newsletter of the Derby and District Amateur Radio Society, I see that Tom Douglas, G3BA, recently talked to the society about how, during the 1939-45 war he built and concealed radio receivers while in a Japanese prisoner-of-war camp.

One of the few detailed accounts of such activities by radio amateurs that have been committed to paper is that of Herb Dixon, ZL2BO, who as a lieutenant in the RNZNVR was taken prisoner in Hong Kong. He played a leading role in the construction and operation of three h.f. receivers which successfully picked up news broadcasts from Britain until September 1943.

In one camp a derelict Austin 7 provided wire, nuts and bolts, and the rim of the horn formed part of a vernier tuning dial; headphones were constructed; flux obtained from pine-gum; solder scrounged from tag boards of defunct power equipment; fellow prisoners contributed more than 300 precious torch batteries. Valves were located in and smuggled out of a prison operating theatre (an unwitting PoW who complained of a pain lost a perfectly sound appendix but brought out three valves in his bandages).

In one camp the receiver was hidden in a watertight container in a lavatory cistern; at North Point a hole was dug under a hut under cover provided by the Canadian Brass Band.

Unfortunately on September 21, 1943, after a four-hour search a receiver was discovered and Herb Dixon was one of nine officers interrogated and sentenced to long terms of imprisonment (of which he served two) under extremely harsh conditions. The set was regarded by the Japanese as a "museum piece" though it is not known if any of these receivers survived the war (as did some of those made in German camps).

Here and there

The latest Home Office statistics on interference complaints (1975) show a further decrease of 8.5% compared with 1974, with those relating to television down by 13%. Amateur transmitters accounted for 785 of the 40,000 or so complaints, the lowest figure for many years: 1969, 1442; 1970, 1161; 1971, 1027; 1972, 1242; 1973, 1169; 1974, 886. Most amateurs however accept that the official statistics represent only part of the tvi problem as many cases of interference are dealt with by the amateurs without involving Post Office investigation.

Many amateurs will greatly regret the death of Bob Palmer, G5PP, for long an ardent member — and former president — of the Midland Amateur Radio Society. He was a well-known Coventry amateur with great interest in 1.8MHz operation, in construction, and in the organization of mobile rallies.

BARTG reports that plans are being formulated for an r.t.t.y.-only repeater in the UK, although much work remains to be done; it is also hoped to add r.t.t.y. identification signals to the new 23cm beacon at Andover, Hampshire (1296.87MHz, 5 watts e.r.p.) which is now operational.

Leslie Fraser, GM3GNX (37 Witchill Road, Fraserburgh, Aberdeen), is seeking support for a Braille magazine for visually handicapped amateurs. The callsign G5LK for long held by a well-known blind amateur, the late Leslie Knight, has been re-issued to the Reigate Amateur Transmitting Society to perpetuate his memory.

At November 30, 1976 some 22,450 people held Home Office amateur licences. A revival of interest in 144MHz amplitude modulation has been reported: for several years this mode has been fast losing support in favour of n.b.f.m. and s.s.b.

PAT HAWKER, G3VA

New Products

Monitoring system

A surveillance and monitoring system, from Eddystone Radio Ltd, consists of the 1990R v.h.f./u.h.f. communications receiver and the EP961 Mk IIB panoramic receiver mounted in one compact cabinet. The system allows both visual and aural examination of signals in the range 25 to 500MHz. The 1990R receiver is capable of identifying and locking on to a signal with an accuracy of 100Hz. A range of omnidirectional discone aerials, suitable for use with the system, is also available. Eddystone Radio Limited, Alvechurch Road, Birmingham B31 3PP.

WW 401 for further details

Filters to users' specifications

A range of filters, available to users' specifications from Lexor Electronics Ltd, extends from sub-audio frequencies to over 20MHz. The range includes passive inductor-capacitor networks, active filters and high discrimination quartz filters, having high pass, low pass, bandpass or bandstop characteristics. These include high and low pass filters with Butterworth, Tchebycheff or elliptical characteristics, and filters having shaped pass and stop bands. Lexor Electronics Limited, 25/31 Allesley Old Road, Coventry CV5 8BW.

WW 402 for further details

Audio power meter

An audio-output power meter, from Genrad, is suitable for load impedances, from 0.6Ω to 32kΩ. The GR 1840 uses true r.m.s. techniques and is able to measure power as a function of frequency and impedance, from 0.1mW to 20W, in the range 20Hz to 20kHz. Using this instrument the output impedance of a device can be measured by simply plotting for maximum output. True r.m.s. is readable with as much as 20% second and third harmonic present. Accuracy is within 1dB between 30Hz and 10kHz and is better than 0.5dB between 50Hz and 6kHz. Newstech Communications Limited, 22/24 Bell Street, Henley-on-Thames, Oxfordshire, RG9 2BG.

WW 403 for further details

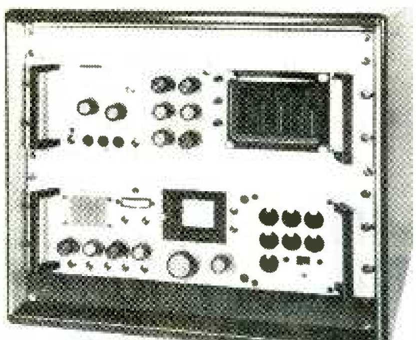
20MHz pulse generator

A pulse generator, designed primarily for use with t.t.l. circuits, gives a maximum of 5V output into a 50Ω load, with a 40mA sink capacity. The instrument, called the Systron Donner model 99, has a variable repetition rate from 2Hz to 20MHz and variable pulse width from 20ns to 200ms, both in seven overlapping ranges. This unit is available ex-stock at a cost of £235 from Electroplan Limited, P.O. Box 19, Orchard Road, Royston, Herts SG8 5HH.

WW 404 for further details

Transmission/noise tester

The TTI 1110A is a transmission and noise test set with a built-in tunable oscillator. It is designed for measuring signal transmission level, frequency, metallic noise, notched noise and noise to ground. Twin digital displays allow simultaneous measurement of the level and frequency of an incoming test tone. Separate transmission and receiver circuits allow the instrument to send test tones while it is measuring various



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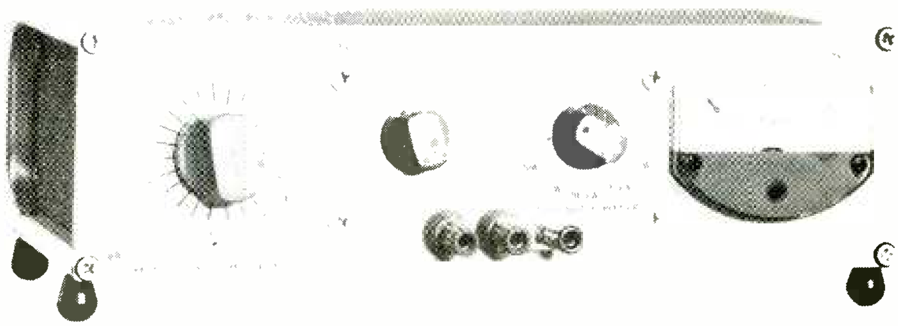


WW 403

WW 404

received parameters. Other features include a 1010Hz notch filter, an 80dB dynamic range, 100dB longtitudinal balance and switch-selectable noise weighting networks. Wandel and Goltermann (UK) Limited, 40-48 High Street, Acton, London W3.

WW 405 for further details

Miniature relays

Miniature two-pole power relays, designated in the MGP(FEME) series, have been uprated to offer 8A contact capacities and maximum switching voltages of 360V. Nominal operating times are 10ms and nominal release times are 5ms. Other features include 5mm minimum spacing between pins, large contact areas and long life. Quiller Components Limited, Cardigan House, Wilton, Bournemouth, Dorest BH9 1AU.

WW 406 for further details

Dual h.v. supply

A dual high-voltage power supply, the N1414, has been added to the NIM range of nuclear instrumentation modules. This unit is designed for supplying pre-amplifiers in multiple arrays of proportional counters. Each output is variable by 2000V in the range 0 to 2.8kV d.c., and each voltage is pre-set by the manufacturer to customer requirements. The unit is compatible with CAMAC data-handling equipment. Brandenburg Limited, Nuclear Engineering Division, 939 London Road, Thornton Heath, Surrey CR4 6JE.

WW 407 for further details

U.h.f. pre-amplifiers

Three low noise, high gain u.h.f. television pre-amplifiers, designated in the CM6051 series, are available from Labgear Ltd for frequency groups A (470-581MHz), B (615-717MHz), and C/D (695-860MHz). This series offers higher reliability than the CM6000 series which it replaces. The amplifiers, which are in weatherproof plastic cases, measure 45 × 85 × 120mm and have gains of 16, 14 and 12dB respectively. Other characteristics include typical noise figures of 5dB, maximum outputs of 28dB (mV) and input/output impedences of 75Ω. Labgear Limited, Abbey Walk, Cambridge CB1 2RQ.

WW 408 for further details

Instrumentation recorder

The DA1432-4 analogue cassette recorder provides four separate channels, each of which may be operated in the direct mode in the range 50Hz to 8kHz and in the f.m. mode from 0 to 1.25kHz. Each channel has a choice of three carrier filter cut-off frequencies on f.m. and switched record sensitivity covering the range 0.1 to 10V. A choice of f.m. carrier frequencies corresponding to I.R.I.G. operation is also provided. Other facilities include monitoring, "voice interrupt" and low-frequency noise compensation on f.m. Price is £1200. Data Acquisition Limited, Brookfield House, Hopes Carr, Stockport, Cheshire SK1 3BQ.

WW 409 for further details

Laser modulator

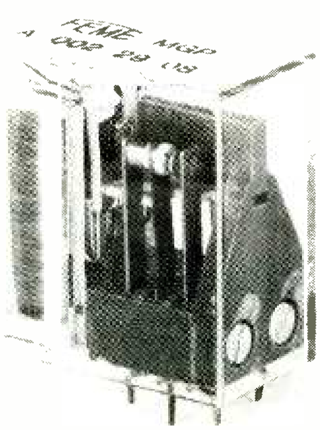
The model 401 modulator, which is claimed to be suitable for use with a He-Ne laser, is supplied complete with an ultrasonic cell, modulation and driver electronics and a power supply, all housed in one compact unit. Details for five basic experiments are also included in the package, enabling functions such as laser beam intensity, frequency modulation, laser beam steering, acoustic imaging and velocity measurements and r.f. spectrum analysis to be observed. Microwave and Electronics Division, REL Equipment & Components Limited, Croft House, Bancroft, Hitchin, Hertfordshire.

WW 410 for further details

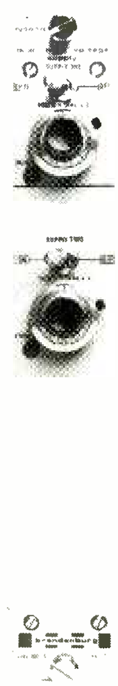
Paper take-up unit

A paper take-up unit, called the P99, is intended for use with miniature drum print heads. This unit has been designed as an ancillary to the Roxburgh MP11

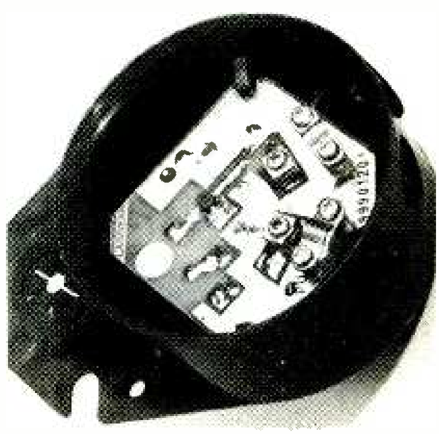
WW 405



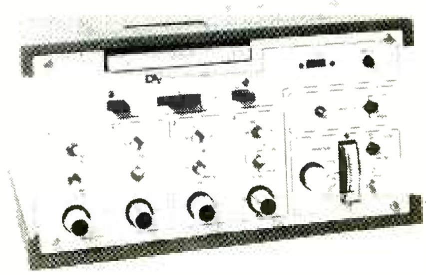
WW 406



WW 407



WW 408



WW 409

drum to rewind paper as it is printed. It can also be used with any printing device having a paper width of 58mm. The unit, which operates from a 6.5V d.c. supply at 500mA, has a minimum operating torque of 70gcm. It has a capacity of 100mm diameter. Roxburgh Electronics Ltd, 22 Winchelsea Road, Rye, Sussex.
WW 411 for further details

Microwave signal source

Three klystron sources, types PCLL, PCLS and PCLX, cover the frequency ranges 0.8 to 3.0GHz, 1.5 to 5.0GHz and 4 to 12GHz respectively. Each source has a plug-in klystron in a tunable coaxial cavity and solid state modulators and power supplies. The internal reflector and resonator voltages are automatically tracked to apply the correct potentials to the klystron at any frequency in the range. Readings on the frequency dial are accurate to 1% and the minimum outputs are 10, 5 and 2mW respectively. Flann Microwave Instruments Limited, Dunmere Road, Bodmin, Cornwall PL31 2QL.
WW 412 for futher details

Auto-ranging counter

The model 8837, from Malden Electronics, is claimed to be the first all-British fully automatic counter. It is a seven-digit instrument capable of measuring frequencies between 10Hz and 250MHz, and accepting sine, square or pulse input waveforms having amplitudes from 10mV to 30V (from 10Hz to 2000MHz). At 300MHz an input of about 100mV is required. The instrument accuracy depends upon the choice of crystal unit selected. The standard model uses a 1MHz crystal having a stability of ±55ppm, but models are also available using 10MHz temperature-compensated crystals or oven-controlled oscillators. Price is £250. Malden Electronics Limited, Malden House, 579 Kingston Road, Raynes Park SW20 8SD.
WW 413 for further details

120 to 420°C soldering

Variable temperature control is accurately maintained in a new soldering unit from Adcola by using a proportional control technique.

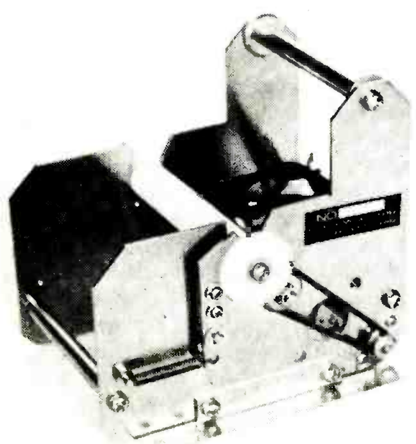
As more and more semiconductor manufacturers recommend a soldering temperature of 280°C, Adcola were faced with the possibility of reducing power input to their thermally-balanced irons to reduce bit temperature, which would have meant that fewer joints could be made. Instead they chose a thermocouple sensor, to BS1829, positioned at the rear of the soldering bit and, through a comparator, zero-voltage switching and triac circuitry, which provides proportional control of the heater to within ±2% of the chosen temperature.

Adcola say the effective power can be increased with this technique, but in practice power increase is limited to 100% because of limitations of the insulating materials. Heating time from 24 to 420°C is less than two minutes and the Noryl handle is virtually cold to the touch during idling.

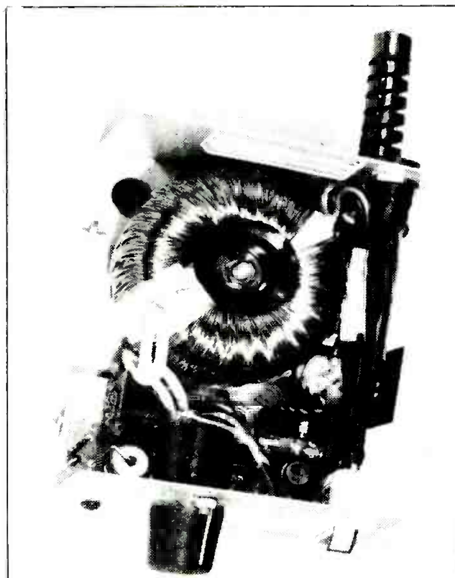
Safety features, designed to meet world wide standards (Adcola sells 50% of its production overseas), include an earthing system to give maximum safety against leakage currents and to allow "earthing" to associated equipment via a jack socket. The silicone rubber lead is burnproof to at least 420°C. Supply to the iron is 24V, from a toroidal transformer. Adcola Products Ltd, Gauden Road, London SW4.
WW 414 for further details

Noise cancelling microphone

Two microphones, models 3500 and 4500 from Selsound, utilize the characteristics and high magnetic energy of recently-available rare earth materials to achieve small size and good sensitivity. The devices are pressure-gradient, moving-coil transducers which are claimed to be able to discriminate between speech in close proximity and very high levels of environmental noise, even approaching the pain threshold. The largest, type 3500, is 16.5mm diameter by 11 mm deep and weighs 7.5g. Both devices have impedances of


WW 411


WW 412



WW 414


WW 413

300Ω and hypercardioid polar responses. Frequency responses are substantially flat from 300 to 3500Hz for the model 3500 and 300 to 5000Hz for the model 4500. Sensitivities with respect to 1V for a pressure of 0.1N/m² are −89 and −94dB respectively. Selsound, Victory Close, Industrial Estate, Chandlers Ford, Hants.
WW 415 for further details

R.f.i. filters

Filters in a range made by Axel Electronics Incorporated are specifically designed to exhibit high attenuation under full load conditions, in the frequency range 14kHz to 10GHz. The filters meet all environmental requirements of MIL-F-15733. For the reduction of current spikes in power supplies, Axel produce filters designed to give high current attenuation at the third harmonic of the power line frequency and above, to meet MIL-Std-461/1-4. JVN Components Limited, Bermuda Road, Nuneaton CV10 7QG.
WW 416 for further details

Keyboard switch

The RSM82 series is a range of low profile keyboard switches which utilize reed switches for reliability. Single pole and double pole switches are available, with or without latching, and an illuminated version may also be obtained. Each unit is designed for p.c.b. mounting and is 0.7in high from the top of the plunger to the base. A large range of button tops, space bars and mechanisms is also available. FR Electronics, Wimborne, Dorset, BH21 2BJ.
WW 417 for further details

Three-core wire stripper

The Rush model RW3 wire stripper is a hand-operated, bench-mounted machine designed to strip the inner conductor and outer sheath insulations of a three-core mains cable in one operation. This tool, made by Eraser International, may be easily adjusted for different strip lengths and cable sizes. Eraser International Ltd, 2/3 Hampton Court Parade, East Molesey, Surrey.
WW 418 for further details

Broadband amplifier

The Model 1W1000 is a broadband r.f. amplifier suitable for r.f. measurement and research applications. This unit, made by Amplifier Research, gives a linear 1W output for an input of 1mW over the frequency range 1MHz to 1GHz. The amplifier is untuned and unconditionally stable and will work into any phase or magnitude of load impedance without damage. Texscan Instruments Ltd, 1 North Bridge Road, Berkhamsted, Herts.
WW 419 for further details

Solid State Devices

Names of suppliers of devices in this section are given in abbreviation after each entry and in full at the end of the section.

Detector diode

The DC1550 is a low-barrier-height silicon Schottky detector-diode intended for zero bias operation as a detector in broadband levelling systems up to 18GHz. It can also be used as an effective replacement for the germanium point contact diode. The tangential sensitivity is −47dBm, the video impedance is 40kΩ and the detection efficiency at −10dBm is 150mV. Continuous wave power is rated at 250mW.
WW 420 AEI Semiconductors

Microprocessor series

The 6500 series of microprocessors extends the 6800 series of eight-bit microprocessors to include high frequency devices. Type 6502 is the basic unit; this operates at 1MHz and is capable of working up to 65k-bytes. Price for one-off is £17.50. 4MHz and 8MHz units are also available.
WW 421 Aardalect

D.c.-d.c. inverter

The AE1012/AA4580, from Astec, is a small-size, low-cost d.c.-d.c. inverter. It is designed for an input of +5V ±10%, from a t.t.l. supply for example, and gives an output of +12V ±5% for loads up to 20mA. This unit measures 29 × 13 × 7mm and, for small quantities, is priced at £2.29.
WW 422 GDS

Sample-hold amplifier

A high performance sample-hold amplifier, designated as SH703, is claimed to meet the requirements for speed and accuracy of nearly all 12-bit data acquisition systems. The unit consists of an op-amp, a low-leakage analogue switch and a mo.s.f.e.t. unity-gain amplifier. An external holding capacitor is required to match the characteristics to the user's application. The amplifier, which can be used for either inverting or non-inverting, has acquisition and settling times of 4μs, a droop rate of 50mV/s (max), an aperture time of 50ns and a signal range of ±10V.
WW 423 Hybrid Systems

Power transistors

Three pairs of n-p-n silicon power transistors, designated 2N6542 to 2N6547, are continuously rated at 5, 8 and 15A. Each pair has a sustaining V_{CEO} of either 300 or 400V d.c. (at 25°C) and d.c. current gains of more than 60. The devices, in TO-3 packages, are suitable for high speed switching in inductive circuits, where fall times may be lower than 800ns. Power dissipation figures for the three pairs are 100, 125 and 175W.
WW 424 Jermyn

Priority encoders

Two eight-line-to-three-line priority encoders are available from Advanced Micro Devices Incorporated. The AM25LS148 is a 16-pin device which performs priority decoding from eight inputs and provides a binary weighted code of the priority order of the inputs. The AM25LS2513, in a 20-pin package, is a gated three-state output version of the above and is suitable for priority interrupt systems. Both of the low-power Shottky devices have been processed to MIL-STD-883 requirements.
WW 425 AMD

C.m.o.s. circuits

Seventeen digital i.cs have been added to the standard CD4000 range from RCA. The devices have quiescent currents specified to 20V, maximum leakage currents of 1μA at 20V, 1V noise margin, standardized symmetrical output characteristics and 5, 10 and 15V parametric ratings. This range includes a shift register, a synchronous down-counter, a buffer driver, an arithmetic logic unit and a "look-ahead" carry generator. In addition there are pre-settable counters, registers, buffers, multiplexers, a dual 4-bit latch and a hex Schmitt trigger inverter.
WW 426 RCA

Suppliers

AEI Semiconductors Ltd, Carholme Road, Lincoln LN1 1SG.
Aardalect Electronics Ltd, Suite E, Georgian House, Trinity Street, Dorchester, Dorset.
Advanced Micro Devices Inc., 901 Thompson Place, Sunnyvale, California, 94086, U.S.A.
GDS Sales Ltd, Michaelmas House, Salt Hill, Bath Road, Slough, Berks.
Hybrid (Component) Systems U.K. Ltd, 12a Park Street, Camberley, Surrey.
Jermyn Distribution, Sevenoaks, Kent.
RCA Solid State-Europe, Sunbury-on-Thames, Middlesex TW16 7HW.

KEF gain a new dimension

KEF engineers today are working with radically new techniques. Their computer-based analysis gives them a deeper insight, a more precise three-dimensional vision of speaker performance than was previously possible. They knew that KEF drive units, with their advanced laminated diaphragms, offered a high level of performance. So research looked even harder at the equally vital dividing networks, at cabinet construction and power handling capability.
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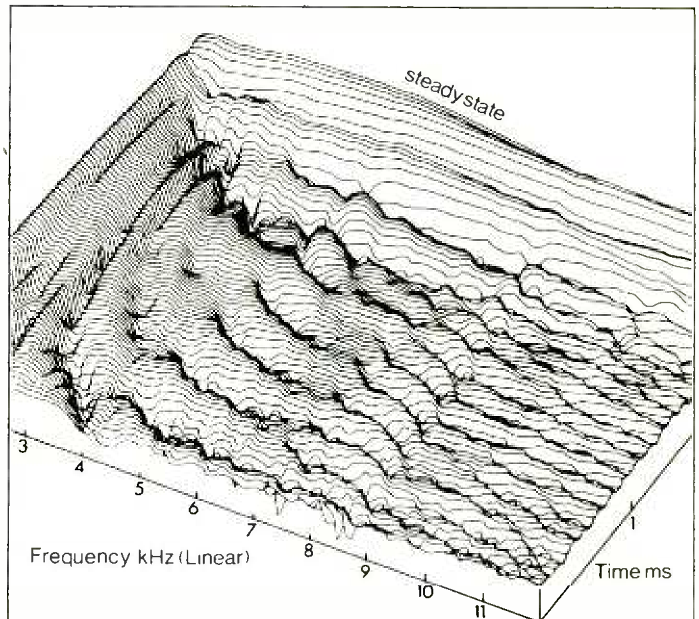
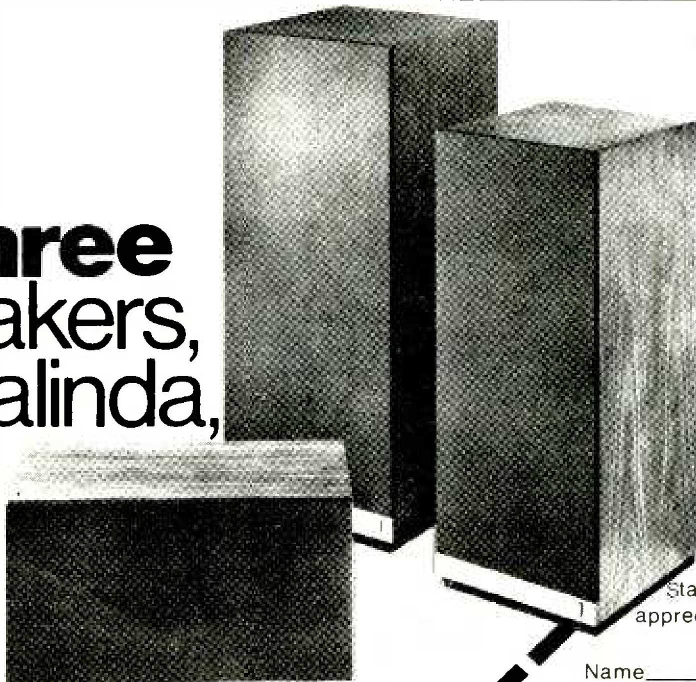
Applied to *your* speaker needs, the KEF programme has created three important new systems. You will be getting to know them well — Corelli, Calinda and Cantata. A 2 way shelf-mounting system, 3 way reflex free-standing enclosure, and larger 3 way system handling 150 watts. All three have the new computer-designed filter circuits. You can *clearly* hear the difference — better transient response, lower coloration. All three have redesigned cabinets, weighty with high-density internal damping laminations. All three handle today's power amplifier outputs with confidence and lower distortion. New speakers from KEF always make headlines. Watch for the reviews.



Cumulative decay spectra



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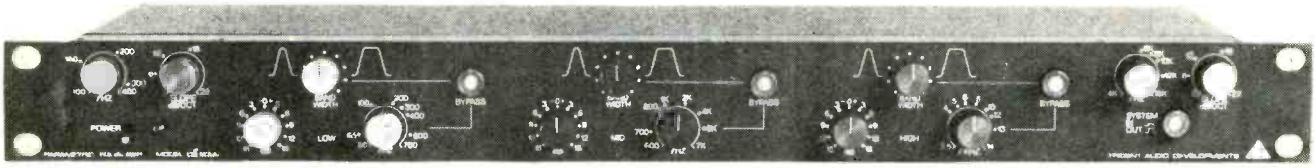
WW3/77

WW—093 FOR FURTHER DETAILS

Put new life into your equalising....



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WW — 100 FOR FURTHER DETAILS

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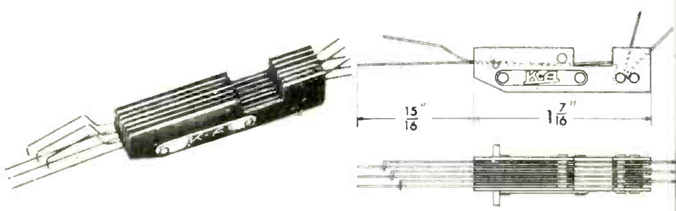

GJ—SPCO:	**24p each**	**GE—4 pairs :**	**45p each**
GB—2 pairs:	**27p each**	**GH—5 pairs :**	**57p each**
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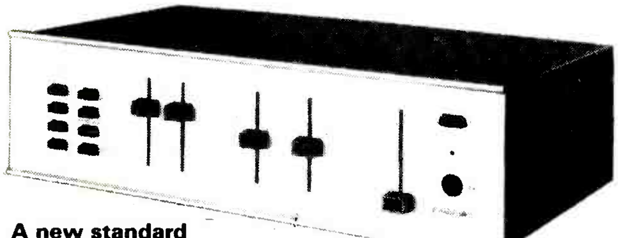
WW—031 FOR FURTHER DETAILS

RADFORD HD250

High Definition Stereo Amplifier



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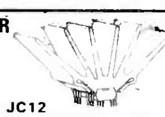

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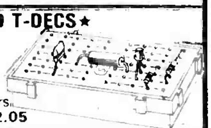

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7407	0.22	7447	0.65	7494	0.40	74164	1.05
7408	0.13	7448	0.60	7495	0.45	74165	1.05
7409	0.13	7450	0.12	7496	0.55	74166	1.05
7410	0.09	7451	0.12	74100	0.89	74170	1.65
7411	0.16	7453	0.12	74107	0.23	74175	0.85
7413	0.25	7454	0.12	74121	0.23	74180	0.80
7414	0.22	7460	0.11	74122	0.37	74181	2.00
7416	0.22	7470	0.24	74123	0.45	74182	0.80
7417	0.22	7472	0.21	74145	0.57	74192	0.95
7420	0.11	7473	0.25	74150	0.75	74193	0.95
7426	0.23	7474	0.25	74151	0.59	74194	0.85
7430	0.11	7475	0.35	74153	0.69	74195	0.78
7432	0.22	7476	0.24	74154	1.05	74198	1.20
7437	0.25	7483	0.69			74199	1.70
7438	0.19						

SCHOTTKY

74S00	24	74S04	29	74S20	29	74S74	29
74S02	.29	74S08	35	74S22	29		
74S03	24	74S10	29	74S32	39		

LOW POWER SCHOTTKY

74LS00	23	74LS20	23	74LS90	1.25	74LS193	1.75
74LS02	23	74LS32	27	74LS93	1.25	74LS197	1.65
74LS04	25	74LS40	33	74LS95	2.10		
74LS08	27	74LS42	1.30	74LS107	39		
74LS10	23	74LS74	39	74LS164	1.80		

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4000A	£ 0.14	4010	£ 0.36	4023	£ 0.65	4050	£ 0.35
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4007	0.14	4014	0.65	4028	0.59		
4008	0.65	4015	0.65	4030	0.36		
4009	0.36	4016	0.38	4035	0.75		
		4020	0.75	4042	0.55		
		4021	0.65	4049	0.35		
		4022	0.14				

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LM300	TO99	£ 0.45	3401	TO92	£ 1.25	739	A DIP	£ 0.65
301	V DIP	0.25	380	A DIP	0.80	741	V DIP	0.22
302	TO99	0.40	381	A DIP	0.90	747	A DIP	0.44
304	TO100	0.50	550	A DIP	0.55	748	V DIP	0.24
305	TO99	0.45	555	V DIP	0.35	5556 (1456)	V DIP	0.95
307	V DIP	0.38	556	B DIP	0.75	5558 (1458)	V DIP	0.45
	TO99	0.45	560	B DIP	2.45	LM3900	A DIP	0.25
308	A DIP	0.59	562	B DIP	2.45	75450	V DIP	1.00
	TO99	0.65	565	A DIP	1.40	75451	V DIP	0.23
309K	TO3	1.10	566	V DIP	1.40	75452	V DIP	0.23
310	T pkg	0.59	567	V DIP	1.55	75453	V DIP	0.23
311	V DIP	0.75	709	A DIP	0.20	75491	A pkg	0.60
320K	TO 3 NEG 5.2 12 15	1.00	710	A DIP	0.25	75492	A pkg	0.65
324	A DIP	1.07	711	A DIP	0.18	ICL8038 Funct Gen		2.80
339	A DIP	1.15	723	A DIP	0.38	Volt Contr Oscillator Sine Sq		
340K	TO3 12V 1 AMP	1.50				8864 22 Pin pkg		1.45

V Mini Dip A 14L Dip B 16L DIP TO99 8 Pin Header TO100 10 Pin Header
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CT7001	Clock Chip	3.85

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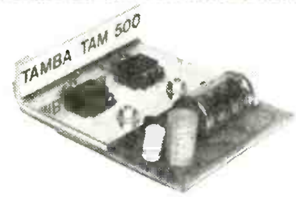

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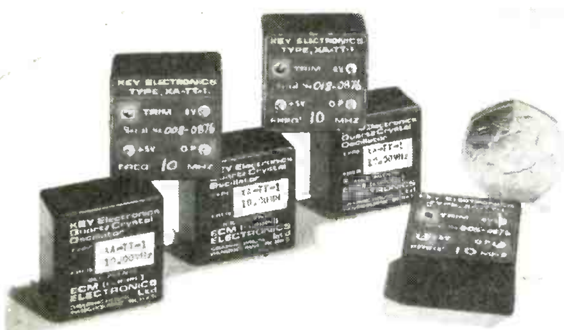

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DY802	43	PCL82	54
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EF80	34	PCL85	57
EF183	39	PCL86	52
EF184	39	PFL200	65
EH90	40	PL36	63
PC86	58	PL84	30
PC88	58	PL504	90
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Type	Price (p)	Type	Price (p)
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ML 232B	£4.20	TA7124P	73
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SL 415A	£2.20	TA 7171P	£1.65
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AC141	24	AD142	62
AC141K	28	AD143	65
AC142	18	AD149	65
AC142K	31	AD161	47
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AC156	28	AF115	22
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AC187K	33	AF124	38
		AF125	27

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AF127	38	BC237	11
AF139	39	BC238	11
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AF180	69	BC303	30
AF181	69	BC327	13
AF239	45	BC328	13
AF240	20	BC337	12
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AL103	£1.30	BC546	13
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AU110	£1.20	BC548	12
AU113	£1.05	BC549	13
BC107	10	BC550	14
BC107B	15	BC557	13
BC108	10	BC558	12
BC109	12	BCY72	16
BC109C	14	BD115	39
BC113	15	BD116	59
BC114	15	BD124	75
BC115	17½	BD131	35
BC116	17½	BD132	39
BC116A	25	BD133	45
BC117	14	BD135	29
BC118	15	BD136	30
BC119	27	BD137	30
BC125	17½	BD138	33
BC125B	18	BD139	37
BC126	15	BD140	39
BC132	15	BD144	£1.99
BC135	15	BD160	£1.65
BC136	16	BD181	80
BC137	20	BD182	90
BC138	30	BD183	80
BC139	28	BD184	£1.10
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BC142	20	BD232	50
BC143	25	BD233	43
BC147	8	BD234	49
BC147A	11	BD235	49
BC148	9	BD236	53
BC149	10	BD237	49
BC153	20	BD238	55
BC154	20	BDX32	£2.40
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BC158	10	BF115	38
BC159	11	BF152	20
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BC172	10	BF173	25
BC173	15	BF178	33
BC178	18	BF179	38
BC178B	20	BF180	31
BC179	22	BF181	35
BC182	11	BF182	30
BC182L	12	BF183	30
BC183L	12	BF184	29
BC184	12	BF185	30
BC186	25	BF186	26
BC187	25	BF194	8
BC204	14	BF195	8
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BC213	11	BF198	23
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BF241	17	BU208/02	£2.75
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BF258	26	BUY69A	£2.65
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BF337	35	MJE520	44
BF338	34	2N696	30
BF355	50	2N706	15
BF457	37	2N3053	20
BF458	37	2N3054	65
BF459	38	2N3055	55
BFT42	35	2N3702	12
BFT43	35	2N3703	12
BFX29	29	2N3704	10
BFX84	29	2N3705	10
BFX85	30	2N3706	10
BFX86	28	2N3819	38
BFX88	25	2N5296	40
BFY50	19	2N5496	53
BFY51	19	OC71	29
BFY52	20	OC72	29
BFY90	£1.10	R2008B	£1.90
BR100	32	R2010B	£1.90
BR101	38	RCA16334	80
BRC4443	80	RCA16335	80
BRY39	38	S2802	£2.99
BSY52	30	S6080 A KIT	£4.90
BT106	£1.20		
BT108	£1.50	TIP31A	52
BT116	£1.25	TIP32A	62
BU105/02	£1.60	TIP41A	60
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BA148	16	OA95	5½
BA154/201	12	OA202	8
BA155	15	IN914	6
BAX13	6	IN4001	4
BAX16	6	IN4002	5
BY126	11	IN4003	5
BY127	10	IN4004	5
BY199	25	IN4005	5
BY206	17	IN4006	6
BYX10	14	IN4007	6
OA47	8	IN4148	4

★20p or less. Minimum 5 items

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Type	Order Code	Price
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ITT, Philips Mono Large Screen	D105C	£0.61
Rank Z 718	D106A	£1.54
Thorn 3000/3500	D107J	£5.34
Thorn 8000	D108H	£1.98
Thorn 8500	D109F	£4.14
Thorn 9000	D110Y	£6.50
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Screen	Type	Equivalent	Price
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24″	A61-120WR	CME 2413	£17.30

New Colour Tubes (90°)

Screen	Type	Equivalent	Price
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Type	Price
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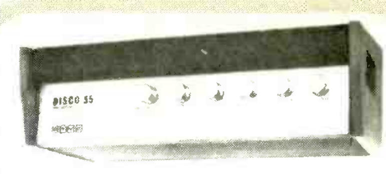
30 x 30 WATT AMPLIFIER KIT

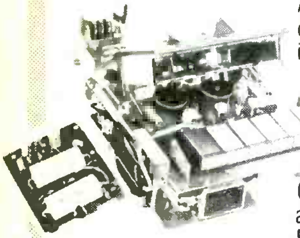
Specially designed by RT-VC for the experienced constructor, this kit comes complete in every detail. Same facilities as Viscount IV amplifier. Chassis is ready punched; drilled and formed Cabinet is finished in teak veneer. Black fascia and easy-to-handle aluminium knobs. Output 30+30 watts rms, 60+60 peak.

£29.00 + p & p £2.10



35-WATT DISCO AMP

Here's the mono unit you need to start off with. Gives you a good solid 35 watts rms, 70 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume. £27.50 p & p £1.50



STEREO CASSETTE DECK KIT

Again, this kit is specially designed for the experienced constructor – for mounting into his own cabinet. Features include solenoid-assisted AUTO-STOP, 3-digit counter, record/replay PC board mains transformer and input and output controls. AC BIAS AND ERASE. £32.50 + p & p £1.50

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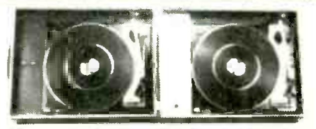


with built-in pre-amplifiers

Here's the big-value portable disco console from RT-VC! It features a pair of BSR MP 60 type auto-return, single-play professional series record decks. Plus all the controls and features you need to give fabulous disco performances. Simply connects into your existing slave or external amplifier. £55.00 + p & p £6.50

DIY SPEAKER KITS

EASY-TO-BUILD WITH ENCLOSURE

Specially designed by RT-VC for cost-conscious hi-fi enthusiasts, these kits incorporate two teak-simulate enclosures, two EMI 13″×8″ (approx.) woofers, two tweeters and a pair of matching cross-overs. Easily constructed, using a few basic tools. Supplied complete with an easy-to-follow circuit diagram, and crossover components. Input 15 watts rms. 30 watts peak, each unit. Cabinet size 20″×11″×9½″ (approx). £25.50 PER PAIR + p & p £5.50

'COMPACT' FOR TOP VALUE

How about this for incredible bookshelf value from RT-VC! A pair of high efficiency units for only £7.50 – just what you need for low-power amplifiers. These infinite baffle enclosures come to you ready mitred and professionally finished. Each cabinet measures 12″×9″×5″ (approx.) deep, and is in wood simulate. Complete with two 8″ (approx.) speakers for max. power handling of 7 watts. £7.50 per pair + p & p £1.70

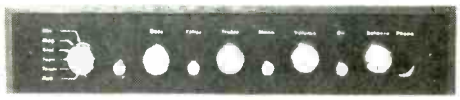
15-WATT KIT IN CHASSIS FORM

£8.50 PER SET + p & p £1.70

When you are looking for a good speaker, why not build your own from this kit. It's the unit which we supply with the above enclosures. Size 13″×8″ (approx.) woofer, (EMI) tweeter, and matching crossover. Power handling capacity 15 watts rms. 30 watts peak.

20 x 20 WATT STEREO AMPLIFIER

£29.90 p & p £2.10



Superb Viscount IV unit in teak-finished cabinet. Silver fascia with aluminium rotary controls and pushbuttons, red mains indicator and stereo jack socket. Function switch for mic, magnetic and crystal pick-ups, tape, tuner, and auxiliary. Rear panel features two mains outlets, DIN speaker and input sockets, plus fuse. 20 + 20 watts rms, 40 + 40 watts peak.

HOW YOU CAN SAVE

SYSTEM 1B For only £80, you get the 20+20 watt Viscount IV amplifier, a pair of our 12-watt-rms Duo Type IIb matched speakers; a BSR MP 60 type deck complete with magnetic cartridge, de luxe plinth and cover. £80.00 p & p £6.50

SYSTEM 2 Comprising our 20+20 watt Viscount IV amplifier: a pair of our large Duo Type III matching speakers which handle 20 watts rms each, and a BSR MP 60 type deck with magnetic cartridge, de luxe plinth and cover. £92.00 p & p £7.60

Carriage surcharge to Scotland System 1B £2.50 System 2 £5.00

SPEAKERS Two models – Duo IIb, teak veneer, 12 watts rms, 24 watts peak, 18½″ × 13½″ × 7¼″ approx. £34 PER PAIR p & p £6.50

Duo III, 20 watts rms, 40 watts peak, 27″ × 13″ × 11½″ approx £48 PER PAIR p & p £7.50

TURNTABLE Popular BSR MP 60 type, complete with magnetic cartridge, diamond stylus, and de luxe plinth and cover. £24.00 p & p £3.50

70 & 100 WATT DISCO AMPS

Brilliantly styled for easy disco performance! Sloping fascia, so that you can use the controls without fuss or bother. Brushed aluminium fascia and rotary controls. Five smooth-acting, vertically mounted slide controls – master volume, tape level, mic level, deck level, PLUS INTER-DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre-fade level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level 70 watts rms, 140 watts peak output. All the big features as on the 70-watt disco amplifier, but with a massive 100 watts rms, 200 watts peak output power.

70 WATT £49.00 + p & p £3.00

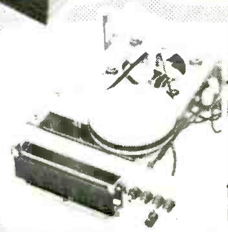
100 WATT £65.00 + p & p £4

Special offer to personal shoppers only

PYE STEREO GRAM CHASSIS

complete with circuit-diagrams

Complete ready to install. Wave bands L, M, VHF STEREO, VHF MONO. Controls for tuning volume, balance, bass and treble. Power output 7 watts R.M.S. per channel 14 watts peak into 8 ohms. 2×8″ approx chassis speakers and BSR C141 auto record player deck. £35.00



BSR T145 8-TRACK CARTRIDGE PLAYER MECHANISM

SPECIAL OFFER

Requires some attention. Complete with built in pre-amp, A.C. 240V £6.95 + p & p £1.50

DECCA 20 WATTS STEREO SPEAKER

This matching loudspeaker system is hand-made, as only Decca know how, built to a specification, not down to a price. The kit comprises of two 8″ diameter approx. base drive unit, with heavy die cast chassis laminated cones with rolled PVC surrounds. Two 3½″ diameter approx. domed tweeters complete with crossover networks.

Our price per stereo pair £30.00 + p & p £4.00

CAR RADIO KIT

MOTOR TOP 10 AWARD

Complete with speaker, baffle and fixing strip. The Tourist IV for the experienced constructor only. The Tourist IV has five push buttons, four medium band and one for long wave band. The tuning scale is illuminated and attractive small aluminium control knobs are used for manual tuning and volume control.

The modern style fascia has been designed to blend with most car interiors and the finished radio will slot into a standard car radio aperture. Size approx 7″ × 2″ × 4½″. Power Supply Nominal 12 volts positive or negative earth (altered internally). Power Ouptut 4 watts into 4 ohms. £10.50 p & p £1.50

ALL PRICES INC. VAT. AT 12½%

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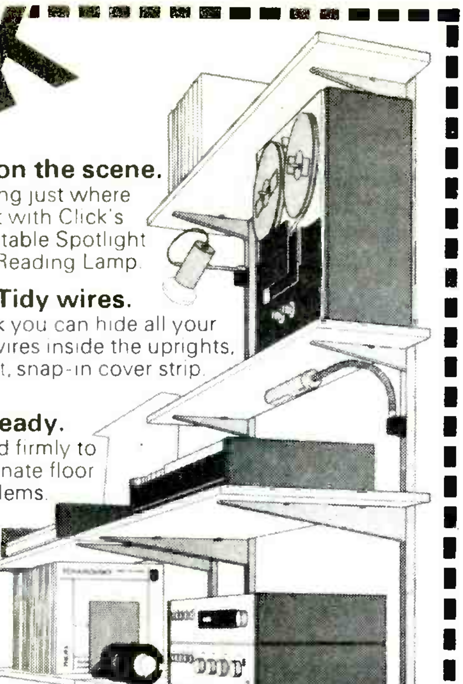

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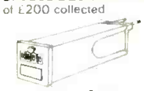

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8"x5½"x5"	£1 94	£2 71
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Ref.	VA (Watts)	£	P&P
07*	20	3.57	66
149	60	5.39	80
150	100	6.13	95
151	200	9.82	1 25
152	250	11.87	1 53
153	350	14.34	1.53
154	500	16.48	1 79
155	750	25.23	OA
156	1000	35.16	OA
157	1500	40.12	OA
158	2000	44.76	OA
159	3000	70.70	OA

*115 or 240 sec only

12 and/or 24-VOLT

Separate 12v windings
Primary 220-240 Volts

Ref	Amps 12v	Amps 24v	£	P&P
111	0 5	0 25	1.77	36
213	1 0	0 5	2.14	65
71	2	1	2.77	65
18	4	2	3.42	80
70	6	3	5.09	80
108	8	4	5.85	95
72	10	5	6.33	95
116	12	6	6.67	1 10
17	16	8	8.60	1,10
115	20	10	12.55	1 73
187	30	15	16.33	1.73
226	60	30	20.32	OA

50 VOLT RANGE

Primary 220-240V
SEC. TAPS 0-19-25-33-40-50V

Ref.	Amps	£	P&P
102	0 5	3.12	65
103	1.0	4.08	80
104	2.0	5.69	95
105	3.0	7.02	1 10
106	4.0	9.18	1.25
107	6.0	14.62	1.37
118	8.0	15.56	1 73
119	10.0	20.41	OA

30 VOLT RANGE

Primary 220-240V
SEC. TAPS 0-12-15-20-25-30V

Ref.	Amps	£	P&P
112	0 5	2.27	65
79	1 0	2.90	80
3	2.0	4.34	80
20	3.0	5.41	95
21	4 0	6.39	95
51	5 0	7.74	1 10
117	6.0	8.65	1.25
88	8 0	11.73	1 37
89	10.0	11.91	1 53

60 VOLT RANGE

Primary 220-240V
SEC TAPS 0-24-30-40-48-60V

Ref.	Amps	£	P&P
124	0 5	2.85	80
126	1 0	4.23	80
127	2 0	6.13	95
125	3.0	9.09	1 10
123	4.0	10.57	1 53
40	5.0	11.78	1.37
120	6.0	13.88	1 53
121	8 0	18.11	BRS
122	10 0	22.31	BRS
189	12.0	23.30	BRS

AUTO TRANSFORMERS

Ref.	VA (Watts)	TAPS	£	P&P
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64	75	0-115-210-240V	3.51	80
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66	300		7.03	95
67	500		10.76	1 37
84	1000		16.51	1 73
93	1500		21.87	BRS
95	2000		29.22	BRS
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350	247	12.57	1 53
1000	250	30.26	BRS
2000	252	50.74	BRS

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Ref.	mA	Volts	£	P&P
238	200	3-0-3	1.86	46
212	1A, 1A	0-6, 0-6	2.22	65
13	100	9-0-9	1.79	32
235	330, 330	0-9, 0-9	1.89	32
207	500, 500	0-8-9, 0-8-9	2.32	59
208	1A, 1A	0-8-9, 0-8-9	3.53	65
236	200, 200	0-15, 0-15	1.79	32
214	300, 300	0-20, 0-20	2.33	65
221	700 (DC)	20-12-0-12-20	2.74	65
206	1A, 1A	0-15-20, 0-15-20	4.17	80
203	500, 500	0-15-27, 0-15-27	3.62	80
204	1A, 1A	0-15-27, 0-15-27	4.76	80
S112	500	0-12-15-20-24-30	2.27	65

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5 watt RMS Amplifier	£2.65
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NEW STEREO 30

Complete chassis, inc. 7+7w r.m.s. amps, pre-amp, power supply, front panel, knobs (needs mains trans.). **£15.75.** Mains trans **£2.45.** Teak veneered cab **£3.65.** P&P 88p VAT 12½%

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4 Pre-selected stations
Switched AFC
Supply 20-35v 90Ma Max
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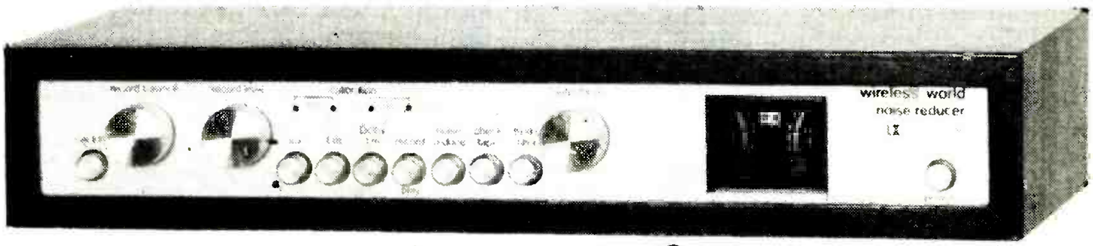

Wireless World Dolby(TM) noise reducer

Trademark of Dolby Laboratories Inc.

We are proud to announce the latest addition to our range of matching high fidelity units.

Featuring:

- switching for both encoding (low-level h.f. compression) and decoding
- a switchable f.m. stereo multiplex and bias filter
- provision for decoding Dolby f.m. radio transmissions (as in USA)
- no equipment needed for alignment
- suitability for both open-reel and cassette tape machines
- check tape switch for encoded monitoring in three-head machines

The kit includes:

--complete set of components for stereo processor
--regulated power supply components
--board-mounted DIN sockets and push-button switches
--fibreglass board designed for minimum wiring
--solid mahogany cabinet, chassis, twin meters, front panel, knobs, mounting screws and nuts

Typical performance

Noise reduction: better than 9dB weighted

Clipping level: 16.5dB above Dolby level (measured at 1% third harmonic content)

Harmonic distortion 0.1% at Dolby level typically 0.05% over most of band, rising to a maximum of 0.12%

Signal-to-noise ratio: 75dB (20Hz to 20kHz, signal at Dolby level) at Monitor output

Dynamic Range > 90dB

30mV sensitivity.

PRICE: £37.90+VAT

Also available ready built and tested . . . . **Price £52.00**+VAT

Calibration tapes are available for open-reel use and for cassette (specify which) . . . . **Price £2.00**+VAT*

Single channel plug-in Dolby(TM) PROCESSOR BOARDS (92 x 87mm) with gold plated contacts are available with all components . . . . **Price £7.20**+VAT

Single channel board with selected fet . . . . **Price £2.20**+VAT

Gold plated edge connector . . . . **Price £1.40**+VAT*

Selected FET's. **60p** each+VAT, **100p**+VAT for two, **£1.90**+VAT for four

Please add VAT 12½% unless marked thus*, then 8% applies
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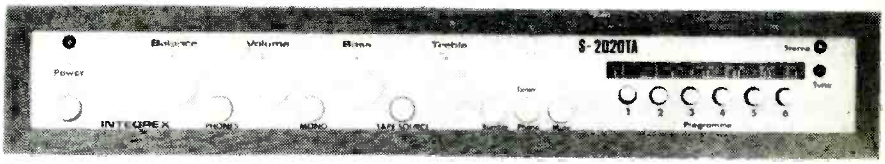
INTEGREX

S-2020TA STEREO TUNER/AMPLIFIER KIT

SOLID MAHOGANY CABINET



A high-quality push-button FM Varicap Stereo Tuner combined with a 24W r.m.s. per channel Stereo Amplifier.

Brief Spec. Amplifier: Low field Toroidal transformer, Mag. input, Tape In/Out facility (for noise reduction unit, etc), THD less than 0.1% at 20W into 8 ohms. Power on/off FET transient protection. All sockets, fuses, etc., are PC mounted for ease of assembly. Tuner section: uses 3302 FET module requiring no RF alignment, ceramic IF, INTERSTATION MUTE, and phase-locked IC stereo decoder. LED tuning and stereo indicators. Tuning range 88—104MHz. 30dB mono S/N @ 1.2µV. THD 0.3%. Pre-decoder 'birdy' filter.

PRICE: £53.95+VAT

NELSON-JONES STEREO FM TUNER KIT

A very high performance tuner with dual gate MOSFET RF and Mixer front end, triple gang varicap tuning, and dual ceramic filter/dual IC IF amp.

Brief Spec. Tuning range 88—104MHz. 20dB mono quieting @ 0.75µV. Image rejection — 70dB. IF rejection—85dB. THD typically 0.4%
IC stabilized PSU and LED tuning indicators. Push-button tuning and AFC unit. Choice of either mono or stereo with a choice of stereo decoders.

Compare this spec. with tuners costing twice the price

Mono £29.15+VAT
With ICPL Decoder £33.42+VAT
With Portus-Haywood Decoder £35.95+VAT

STEREO MODULE TUNER KIT

A low-cost Stereo Tuner based on the 3302 FET RF module requiring no alignment. The IF comprises a ceramic filter and high-performance IC Variable INTERSTATION MUTE. PLL stereo decoder IC. Pre-decoder 'birdy' filter

Sens. 30dB S/N mono @ 1.2µV
THD typically 0.3%
Tuning range 88—104MHz
LED sig. strength and stereo indicator

PRICE: Mono £26.85+VAT
Stereo £29.95+VAT

S-2020A AMPLIFIER KIT

Developed in our laboratories from the highly successful "TEXAN" design. PC mounting potentiometers, switches, sockets and fuses are used for ease of assembly and to minimize wiring
Power 'on/off' FET transient protection.

Typ Spec. 24+24W r.m.s. into 8-ohm load at less than 0.1% THD. Mag. PU input S/N 60dB. Radio input S/N 72dB. Headphone output. Tape In/Out facility (for noise reduction unit, etc.). Toroidal mains transformer.

PRICE: £31.95+VAT

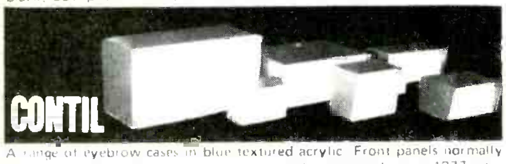
ALL THE ABOVE KITS ARE SUPPLIED COMPLETE WITH ALL METALWORK, SOCKETS, FUSES, NUTS AND BOLTS, KNOBS, FRONT PANELS, SOLID MAHOGANY CABINETS AND COMPREHENSIVE INSTRUCTIONS

BASIC NELSON-JONES TUNER KIT **£14.28**+VAT
BASIC MODULE TUNER KIT (stereo) **£16.75**+VAT
PHASE-LOCKED IC DECODER KIT .... **£4.47**+VAT
PUSH-BUTTON UNIT .... **£4.50**+VAT

PORTUS-HAYWOOD PHASE-LOCKED STEREO DECODER KIT .... **£8.00**+VAT

WEST HYDE Instrument cases WEST HYDE

Offer instrument manufacturers low cost cases ex stock. Blue PVC coated steel strength and rigidity. PVC aluminium grey front and rear panels are removable. PCB and PSU mounting system available. Also available in black. 301 price of 302. Bk 302 303. Bk 304 305



A range of eyebrow cases in blue textured acrylic. Front panels normally white zintec or PVC aluminium, also available unpainted up to 1277 size. Aluminium panels 20p extra up to 16127 only

All dimensions are Width x Height x Depth

PRICES 1 off inc P & P but not VAT

MOD-3 (including chassis)

301	7x3 x5¼"	5.75
302	7x4½x5¼"	6.17
303	7x6 x5¼"	7.87
304	11x3 x5¼"	7.08
305	11x4½x5¼"	8.35
306	11x6 x5¼"	9.99

CONTIL TEXTURED

755	7x5x5"	7.98
867	8x7x6"	9.48
975	9x5x7"	9.48
1277	12x7x7"	10.92
1277	unpainted	8.11
16127	16x7x12"	15.05
191010	19x10x10"	20.66

ELF CASES Grey (inc chassis)

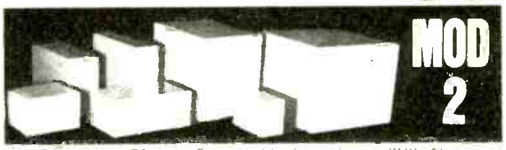
Elf	6x4x4"	3.20
Bare Elf	(less ft, ch, pnl)	2.15
Giant Elf	8x5" x5"	4.50
Long Elf	9x4x3"	3.60
Jumbo Elf	10¼x5¼x5⅛"	5.40

MOD-2 CASES (including chassis)

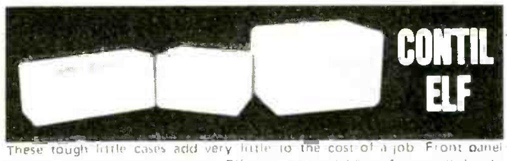
A	4.5x 3x 6.5"	6.05
B	4.5x 7x 6.5"	7.02
C	4.5x10x 6.5"	8.59
D	9 x 3x 6.5"	8.59
E	9 x 7x 6.5"	9.50
F	9 x10x 6.5"	11.20
G	13 x 3x 6.5"	9.50
H	13 x 7x 6.5"	11.20
I	13 x10x 6.5"	12.65
J	18 x 3x 6.5"	11.20
K	18 x 7x 6.5"	15.43
L	18 x10x 6.5"	19.06
M	4.5x 3x13"	7.02
N	4.5x 7x13"	9.50
O	4.5x10x13"	12.65
P	9 x 3x13"	9.50
Q	9 x 7x13"	12.65
R	9 x10x13"	15.43
S	13 x 3x13"	12.65
T	13 x 7x13"	15.43
U	13 x10x13"	19.06
V	18 x 3x13"	15.43
W	18 x 7x13"	19.06
X	18 x10x13"	22.39

Prices correct at 31 Dec. '76

Mod 2 in Woodgrain or Black finish in sizes A-L & N. Prices as for one price up on Mod 2, e.g. Mod 2A Woodgrain or Black is as Mod 2B



Mod-2 cases over 24 sizes. Front and back panels grey PVC. Aluminium chassis included. Packed flat. Outer casing blue PVC steel or up to size L also available in wood-grain and black. (Price as for next price higher ie A Black is B price)

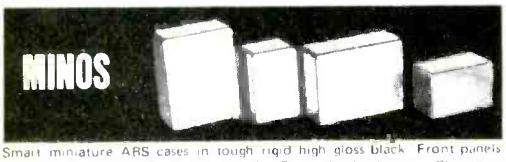


These tough little cases add very little to the cost of a job. Front panel aluminium with protective coat. Elf cases are available in 4 sizes, all dough-moulded in grey glass polyester, all panels, feet and chassis included.

All West Hyde cases are available with substantial discounts for quantities. Most cases have discounts at 5 off and 25 off with discounts up to 25% at 100 off. Prices include P & P and are less 10% if collected on first three price breaks on cases only

BUY A CASE FROM A SMALL RANGE, YOU GET A CASE—BUY A CASE FROM A BIG RANGE, YOU GET A SOLUTION

A prestige anodised case, black PVC steel top and bottom which can be supplied louvred at no extra cost. Free standing or rack mounting, available in rack or half width assembled in special polystyrene pack for safe postage



Smart miniature ABS cases in tough rigid high gloss black. Front panels either all or PVC steel. Built in slots for PC cards, dividers etc. Chassis or PC boards can be supported on 'P' clips from internal pillars

THE INSTRUMENT

Instrument cases

BRIGHTCASE MARK II

BC212	(3½" Full Rack)	18.07
BC222	(3½" Half Rack)	16.59
BC312	(5¼" Full Rack)	19.56
BC322	(5¼" Half Rack)	18.07

Rack Brackets available. No extra for Louvres (add L)

MINOS

M2	65x100x50mm	.67
M3	100x130x50mm	.85
M2	Bare	.44
M3	Bare	.50

SAMOS

S1	100x 50x50mm	1.24
S2	100x100x50mm	1.42
S3	100x150x50mm	1.58
S4	125x 50x75mm	1.78
S5	125x100x75mm	2.04
S6	125x150x75mm	2.39
S7	125x200x75mm	2.65

HEAVY DUTY CASE

8x 8x5"	14.18
10x10x7"	15.75
12x10x7"	19.95

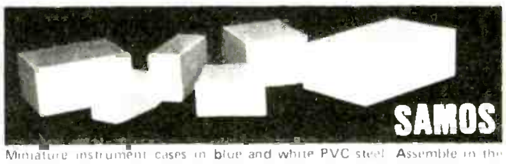
OVER 400 DIFFERENT CASES IN STOCK—SIZE RANGE OVER 5000:1 IN VOLUME

Prices as January 77. Please check with us in case of price change

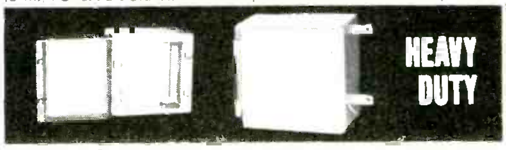
Send for catalogue

WEST HYDE DEVELOPMENTS LIMITED

Ryefield Cres., Northwood Hills, Northwood, Middx., HA6 1NN
Telephone: Northwood 24941/26732/27051
Telex: 923231 West Hyde Nthwd.



Miniature instrument cases in blue and white PVC steel. Assemble in the lower half, clip in feet, 2 screws allow the cover to hinge off cases. 2 more to fix. PC feet are available to hold up to 4 PC boards horizontally in case



Available in 3 sizes. Heavily constructed in zintec steel, welded corners with heavy hinges. 2 screw fixings and foam around the door. In the base is a gland plate with gasket and a chassis with screws provided

CASE SPECIALISTS

WW—065 FOR FURTHER DETAILS

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CA3020A	2.29	LM382N	1.25	NE556	1.05	TAA560	1.60	TCA280A	1.30	**THYRISTORS**	
CA3028A	1.01	LM384N	1.45	NE565	1.30	TAA570	2.30	TCA290A	3.13	**Plastic**	
CA3028B	1.29	LM386N	0.80	NE566	1.65	TAA611B	1.85	TCA420A	1.84	5A 100V	0.35
CA3030	1.24	LM387N	1.05	NE567	1.80	TAA621	2.15	TCA730	3.22	5A 200V	0.40
CA3036	0.97	LM388N	1.00	SAS560		TAA661B	1.32	TCA740	2.76	5A 400V	0.49
CA3045	1.40	LM389N	1.00	SAS570		TAA700	3.91	TCA750	2.30	8A 100V	0.43
CA3046	0.89	LM702C	0.75	SO42P		TAA930A	1.00	TCA760	1.38	8A 200V	0.49
CA3048	2.23	LM709C	0.65	76001N	1.57	TAA930B	1.05	TCA800	3.13	8A 400V	0.62
CA3049	1.66	LM709N	0.45	76003N	2.55	TAD100	1.95	UAA170	2.00	**BRIDGE**	
CA3052	1.62	LM710C	0.60	76008K	2.50	TBA120	0.65	UAA180	2.00	**RECTIFIERS**	
CA3053	0.60	LM710N	0.60	76013N	1.70	TBA400	1.50	CD4000	0.20	W005	0.30
CA3080	0.68	LM723C	0.86	76013ND	1.57	TBA500	2.21	CD4001	0.20	W01	0.33
CA3080A	1.88	LM723N	0.75	76018K	2.50	TBA500Q	2.30	CD4002	0.20	W02	0.34
CA3086	0.51	LM741C	0.65	76023N	1.70	TBA510	2.21	CD4006	1.10	W04	0.40
CA3088	1.59	LM741N	0.50	76023NO	1.57	TBA510Q	2.30	CD4007	0.20	W06	0.50
CA3089	2.52	LM741-8	0.40	76033N	2.55	TBA520	2.21	CD4008	0.97	BY164	0.57
CA3090	3.80	LM747N	0.90	76110N	1.46	TBA520Q	2.30	CD4009	0.57	B40C1500	0.48
CA3130	0.94	LM748 8	0.50	76115N	1.87	TBA530	1.98	CD4010	0.57	B40C3200	1.10
LM301A	0.65	LM748N	0.90	76116N	2.06	TBA530Q	2.07	CD4011	0.20	B80C1500	0.75
LM301N	0.44	LM1800	1.76	76131N	1.30	TBA540	2.21	CD4012	0.20	B80C3200	1.15
LM304	2.45	LM1808	1.92	76226N	1.94	TBA540Q	2.30	CD4013	0.57		
LM307N	0.65	LM1828	1.75	76227N	1.51	TBA550	3.13	CD4014	1.01	**OPTO-ELEC-**	
LM308N	1.17	LM3301N	0.85	76228N	1.75	TBA550Q	3.22	CD4015	1.01	**TRONICS**	
LM309K	2.10	LM3302N	1.40	76530N	0.91	TBA560Q	3.22	CD4016	0.56	**LEDs**	
LM317K	3.00	LM3401N	0.70	76532N	1.50	TBA570	1.29	CD4017	1.01	3mm Red	0.18
LM318N	2.25	LM3900	0.75	76533N	1.30	TBA570Q	1.38	**DIL**		5mm Red	0.20
LM323K	6.40	LM3905	1.60	76544N	1.44	TBA6418	2.50	**SOCKETS**		3mm Grn	0.25
LM339N	1.75	LM3909	0.68	76545N	2.09	TBA651	1.80	8 Pin	0.15	5mm Grn	0.26
LM348N	1.91	MC1035	1.75	76546N	1.44	TBA700	1.52	14 Pin	0.16	3mm Yel	0.25
LM360N	2.75	MC1303	1.47	76550N	0.41	TBA700Q	1.61	16 Pin	0.18	5mm Yel	0.26
LM370N	3.00	MC1305	1.85	76552N	0.65	TBA720Q	2.30	22 Pin	0.30		
LM371N	2.25	MC1306	1.00	76570N	2.08	TBA750	1.98	24 Pin	0.35	**SC/MP**	
LM372N	2.15	MC1310	1.91	76620N	1.10	TBA750Q	2.07	28 Pin	0.45	Intro Kit	68.61
LM373N	2.25	MC1312	1.98	76650N	1.10	TBA800	1.20	40 Pin	0.55	**KEYBOARD**	
LM374N	2.25	MC1327	1.54	76660N	0.60	TBA810	1.16	**TRIACS**		**KIT**	£65.84
LM377N	1.75	MC1330	0.92	76666N	0.92	TBA820	1.03	**Plastic**		2101-2	4.14
LM378N	2.25	MC1350	0.75	TAA310A	1.50	TBA920	1.79	4A 400V	0.70	2102-2	2.90
LM379S	3.95	MC1351	1.20	TAA320A	1.15	TBA920Q	2.99	6A 400V	0.75	2111-2	4.14
LM380 8	0.90	MC1352	0.97	TAA350A	2.48	TBA940	1.62	8A 400V	0.80	2112-2	4.14
LM380N	0.98	MC1357	1.45	TAA521	1.00	TCA160C	1.85	10A 400V	0.90	2513	8.00
LM381A	2.45	MC1458	0.91	TAA522	1.90	TCA160B	1.61	12A 400V	1.10	MM5204	32.30
LM381N	1.60	NE555	0.53	TAA550	0.60	TCA270	2.25	16A 400V	1.60	MM5214	26.95

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POPULAR SEMICONDUCTORS (A very small selection from our vast stocks, please enquire about devices not listed.)

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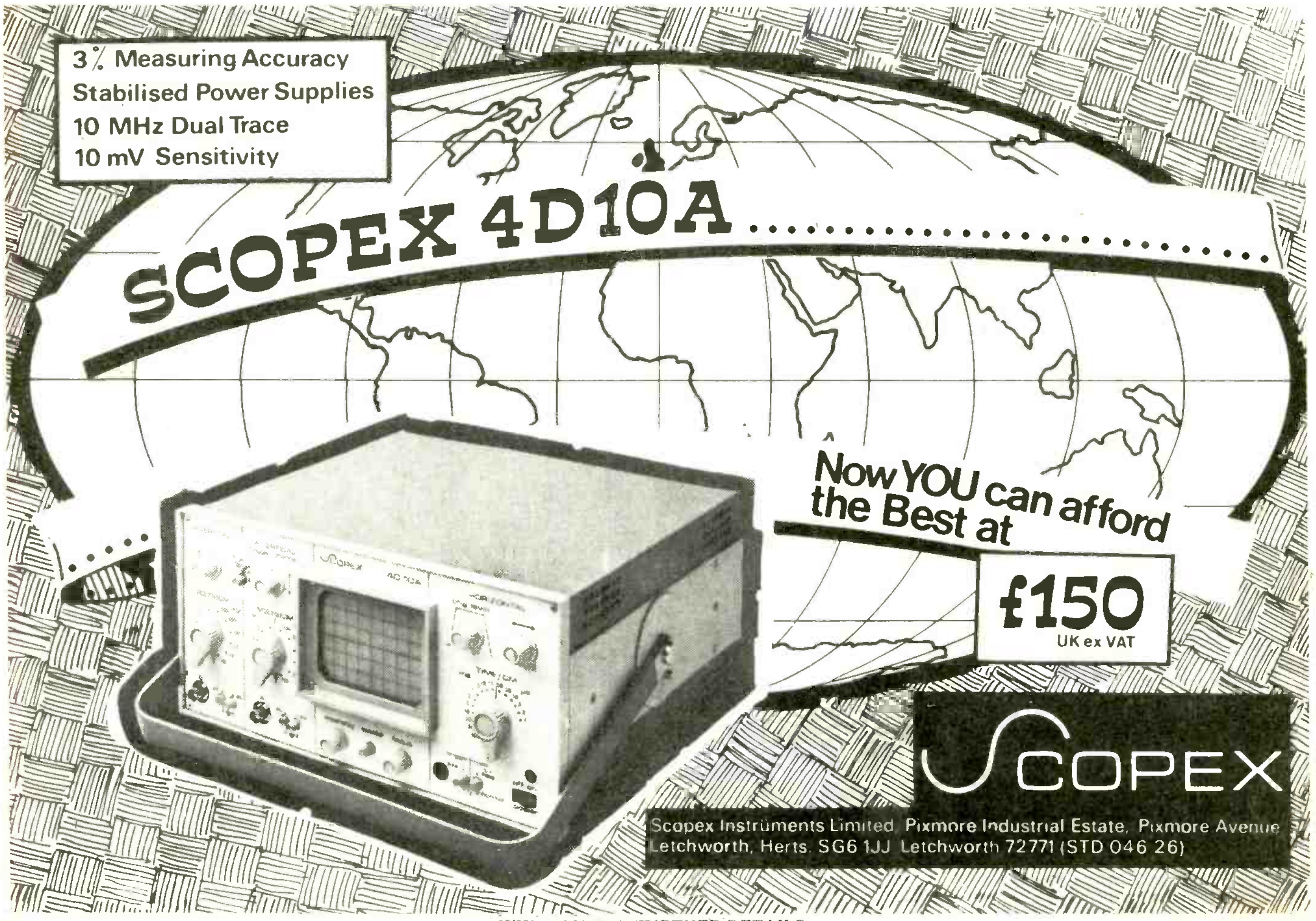
2N697	0.30	2N3054	0.60	2N4060	0.20	AC127	0.44	BC153	0.27	MPF111	0.35
2N698	0.62	2N3055	0.70	2N4061	0.17	AC128	0.37	BC157	0.12	MPT8111	0.35
2N699	0.55	2N3390	0.25	2N4062	0.18	AC151	0.35	BC158	0.11	MP5U56	0.60
2N706	0.24	2N3391	0.25	2N4126	0.17	AC152	0.50	BC159	0.11	TIP29A	0.45
2N706A	0.12	2N3391A	0.25	2N4289	0.20	AC153	0.49	BC160	0.50	TIP42C	0.95
2N708	0.21	2N3392	0.16	2N4919	0.65	AC53K	0.56	BC161	0.50	TIP2955	0.65
2N718	0.27	2N3393	0.15	2N4921	0.50	AC176	0.40	BC167	0.12	TIP3055	0.85
2N718A	0.50	2N3394	0.15	2N4922	0.55	AC176K	0.60	BC168	0.12	TIS43	0.40
2N914	0.35	2N3439	0.88	2N4923	0.70	AC187K	0.55	BC169	0.12		
2N916	0.30	2N3440	0.64	2N5191	0.70	AC188K	0.55	BC170	0.16	**20B Miniature**	
2N918	0.38	2N3441	0.85	2N5195	0.90	AD161	0.85	BC171	0.14	**Toggles**	
2N929	0.25	2N3442	1.35	2N5245	0.35	AD162	0.85	BC172	0.12	1pON	0.60
2N930	0.28	2N3638	0.16	2N5294	0.40	AF106	0.55	BC177	0.20	SPDT	0.65
2N1131	0.60	2N3638A	0.16	2N5295	0.40	AF109	0.75	BC178	0.20	OPDT	
2N1132	0.60	2N3641	0.20	2N5296	0.40	AF124	0.65	BC179	0.23	C OF1	0.80
2N1613	0.35	2N3702	0.17	2N5298	0.40	AF125	0.65	BC182	0.11		
2N1711	0.37	2N3703	0.16	2N5447	0.15	AF126	0.65	BC183	0.11		
2N1893	0.30	2N3704	0.15	2N5448	0.15	AF127	0.65	BC184	0.12		
2N2102	0.60	2N3705	0.15	2N5449	0.19	AF139	0.69	BC184L	0.14	**Potentiometers**	
2N2218	0.33	2N3706	0.16	2N5457	0.22	AF200	0.70	BC207	0.12	1KΩ to 2MΩ	
2N2218A	0.37	2N3707	0.18	2N5458	0.33	AF239	0.74	BC208	0.11	(E3) Linear or	
2N2219	0.30	2N3708	0.16	2N5459	0.29	AF240	0.98	BC212	0.14	Log	
2N2219A	0.32	2N3709	0.18	2N5484	0.34	AF279	0.80	BC213	0.14		
2N2220	0.35	2N3710	0.16	2N5486	0.38	AF280	0.85	BC213L	0.16	Rotary	
2N2221	0.22	2N3711	0.18	2N6027	0.53	BC107	0.15	BC214	0.16	Single	25p
2N2221A	0.26	2N3713	2.30	2N6101	0.65	BC168	0.15	BC214L	0.17	Double	75p
2N2222	0.25	2N3714	2.45	2N6107	0.42	BC109	0.15	BC237	0.14	Switched	
2N2222A	0.25	2N3715	2.55	2N6109	0.42	BC113	0.17	BC238	0.12	Single	55p
2N2368	0.25	2N3716	2.80	2N6121	0.38	BC115	0.19	BC239	0.15	Single	
2N2369	0.25	2N3771	1.85	2N6122	0.41	BC116	0.19	BC251	0.15	Slider	45p
2N2369A	0.25	2N3772	2.00	2N6123	0.43	BC117	0.22	BC253	0.22	Double	
2N2646	0.75	2N3773	2.90	2N6126	0.45	BC118	0.16	BC257A	0.17	Slider	75p
2N2904	0.36	2N3789	2.90	40361	0.45	BC121	0.45	BC259B	0.18		
2N2904A	0.37	2N3790	3.10	40362	0.48	BC132	0.30	BD131	0.51		
2N2905	0.37	2N3791	3.10	40363	1.20	BC134	0.15	BD135	0.37	A comprehensive	
2N2905A	0.28	2N3794	0.20	40406	0.58	BC135	0.15	BD139	0.40	range of Capaci-	
2N2906	0.28	2N3819	0.36	40407	0.45	BC136	0.19	BD140	0.40	tors and Resis-	
2N2906A	0.25	2N3820	0.38	40408	0.65	BC140	0.40	BD529	0.42	tors always in	
2N2907	0.21	2N3823	0.75	40409	0.65	BC141	0.45	BF160	0.30	stock plus many	
2N2907A	0.22	2N3904	0.21	40410	0.65	BC142	0.30	BF184	0.38	other compon-	
2N2924	0.15	2N3906	0.22	40411	2.85	BC143	0.30	BF459	0.45	ents	
2N2926	0.12	2N4036	0.67	40595	0.86	BC147	0.12	BO105	1.50	Over 8,000 line	
2N3019	0.55	2N4037	0.55	40673	0.73	BC148	0.12	ME0402	0.20	items	

Prices correct at 10 January, 1977, but please add V.A.T. Post & Packing 30p



WW — 063 FOR FURTHER DETAILS

SEMICONDUCTORS - COMPONENTS

SUPER UNTESTED PAKS

PAK	No.	Order No.	Price
U50	100 Germ. Gold bonded OA47 diode	16130	£0.60
U51	150 Germ. OA70/81 diode	16131	£0.60
U52	100 Silicon Diodes 200mA OA200	16132	£0.60
U53	150 diodes 75mA 1N4148	16133	£0.60
U54	50 Sil Rect Top Hat 750mA	16134	£0.60
U55	20 Sil Rect Stud Type 3 Amp	16135	£0.60
U56	50 400mW Zeners DO7 Case	16136	£0.60
U57	30 NPN Trans BC107/8 Plastic	16137	£0.60*
U58	30 PNP Trans BC177/178 Plastic	16138	£0.60*
U59	25 NPN TO39 2N697/2N1711 sil	16139	£0.60
U60	25 PNP TO59 2N2905 silicon	16140	£0.60
U61	30 NPN TO18 2N706 silicon	16141	£0.60
U62	25 NPN BFY50/51	16142	£0.60
U63	30 NPN Plastic 2N3906 silicon	16143	£0.60*
U64	30 PNP Plastic 2N3905 silicon	16144	£0.60*
U65	30 Germ. 0071 PNP	16145	£0.60
U66	15 Plastic Power 2N3055 NPN	16146	£1.20
U67	10 TO3 Metal 2N3055 NPN	16147	£1.20
U68	20 Unijunction trans IIS43	16148	£0.60
U69	10 1 amp SCR TO39	16149	£1.20
U70	8 3 amp SCR TO66 case	16150	£1.20

Code No.s mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

COMPONENT PACKS

Pack No.	Qty.		Order No.	Price
C1	200	Resistor mixed value approx (Count by weight)	16164	*£0.60
C2	150	Capacitors mixed value approx (Count by weight)	16165	*£0.60
C3	50	Precision resistors. Mixed values	16166	*£0.60
C4	80	⅛th W Resistors mixed preferred values	16167	*£0.60
C5	5	Pieces assorted ferrite rods	16168	*£0.60
C6	2	Tuning gangs MW/LW VHF	16169	*£0.60
C7	1	Pack wire 50 metres assorted colours single strand	16170	*£0.60
C8	10	Reed switches	16171	*£0.60
C9	3	Micro switches	16172	*£0.60
C10	15	Assorted pots	16173	*£0.60
C11	5	Metal jack sockets 3 x 3.5mm 2 x standard switch types	16174	*£0.60
C12	30	Paper condensers preferred types mixed values	16175	*£0.60
C13	20	Electrolytics trans. types	16176	*£0.60
C14	1	Pack assorted hardware — Nuts/bolts, grommets, etc	16177	*£0.60
C15	5	Mains slide switches ass	16178	*£0.60
C16	20	Assorted tag strips and panels	16179	*£0.60
C17	15	Assorted control knobs	16180	*£0.60
C18	4	Rotary wave change switches	16181	*£0.60
C19	2	Relays 6 — 24V operating	16182	*£0.60
C20	1	Pak. copper laminate approx. 200 sq ins	16183	*£0.60
C21	15	Assorted fuses 100mA-5 amp	16184	*£0.60
C22	50	Metres PVC sleeving assorted size and colour	16185	*£0.60
C23	60	½ watt resistors mixed preferred values	16188	*£0.60
C24	25	Presets assorted type and value	16186	*£0.60
C25	30	Metres stranded wire assorted colours	16187	*£0.60

SLIDER PAKS

Pack No.	Qty.		Order No.	Price
S1	6	Slider potentiometers, mixed values	16190	*£0.60
S2	6	Slider potentiometers, all 470 ohms	16191	*£0.60
S3	6	Slider potentiometers, all 10k lin	16192	*£0.60
S4	6	Slider potentiometers, all 22k lin	16193	*£0.60
S5	6	Slider potentiometers, all 47k lin	16194	*£0.60
S6	6	Slider potentiometers, all 47k log	16195	*£0.60

PANEL METERS

4" RANGE

Size 4¼" × 3¼" × 1¾"

Value	No.	Price
0-50UA	1302	£4.50
0-100UA	1303	£4.50
0-500UA	1304	£4.50
0-1MA	1305	£6.00
0-50V	1306	£6.00

2" RANGE

Size 2¾" × 1⅞" × 1½"

Value	No.	Price
0-50UA	1307	£3.50
0-100UA	1308	£3.50
0-500UA	1309	£3.50
0-1MA	1310	£3.50
0-50V	1311	£3.50

MR2P TYPE

Size 42 × 42 × 30mm

Value	No.	Price
0-50UA	1313	£4.80
0-1MA	1315	£3.20

EDGEWISE

Size 3½" × 1⅛" × 2⅛"
Cut out 2⅜" × 1¼"

Value	No.	Price
0-1MA	1316	£4.05
0-500UA	1317	£4.05

MINIATURE BALANCE/TUNING METER

Size 23 × 22 × 26mm
Sensitivity 100/0 100MA
No. 1318 Price £1.95

BALANCE/TUNING

Size 45 × 22 × 34mm
Sensitivity 100 0 100UA
No. 1319 Price £2.00

MIN. LEVEL METER

Size 23 × 22 × 26mm
Sensitivity 200UA
No. 1320 Price £1.95

Vu METER

Size 40 × 40 × 29mm
Sensitivity 130UA
No. 1321 Price £2.00

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CARBON POTENTIOMETERS

SINGLE GANG

Linear Track Value	No.	Price	Log Track Value	No.	Price
1K	1831	*£0.22	4K7	1842	*£0.22
2K2	1832	*£0.22	10K	1843	*£0.22
4K7	1833	*£0.22	22K	1844	*£0.22
10K	1834	*£0.22	47K	1845	*£0.22
22K	1835	*£0.22	100K	1846	*£0.22
47K	1836	*£0.22	220K	1847	*£0.22
100K	1837	*£0.22	470K	1848	*£0.22
220K	1838	*£0.22	1M	1849	*£0.22
470K	1839	*£0.22	2M2	1850	*£0.22
1M	1840	*£0.22			
2M2	1841	*£0.22			

DUAL GANG

Linear Track Value	No.	Price	Log Track Value	No.	Price
4K7	1851	*£0.68	4K7	1860	*£0.68
10K	1852	*£0.68	10K	1861	*£0.68
22K	1853	*£0.68	22K	1862	*£0.68
47K	1854	*£0.68	47K	1863	*£0.68
100K	1855	*£0.68	100K	1864	*£0.68
220K	1856	*£0.68	220K	1865	*£0.68
470K	1857	*£0.68	470K	1866	*£0.68
1M	1858	*£0.68	1M	1867	*£0.68
2M2	1859	*£0.68	2M2	1868	*£0.68

SINGLE GANG SWITCHES

Linear Track Value	No.	Price	Log Track Value	No.	Price
4K7	1870	*£0.48	4K7	1879	*£0.48
10K	1871	*£0.48	10K	1880	*£0.48
22K	1872	*£0.48	22K	1881	*£0.48
47K	1873	*£0.48	47K	1882	*£0.48
100K	1874	*£0.48	100K	1883	*£0.48
220K	1875	*£0.48	220K	1884	*£0.48
470K	1876	*£0.48	470K	1885	*£0.48
1M	1877	*£0.48	1M	1886	*£0.48
2M2	1878	*£0.48	2M2	1887	*£0.48

VEROBOARDS

DRILLED COPPER P.C.B.

.1 Pitch Size	No.	Price	.15 Pitch Size	No.	Price
2.5" x 5"	2201	£0.46	2.5" x 17"	2209	£1.13
2.5" x 3.75"	2202	£0.39	2.5" x 5"	2210	£0.42
2.5" x 17"	2203	£1.42	2.5" x 3.75"	2211	£0.31
3.75" x 5"	2204	£0.52	3.75" x 17"	2212	£1.51
3.75" x 3.75"	2205	£0.46	3.75" x 5"	2213	£0.57
3.75" x 17"	2206	£1.82	3.75" x 3.75"	2214	£0.42
4.75" x 17.9"	2207	£2.34	2.5" x 1" (pack of five)	2216	£0.52
2.5" x 1" (pack of five)	2208	£0.57			

DRILLED PLAIN P.C.B.

.1 Pitch Size	No.	Price	.15 Pitch Size	No.	Price
3.75" x 17"	2217	£1.18	2.5" x 17"	2221	£0.78
3.75" x 2.5"	2218	£0.26	3.75" x 17"	2222	£1.00
5" x 3.75"	2219	£0.42	2.5" x 5"	2223	£0.26
			2.5" x 3.75"	2224	£0.21
			5" x 3.75"	2225	£0.36

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PLUGS AND SOCKETS

PLUGS

		No.	Price
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P2	DIN 3-pin	1690	*£0.12
P3	DIN 4-pin	1691	*£0.16
P4	DIN 5-pin 180	1692	*£0.14
P5	DIN 5-pin 240	1693	*£0.15
P6	DIN 6-pin	1694	*£0.20
P7	DIN 7-pin	1695	*£0.20
P8	Jack Plug 2.5mm screened	1696	*£0.12
P9	Jack Plug 3.5mm plastic	1697	*£0.10
P10	Jack Plug 3.5mm screened	1698	*£0.15
P11	Jack Plug mono plastic	1699	*£0.14
P12	Jack Plug mono screened	16100	*£0.28
P13	Jack Plug stereo screened	16101	*£0.32
P14	Phono	16102	*£0.10
P15	Car aerial	16103	*£0.16
P16	Coax free TV	16104	*£0.16
P17	Right angle jack	16105	*£0.12
P18	Jack 2.5mm plastic	16106	*£0.12
P19	Jack stereo plastic	16107	*£0.20
P20	Phono free, screened	16108	*£0.14
P21	D.C. 2.1 plug	16109	*£0.12
P22	D.C. 2.5mm plug	16110	*£0.12
P23	2-pin AC plug U.S. type	16111	*£0.18
P24	AM aerial	16112	*£0.13
P25	Cassette mains plug	16113	*£0.15
P26	FM 300 ohms plug	16114	*£0.13

CHASSIS SOCKETS

		No.	Price
CS1	DIN/LS 2-pin loudspeaker	1652	*£0.08
CS2	DIN 3-pin	1653	*£0.10
CS3	DIN 5-pin 180	1654	*£0.10
CS4	DIN 5-pin 240	1655	*£0.12
CS5	Jack 2.5mm	1656	*£0.06
CS6	Jack 3.5mm	1657	*£0.06
CS7	Jack Mono switched	1658	*£0.15
CS8	Jack Stereo switched	1659	*£0.18
CS9	Phono single	1660	*£0.08
CS10	Phono double	1661	*£0.10
CS11	Coax surface	1662	*£0.21
CS12	Coax flush	1663	*£0.25
CS13	Jack switched, Mono	1664	*£0.20
CS14	Jack socket DPDT switch	1665	*£0.32
CS15	Car aerial	1666	*£0.10
CS16	AC mains US type	1667	*£0.16
CS17	Phono 4-way	1668	*£0.16
CS18	D.C. power	1669	*£0.18
CS19	AC switched	1670	*£0.32
CS20	Phono 8-way	1671	*£0.32

INLINE SOCKETS

		No.	Price
IS1	DIN/LS5 2-pin speaker	1672	*£0.10
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IS3	DIN 5-pin 180	1674	*£0.17
IS4	DIN 5-pin 240	1675	*£0.18
IS5	Jack inline 2.5mm	1676	*£0.08
IS6	Jack inline 3.5mm	1677	*£0.08
IS7	Jack ¼" mono plastic	1678	*£0.14
IS8	Jack ¼" mono Chrome	1679	*£0.28
IS9	Jack stereo plastic	1680	*£0.20
IS10	Jack stereo Chrome	1681	*£0.42
IS11	Phono screened	1682	*£0.12
IS12	Car aerial	1683	*£0.22
IS13	Coax television	1684	*£0.40
IS14	Coax back-back	1685	*£0.21
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C60	307	£1.29
C90	308	£1.56
C120	309	£2.22
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C90	311	£1.23
C120	312	£1.80
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C60	321	£0.95
C90	322	£1.44
C120	323	£2.04
T.D.K. E.D.		
C60	324	£1.48
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ECC81	0.45	EL95	0.70	PCL81	0.60
ECC82	0.40	EL504	0.80	PCL82	0.45
ECC83	0.40	EL821	3.00	PCL83	0.70
ECC84	0.35	EM31	0.75	PCL84	0.50
ECC85	0.45	EM80	0.55	PCL86	0.60
ECC86	1.25	EM81	0.60	PCL805/85	0.60
ECC88	0.55	EM84	0.40	PFL200	0.70
ECC189	0.80	EM87	1.00	PL36	0.60
ECF80	0.45	EY51	0.45	PL81	0.55
ECF82	0.45	EY81	0.45	PL82	0.50
ECF801	0.75	EY86/87	0.50	PL83	0.50
ECH42	0.85	EY88	0.50	PL84	0.50
ECH81	0.45	EZ40	0.60	PL504	0.85
ECH84	0.50	EZ41	0.75	PL508	0.95
ECL80	0.60	EZ80	0.30	PL509	1.35
ECL82	0.40	EZ81	0.35	PL802	2.00
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ECL86	0.55	GY501	0.75		
EF36	0.75	GZ32	0.65		
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PY82	0.45	U27	1.00	UF85	0.50	IS4	0.40	5Y3GT	0.65	6AU6	0.40
PY83	0.50	U191	0.75	UF89	0.50	IS5	0.40	5Z3	1.00	6AV6	0.50
PY88	0.50	U801	0.80	UL41	0.75	IT4	0.40	5Z4G	0.70	6AX4GT	0.80
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SP61	0.85	UCH42	0.80	Z900T	1.50	5B/254M	5.50	6AM6	0.65	6BW7	1.00
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AC126	AFZ12	BF167	NKT222	OC42	ZR11	2N3819
AC127	ASY26	BF173	NKT304	OC44	ZR21	2N4038
AC128	ASY27	BF185	NKT404	OC45	ZR22	2N4058
AC176	ASY28	BFY51	OA5	OC70	2N456A	2N4061
ACY17	BC107	BFY52	OA47	OC73	2N525	2N4172
ACY18	BC108	BSY27	OP70	OC75	2N696	2N5295
ACY19	BC109	BSY38	OA71	OC78	2N708	3N126
ACY20	BC113	BSY95A	OA73	OC78D	2N918	3N128
ACY39	BC116	BY100	OA79	OC81	2N1305	3N154
ACY40	BC118	BYZ16	OA91	OC82	2N1307	SX754
AD149	BC136	CRS1/20	OA200	OC82OM	2N1309	2S303
AD161	BC137	CRS1/30	OA202	OC83	2N2062	T12082
AD162	BC148A	CRS3/10	OAZ200	OC83B	2N2411	40235
ADZ11	BC172	CRS3/20	OC22	OC139	2N2989	40250
ADZ12	BC172A	CRS3/30	OC25	OC140	2N3053	40251
AF114	BC212A	CRS3/40	OC26	OC170	2N3054	IN23A
AF115	BCY31	CRS25/025	OC28	OC172	2N3055	IN25
AF116	BCY33	GET115	OC29	OC200	2N3391	IN38A
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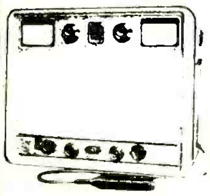

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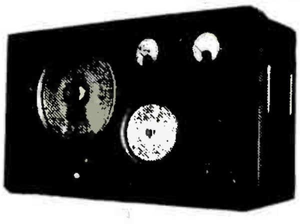
KAHN SSB ADAPTOR TYPE RSSB — 62 — 18. Designed for receivers with 455-500KHz IF at 100mV (max) input Features electronic AFC carrier freq diversity to combat fading 20 sce R C memory to maintain tuning during severe fading Individual carrier meters nuvishers lOW distortion production demodulator **£65** carriage £5 00

HR 23 TRIPLE DIVERSITY SSB RECEIVERS. Freq 3-275MHz V F O at 6 Xtal positions Reception of independent single or double side band transceivers Full spec on application **£350** carriage £35 00

DECADE OSCILLATOR D-890-A. This oscillator which has been adapted for use by NATO has the same frequency range (1C/S-110Kc/s) as the widely known D-650-B oscillator which it supercedes Frequency accuracy without crystal check facility X1 range ± 0 2% or ± 0 2c/s whichever is greater, X10 range ± 0 4% (above 10kc/s) Maximum output 8K ohms load, 126V (2 watts) 20c/s-50kc/s, 90V (1 watt) 20c/s-110kc/s
600 ohm load 25V (1 watt) 300c/s-110kc/s, 17V (0.5 watt) at 200 c/s decreasing to 5V (40mW) at 60 c/s Full spec on request **£249.00** carriage £10 00

PLEASE SEND STAMP WITH ENQUIRIES



TF 8010/1/S SIGNAL GENERATOR. Range 10-485MHz in 5 ranges R.F output 0 1 μV-1V Source C M Dial calibrated in volts, decibels and power relative to thermal noise Piston type attenuator 50Ω output impedance. Internal modulation at 1KHz at up to 90% depth also external sine and pulse modulation Built in 5MHz crystal calibrator Separate RF and mod. meters. P O A

TF 1066 SIGNAL GENERATOR. Freq 10-470MHz with attenuator EMF from 50Ω square, —6dB Price on application

TF 801B/2. Spec as for 801D but minor circuit differences. Few only left **£150** carriage £5 00

FREQUENCY ANALYSER D-669-A. Frequency range 30c/s-30kc/s in 6 ranges. Amplitude stability ± 1db over a period, input impedance 100k ohm shunted by 80pF selectivity normally set for Q = 50 (variable from 1 to 150) **£120.00** carriage £10.00

SINGER PANORAMIC SPECTRUM ANALYSER TYPE SPA 10
Frequency range 10MHz-6Hz. Full spec and price on request.

MUIRHEAD

PAMETRADA WAVE ANALYSER TYPE D-489-G. Freq range 19 c/s-21 Kc/s continuously variable in nine ranges 19-90 c/s, 79-150 c/s 139-210 c/s (x 1, x 10, x 100) Freq accuracy x 1 and x 10 ranges ± 0.3% Input voltage for full scale deflection of meter 1 mV minimum to 300V maximum Maximum permissible input is 300V r m s

ANCILLARY EQUIPMENT: D-625-A LOW FREQ. MODULATOR. Freq range 2 c/s-20 c/s (down to 1 c/s when analyser is used in "High Q") Freq accuracy ± 0 1 c/s (providing supply freq is first measured) Specification on request Price **£275.00,** packing and carriage £4 00

H.F. SIGNAL GENERATOR TYPE 201. Constant output level — within ± 0 5 dB — over entire frequency range. Freq 30kHz to 30MHz in 7 bands Stability better than 0 005% amplitude modulation continuously variable 0-100% Maximum R F high output is approx 9V r m s Price **£65** P&C £4

MODULATION METER TYPE 210. AM/FM Frq range 3MHz-300MHz in 7 ranges Price **£75.** P&C £4

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TF 934 DEVIATION METER. 250MHz **£55** carriage £3 00

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VAT FOR TEST EQUIPMENT
8% PLEASE ADD **8%**

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TF 885A/1 VIDEO OSCILLATOR. 0-30KHz, 5MHz 1Mv-31 6v **£85** carriage £4 00

TF 1400S DOUBLE PULSE GENERATOR WITH TM 6600 SECONDARY PULSE UNIT for testing radad nucleonics scopes, counters filters, etc

TF.455E WAVE ANALYSER. Freq range 20 c/s to 16 kc/s, double crystal filter gives 4 c/s pass band Envelope distortion test on r.f inouts up to 400 Mc/s. **£98.00,** packing & carriage £6 00

RADIOMETER TYPE MS111 SIGNAL GENERATOR. High quality Danish production 10KHz-110MHz **£200** carriage £5 00

DIVERSITY SWITCH TYPE MA168B. Solid state **£45.00.**

REDIFON SSB TRANSMITTER/RECEIVER TYPE GR410. Full particulars and price on request

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A portable instrument for measuring the noise factor of radio receiving equipment, metric radar receivers and radar wide-band i f amplifiers, in the band 15kHz-160MHz Output impedance 50 or 75 ohms A built-in audio power meter has a switched input circuit giving impedances of 10, 15, 6,000 and 20 000 ohms and has a basic range of 10μW to 1W (—20db to +30db to 1W) Price **£85** carriage £5 00

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DIGITAL VOLTMETER LM1426. 5 digit 6 ranges, accuracy long term ranges 2-6 ± 0.01% of full scale ± 0 02% of recording Price **£120.00,** packing & carriage £4 00

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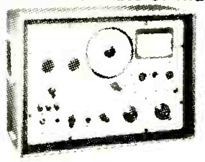

TF 995A/1 or A/2 or A/2M or A5 SIGNAL GENERATORS. Very high class AM/FM 1 5MHz to 220MHz Detailed spec and price on application.

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Five-pen recorders: 50mm

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Chart drive: 200-250V 50Hz
Recording: Syphon pen directly attached to moving coil frames. Curvilinear co-ordinates.
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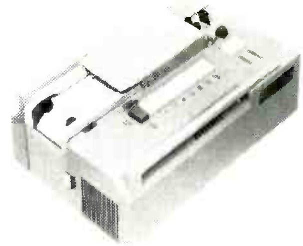
Series H327



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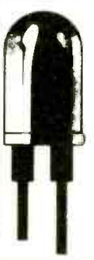

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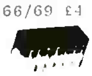

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POWERTRAN ELECTRONICS INCORPORATING AMBIENTACOUSTICS

HI-FI NEWS 75W/CHANNEL AMPLIFIER

By J. L. Linsley Hood

In Hi-Fi News there was published by Mr. Linsley-Hood a series of four articles (November, 1972-February, 1973) and a subsequent follow-up article (April, 1974) on a design for an amplifier of exceptional performance which has as its principal feature an ability to supply from a direct coupled fully protected output stage, power in excess of 75 watts whilst maintaining distortion at less than 0.01% even at very low power levels. The power amplifier is complemented by a pre-amplifier based on a discrete component operational amplifier referred to as the Liniac which is employed in the two most critical points of the system, namely the equalization stage and tone control stage, positions where most conventional designs run out of gain at the extremes of the frequency spectrum. Unusual features of the design are the variable transition frequencies of the tone controls and the variable slope of the scratch filter. There is a choice of four inputs, two equalized and two linear, each having independently adjustable signal level. The attractive slimline unit pictured has been made practical by highly compact PCBs and a specially designed Toroidal transformer.

Pack	Price
1. Fibreglass printed-circuit board for power amp	£1.15
2. Set of resistors, capacitors, pre-sets for power amp	£2.15
3. Set of semiconductors for power amp	£6.50
4. Pair of 2 drilled, finned heat sinks	£1.10
5. Fibreglass printed-circuit board for pre-amp	£1.75
6. Set of low noise resistors, capacitors, pre-sets for pre-amp	£3.40
7. Set of low noise, high gain semiconductors for pre-amp	£2.40
8. Set of potentiometers (including mains switch)	£3.15
9. Set of 4 push-button switches, rotary mode switch	£4.50
10. Toroidal transformer complete with magnetic screen/housing primary: 0 117-234 V; secondaries: 33-0-33 V, 25-0-25 V	£10.95
11. Fibreglass printed-circuit board for power supply	£0.85
12. Set of resistors, capacitors, secondary fuses, semi-conductors for power supply	£4.60
13. Set of miscellaneous parts including DIN skts, mains input skt, fuse holder, inter-connecting cable, control knobs	£5.35
14. Set of metalwork parts including silk screen printed fascia panel and all brackets, fixing parts, etc.	£7.30
15. Handbook	£0.30
16. Teak cabinet 18.3" x 12.7" x 3.1"	£9.85

2 each of packs 1-7 inclusive are required for complete stereo system. Total cost of individually purchased packs £83.75

FREE TEAK CASE WITH FULL KITS

KIT PRICE ONLY **£73.90**

WIRELESS WORLD FM TUNER

Designed in response to demand for a tuner to complement the world-wide acclaimed Linsley Hood 75W Amplifier, this kit provides the perfect match. The Wireless World (Skingley and Thompson — April, May 1974) published original circuit has been developed further for inclusion into this outstanding slimline unit and features a pre-aligned front end module, excellent a.m. rejection and temperature compensated varicap tuning, which may be controlled either continuously or by push button pre-selection. Frequencies are indicated by a frequency meter and sliding LED indicators, attached to each channel selector pre-set. The PLL stereo decoder incorporates active filters for "birdy" suppression and power is supplied via a toroidal transformer and integrated regulator. For long term stability metal oxide resistors are used throughout.

Pack	Price
1. Fibreglass printed board for front end IF strip, demodulator, AFC and mute circuits	£2.15
2. Set of metal oxide resistors, thermistor, capacitors, cermet preset for mounting on pack 1	£4.30
3. Set of transistors, diodes, LED, Integrated circuits for mounting on pack 1	£5.25
4. Pre-aligned front end module, coil assembly, three section ceramic filter	£8.50
5. Fibreglass printed circuit board for stereo decoder	£1.10
6. Set of metal oxide resistors, capacitors, cermet preset for decoder	£2.60
7. Set of transistors LED, integrated circuit for decoder	£2.90
8. Set of components for channel selector switch module including fibreglass printed circuit board, push-button switches, knobs, LEDs, preset adjusters etc.	£8.80
9. Function switch, 10 turn tuning potentiometer, knobs	£5.30
10. Frequency meter, meter drive components, fibreglass printed circuit board	£9.45
11. Toroidal transformer with electrostatic screen. Primary: 0—117V—234V	£4.45
12. Set of capacitors, rectifiers, voltage regulator for power supply	£2.95
13. Set of miscellaneous parts, including sockets, fuse holder, fuses, inter-connecting wire, etc.	£1.50
14. Set of metal work parts including silk screen printed facia panel, acrylic silk screen printed tuning Indicator panel insert, internal screen, fixing parts, etc.	£7.50
15. Construction notes (free with complete kit)	£0.25
16. Teak cabinet 18.3" x 12.7" x 3.1"	£9.85

One each of packs 1-16 inclusive are required for complete stereo FM tuner. Total cost of Individually purchased packs £76.85

FREE TEAK CASE WITH FULL KITS

KIT PRICE only **£66.75**

NEW KIT!

LINSLEY-HOOD CASSETTE DECK

Published in Wireless World (May, June, August 1976) by Mr. Linsley-Hood, this design, although straightforward and relatively low cost nevertheless provides a very high standard of performance. To permit circuit optimization separate record and replay amplifiers are used, the latter using a discrete component front-end designed such that the noise level is below that of the tape background. Push button switches are used to provide a choice of equalization time constants, a choice of bias levels and also an option of using an additional pre-amplifier for microphone use. The mechanism used is the Goldring-Lenco CRV, a unit distinguished in its robustness and ease of operation. Speed control and automatic cassette ejection are both implemented by electronic circuitry. This unit which is powered by a toroidal transformer and uses metal oxide resistors throughout offers an excellent match for the Wireless World Tuner and the Linsley-Hood 75 Watt Amplifier.

Pack	Price
1. Stereo PCB (accommodates 2 rep. amps, 2 rec. amps, 2 meter amps, bias/erase osc. relay)	£3.35
2. Stereo set of capitors, M.O. resistors, potentiometers for above	£9.80
3. Stereo set of semiconductors for above	£8.90
4. Miniature relay with socket	£2.45
5. PCB, all components for solenoid, speed control circuits	£3.20
6. Goldring Lenco mechanism as specified	£21.95
7. Function switch, knobs	£1.60
8. Dual VU meter with illuminating lamp	£7.20
9. Toroidal transformer with E.S. screen prim. 0-117V, 234V, Sec. 15V	£4.45
10. Set of capacitors, rectifiers, I.C. voltage regulator for power supply (Powertran design)	£2.80
11. Set of miscellaneous parts, including sockets, fuse holder, fuses, interconnecting wire, etc.	£2.50
12. Set of metalwork including silk screened facia panel, internal screen, fixing parts, etc.	£7.10
13. Construction notes	£0.25
14. Teak cabinet 18.3" x 12.7" x 3.1"	£9.85

One each of packs 1-14 inclusive are required for compete stereo cassette deck. Total cost of individually purchased packs £85.40

PRICE STABILITY

Order with confidence! Irrespective of any price changes we will honour all prices in this advertisement for two months from issue date provided that this advertisement is quoted with your order. E&OE VAT rate changes excluded. All components are brand new first grade full specification devices. All resistors (except where stated) are low noise carbon film types. All printed circuit boards are fibre-glass, drilled, roller tinned and supplied with circuit diagrams and construction layouts.

SPECIAL PRICE FOR COMPLETE KITS £81.35

Further details of above given in our FREE LIST

DEPT. WW3

EXPORT ORDERS. No VAT charged. Postage charged at actual cost plus 50p packing and handling. Please make payment by Bank Draft, Postal Order, International Money Order in sterling.
SECURICOR DELIVERY: For this optional service (U.K. Mainland only) add £2.50 (VAT INC.) per kit.
U.K. ORDERS: **Subject to 12½%★ surcharge for VAT.** Carriage free.
MAIL ORDER ONLY. (★or at current rate if changed)

POWERTRAN ELECTRONICS

PORTWAY INDUSTRIAL ESTATE
ANDOVER, HANTS SP10 3NN

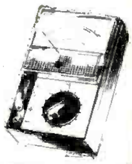
Indonesia Brazil Switzerland Canada Saudi Arabia New Zealand Norway Iceland Sweden

SERVICE TRADING CO

RELAYS

Wide range of AC and DC relays available from stock. Phone or write in your enquiries.

WHY PAY MORE?!



MULTI RANGE METER. A.C. volts 2.5-500. D.C. volts 2.5-500 (Sensitivity 2000Ω/V D.C. & A.C.) D.C. current 0/1/10/100 mA. Ohms range. Sturdy compact moving coil instrument with 21 ranges, dimensions 120 × 80 × 44mm. Weight 0.32 kg. SERVICE TRADING CO. Price **£5.50.** Incl. leads and battery. Post 50p (Total price inc. VAT & Post **£6.48.**)

TRIAC. Raytheon tag symmetrical Triac Type Tag 250/500v 10 amp 500 piv. Glass passivated plastic triac. Swiss precision product for long term reliability **£1.25.** P&P 10p (inclusive of date and application sheet). Suitable Diac **20p.**

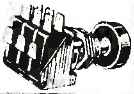
0 to 60 MINUTES CLOCKWORK TIMER.

Double pole 15 amp 230AC. Contacts (no dial) **£1.50.** P&P 30p.

300 V.A. ISOLATING TRANSFORMER

115/230 screened primary, two separate or 115v for 115 or 230v. Secondary two 115v at 150 V.A. for 115 or 230v output. Can be used in series or parallel connections. Fully tropicalised. Length 13.5cm, width 11cm, weight 15lbs. Special price **£6.00,** carr. £1.00.

HONEYWELL PUSH BUTTON PANEL MOUNTING MICRO SWITCH ASSEMBLY.

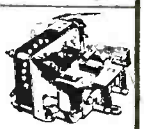


Each bank comprises of a change-over rated at 10 amp 250v A.C. Black knob 1" dia. fixing hole ⅝". Price one bank **40p.** Two bank **50p.** Three bank **60p.** Min. order 5 pieces. P&P 50p.

230 VOLT FAN ASSEMBLY

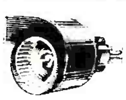
Continuously rated removable aluminium blades. Price **£1.25.** Post 50p. **VAT 12½%.**

21-WAY SELECTOR SWITCH with reset coil.



The ingenious electro mechanical device can be switched up to 21 positions and can be reset from any position energising the reset coil. 230/240v A.C. operation. Unit is mounted on strong chassis. Complete with cover. Price **£5.50.** P&P 75p.

PRECISION CENTRIFUGAL BLOWERS (230/240v AC)



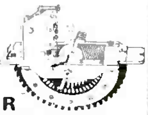
Mfg. by Smiths Industries. Miniature model Series SF/200. Size 95mm × 82mm. Aperture 38mm × 31mm. 12 c.f.m. **£2.75.** Post 50p. Other types available, phone for details. Also available extremely powerful blower mfg. by Fracmo.

FRACMO 115/230v A.C. 2800/3400 r.p.m. fan type aperture 3" × 2½" VBL4 25/c. Price **£12.00.** Post £1.00.

BLOWER UNIT

200/240V a.c. precision German built. Dynamically balanced, quiet, con. rated, reversible. Consumption 60mA. Size 120mm dia. × 60mm dep. Price **£3.50.** Post 50p.

UNISELECTOR SWITCH



4 bank 25 way 75 ohm coil 36-48v D.C. operation. Ex **new** equipment **£4.25.** P&P 75p. Total price inc. VAT **£5.40.**

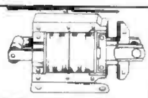
MINIATURE UNISELECTOR

12v. 11 way 4 bank (3 non-bridging 1 homing). **£2.50.** P&P 35p.

MINIATURE ROLLER MICRO SWITCH

M switch OMRON type V15 FL 22-1C. 10 for **£2.00** post 50p (Min. order 10).
Sub miniature Burgess type V 4T 1. 10 for **£2.50.** 50 for **£10.00,** post paid.
LEVER OPERATED 20 amp c/o. Mfg. by Unimax USA. 10 for **£4.00** plus 50p P&P (min. order 10).

NEW HEAVY DUTY SOLENOID



Mfg. by Magnetic Devices. 240v A.C. operation approx. 20lb pull at 1.25". Price **£7.00.** P&P 75p.

230-250 VOLT A.C. SOLENOID

Similar in appearance to illustration. Approximately 1½lb pull. Size of feet 1⅜" × 13/16". Price **£1.00.** Post 25p.

24 VOLT D.C. SOLENOIDS

UNIT containing **1 heavy duty solenoid approx. 25 lb. pull** at 1 in. travel, 2 solenoids of approx. 1 lb. pull at ½ in. travel, 6 solenoids of approx. 4 oz. pull at ½ in. travel. Plus 1 24V D.C. 1 heavy duty 1 make relay. Price **£3.00.** Post £1.00. **ABSOLUTE BARGAIN**

240 A.C. SOLENOID OPERATED FLUID VALVE

Rated 1 p.s.i. will handle up to 7 p.s.i. Forged brass body, stainless steel core and spring. ½ in. b.s.p. inlet outlet. Precision made. British mfg. PRICE **£2.75.** Post 50p. NEW original packing.

600 WATT DIMMER SWITCH

Easily fitted. Fully guaranteed by makers. Will control up to 600 watts of all lighting except fluorescent at mains voltage. Complete with simple instructions. **£3.65.** Post 25p.

1000 watt model	**£5.60.**	Post 25p
2000 watt model	**£9.75.**	Post 40p

VARIABLE VOLTAGE TRANSFORMERS

Carriage extra

INPUT 230 v. A.C. 50/60
OUTPUT VARIABLE 0/260v. A.C.
BRAND NEW. All types.

200W (1 Amp) fitted A/C volt meter	£11.50
0.5 KVA (Max. 2½ Amp)	£14.00
1 KVA (Max. 5 Amp)	£18.00
2 KVA (Max. 10 Amp)	£30.00
3 KVA (Max. 15 Amp)	£38.00
4 KVA (Max. 20 Amp)	£60.00

LT TRANSFORMERS

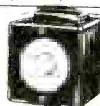
0-12v/24v at 1 amp	£2.50 p&p 50p
0-15v at 1 amp + 0-15v at 1 amp (30v 1 amp.)	£2.50 p&p 50p
25-0-25v at 2½ amp	£4.50 p&p 75p
0-12v/24v 10 amp	£12.35 p&p £1.50
0-4v/6v/24v/32v at 12 amp	£13.00 p&p £1.50
0-12v at 20 amp or 0-24v at 10 amp	£12.40 p&p £1.50
0-6v/12v/17v/18v/20v at 20 amp	£14.00 p&p £1.50
0-6v/12v at 20 amp	£11.85 p&p £1.00

Other types in stock, phone in enquiries.

AUTO TRANSFORMERS

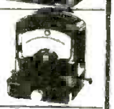
Step up step down 0-115-200-220-240v. 75 watt **£3.50** p&p 60p. 150 watt **£5.00** p&p 80p. 300 watt **£7.00,** p&p 95p. 500 watt **£10.75** p&p £1.25. 1000 watt **£16.00** p&p £1.50p.

RODENE UNISET TYPE 71 TIMER.



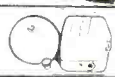
0-60 sec. 230v AC operation. Incorporating a lapsed time indicator and repeat facilities. A precision motorised timer ideal for process timing, photography, welding, mixing, etc. Price **£6.00** p&p 60p.

GALVANOMETER.



50 micro mirror glavo. Calibrated 50-0-50 and 0-100. Mfg. by Griffin & George Ltd. Offered at fraction of maker's price in original ministry packing. **£12.00,** p&p 60p.

GENTS 4" ALARM BELL



3-4½v D.C. Price **£4.50.** P&P 50p.

STROBE! STROBE! STROBE!

HY-LIGHT STROBE Mk. IV

Latest type Xenon white light tube. Solid state timing and triggering circuit. 230/240 volt A.C. operation. Speed adjustable 1-20 f.p.s. Designed for large rooms, halls, etc. Light output greater than many (so called 4 Joule) strobes. Price **£15.40.** Post 75p. Specially designed case and reflector for Hy-Light **£8.25.** Post £1.00.

XENON FLASH GUN TUBES

Range of Xenon tubes available from stock. S.A.E. for full details.

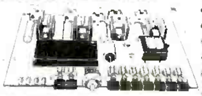
ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES

4ft. 40 watt £7.00 (callers only). **2ft. 20 watt £4.60.** Post 60p (For use in stan. bi-pin fittings). MINI **12in. 8 watt £1.75.** Post 25p. **9in. 6 watt £1.40. 6in. 4 watt £1.40.** Post 25p. Complete ballast unit. Either 6", 9" or 12" tube 230V A.C. op. **£3.50** plus p&p 40p. Also available for 12V D.C. op. **£3.50** plus p&p 40p.

BIG BLACK LIGHT

400W Mercury Vapour Ultra Violet Lamp. Powerful source of UV. P.F. ballast unit is essential with this lamp. Price of bulb and matched ballast unit **£28.** Post £2. Spare bulb only **£10.** Post 80p.

SQUAD LIGHT



A new conception in light control. Four channels each capable of handling 750 watts of spotlights, floodlights or dozens of small mains lamps. Seven programs all speed controlled plus flash modulation, effectively giving 14 different displays. Makes sound-to-light obsolete. Completely electrically and mechanically noise free.

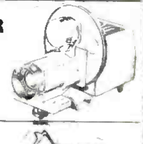
Price only **£60.00**

Post 75p. S.A.E. (Foolscap) for further details.

RELAYS

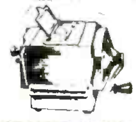
Wide range of AC and DC relays available from stock. Phone or write in your enquiries.

COLOUR WHEEL PROJECTOR TYPE P150 INTACHANGE



200/240V a.c. 50Hz. 150W lamp complete with oil filled colour wheel and motor plate. Takes Intachange accessories and full range of lenses **£29.95.** Post £1.35 (inc. VAT & Post **£33.70**).

INSULATION TESTERS (NEW)



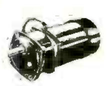
Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L 8 in. W 4 in. H 6 in. weight 6 lb.
500 VOLTS 500 megohms **£40.00** Post 80p
1000 VOLTS 1000 megohms **£46.00** Post 80p
SAE for leaflet

VAT AT CURRENT RATE MUST BE ADDED TO ALL ORDERS FOR THE TOTAL VALUE OF GOODS INCLUDING POSTAGE UNLESS OTHERWISE STATED

ACCOUNT CUSTOMERS MIN. ORDER £10.00

GEARED MOTORS

100 R.P.M. 115 lbs. ins.!!

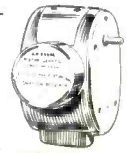


115 lb. ins., 110 volt, 50Hz, 2.8 amp, single phase, split capacitor motor. Immense power. Continuously rated. Totally enclosed. Fan cooled. In-line gearbox. Length 250mm. Dia. 135mm. Spindle Dia. 15.5mm. Length 145mm, ex-equipment tested **£12.00.** Post £1.50. Suitable transformer 230/240 volt **£8.00.** Post 75p.

15 R.P.M.

Type SD48 15 r.p.m. 80 lb. ins. Input 100/120 volt A.C. Length incl. gearbox 270mm. Height 135mm. Width 150mm. Shaft drive 16mm. Weight 8.5 Kilos. BRAND NEW. Price **£10.00,** carr. £1.00. Suitable transformer for use on 220/240 volt A.C. **£3.85.** Post 50p.

DRAYTON MOTOR



Type RQR 230/250v 50c. Continuously rated 1 RPM 90lb in. Reversible motor. Twin spindle size 100mm by 140mm by 125mm. Shaft 50mm by 8mm. Weight 2 kilos. **New** Price **£16.50.** P&P £1.00.

BODINE TYPE N.C.I. GEARED MOTOR

(Type 1) 71 r.p.m. torque 10 lb. in. **Reversible** 1/70th h.p. cycle 38 amp. This U.S.A. motor is offered in as new condition. Input voltage of motor 115v **A.C.** Supplied complete with transformer for **230/240v A.C. input.** Price type **£6.25.** Post 75p or less transformer **£3.75.** Post 65p.
(Type 3) 71 r.p.m. 230 Volt A.C. Continuously rated. Non reversible. **£6.50** Post 75p.

6/9 VOLT D.C. GOVERNED 40mm × 40mm. Spindle 10mm. Dia. 2 mm. **£1.00** Post Paid. Two for **£1.65** Post Paid.

24 R.P.M. 230 volt A.C. Continuously rated. Mfg. Mycalex. Ex-equip. Fully tested **£3.85** Post 75p.

1 R.P.M. 230/240 VOLT A.C. SYNCHRONOUS!! Ex-equipment. Thoroughly tested and guaranteed. **ONLY £1.50.** Post 20p.

20 R.P.M. GEARED MOTOR. 230/240 volt 20 r.p.m. motor **£1.00.** Post 20p.

REVERSIBLE MOTOR 230V A.C.

General Electric 230v A.C. 1,600 r.p.m. 0.25 amp. Complete with anti-vibration mounting bracket and capacitor. O/A size 110mm × 95mm. Spindle 5/16" dia. 20mm long. Ex-equipment tested **£3.00.** Post 50p.

REVERSIBLE MOTOR

AEI 1/12 hp continuous rated reversible motor 100/120v A.C. 50/60 cycle 2850 r.p.m. Flange fixing dia. 4". length 4½" shaft 1" × 5/16". Price **£3.25.** P&P 75p.

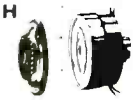
HALF REV. PER HOUR.

Sync. Motor 230/240v A.C. Mfg. by Smiths **£1.** P&P 20p.

METERS NEW 90mm Diameter

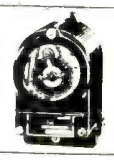
Type: 65CS. D.C. mc. 2, 5, 10, 20, 50 amp **£2.75.** Post 20p. 100 amp **£3.25.** Post 20p. **Type: 62T2** A.C. M/I 20, 50 amp **£2.50** Post 20p. 0-300 Volt A.C. M/I **£2.75** and 300 Volt A.C. R/M/C **£3.00** Post 30p.

BENDIX MAGNETIC CLUTCH



Superb example of electro-mechanics. Main body in two sections. Coil section is fixed and has ⅜" sleeve. The drive section rotating on the outer perimeter. When engaged the transmission is extremely powerful. Diameter 1½". Total width 1¼". 24V D.C. op. Price **£3.50** plus p&p 45p.

TIME SWITCH



Horstmann Type V Mk II Time Switch 200/250 volt A.C. Two on/two off every 24 hours at any manually pre-set time. 30 amp contacts. 36-hour spring reserve in case of power failure. Day omitting device. Fitted in heavy high impact case with glass observation window. Built to highest Electricity Board spec. individually tested. Price **£7.75.** Post 50p. (Total inc. VAT £8.91)

A.C. MAINS TIMER UNIT

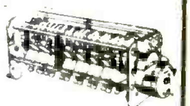
Based on an electric clock with 25 amp single-pole switch which can be preset for any period up to 12 hrs. ahead to switch on for any length of time from 10 mins. to 6 hrs. then switch off. An additional 60 min. audible timer is also incorporated. Ideal for Tape Recorders, Lights, Electric Blankets, etc. Attractive satin copper finish. Size 135 mm × 130 mm × 60 mm. Price **£2.25.** Post 40p. (Total inc. VAT & Post **£2.87.**)

POWER RHEOSTATS

New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.

25 WATT 10, 25, 100, 150, 250, 500, 1k, 1.5k ohm **£1.90.** Post 20p. **50 WATT** 25, 100, 500, 1k ohm **£2.40.** Post 25p. **100 WATT** 1/5/10/25/50/100/250/500/1k/1.5k/2.5k/5k ohm **£3.70.** Post 35p.
Black Silver Skirted knob calibrated in Nos. 1-9, 1½ in. dia. brass bush. Ideal for above Rheostats **22p ea.**

PROGRAMME TIMERS



230 Volt AC Operation. 15 or 20 r.p.m. Each cam operates a c/o micro switch. Ideal for lighting effects, displays, etc. Ex equip. tested. Similar to illustration.

6 CAM model **£5.00**
9 CAM model **£6.50**
12 CAM model **£7.50**

Post 60p. Also available for 50 volt A.C. operation. Prices as above.

SERVICE TRADING CO.

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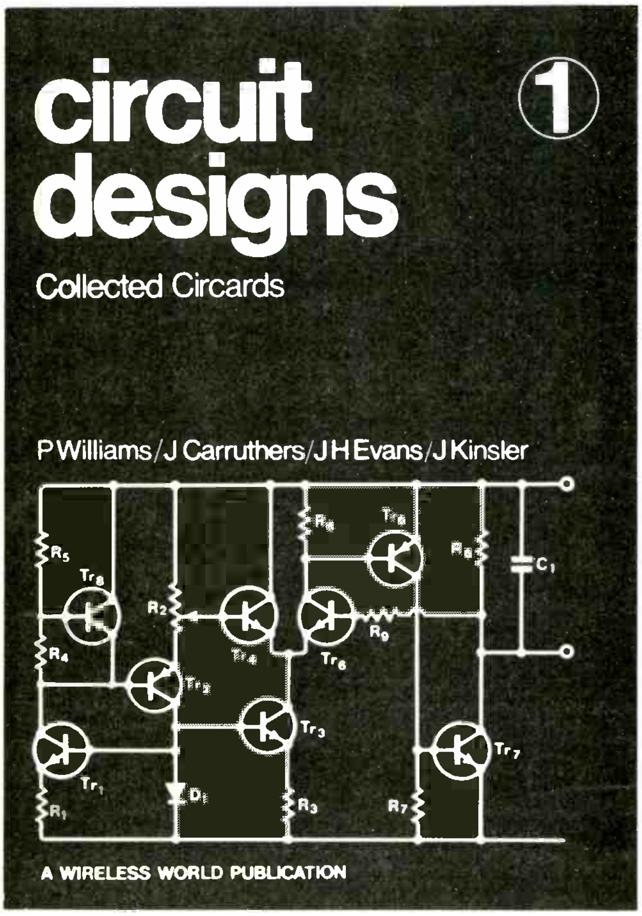
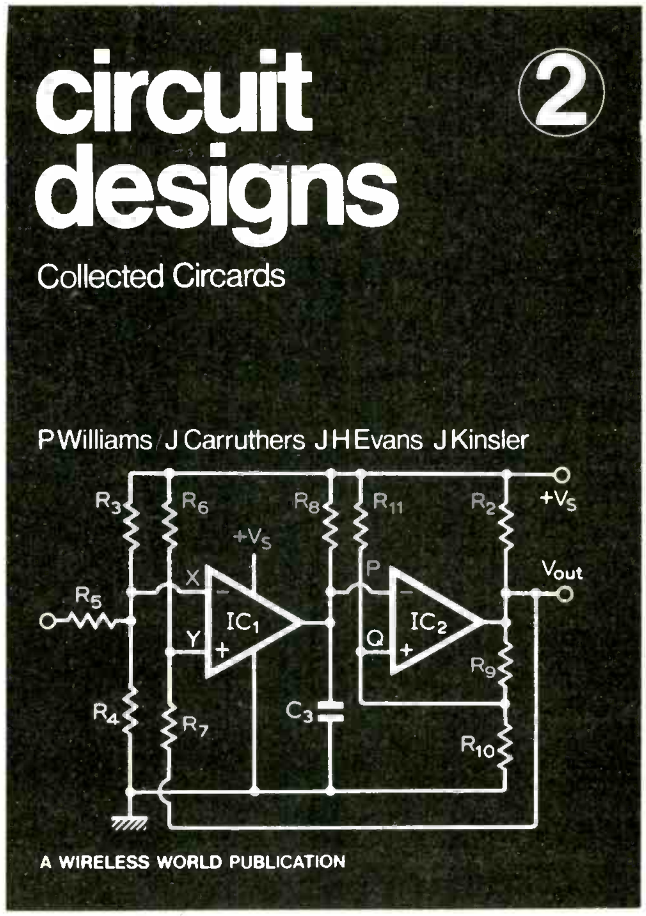
Two books from Wireless World

These books are of very special appeal to all concerned with designing, using and understanding electronic circuits. They comprise information previously included in Wireless World's highly successful Circards – regularly published cards giving selected and tested circuits, descriptions of circuit operation, component values and ranges, circuit limitations, modifications, performance data and graphs. Each of these magazine-size hard cover books contains ten sets of Circards plus additional circuits and explanatory introduction.





BOOK 1

Basic active filters
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Astable circuits
Optoelectronics
Micropower circuits

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SIGNAL SOURCES

ADVANCE
V H F Square wave Generator SG21 10 KHz-100MHz Max o/p 2V **£35**
H1 Audio Signal Generator 15Hz-50KHz Sine and Square **£35.00**
E2 R.F Signal Generator 10KHz-100MHz **£76.00**
H1E Audio Signal Generator Sine & Square Wave 15Hz-50KHz 200uV to 20V (sine)
Distortion < 1% 1 4mV to 140V (square). Brand new condition **£70.00**

AIRMEC
Signal Generator Type 701 30 KHz-30 MHz (2 only) **£75.00**

GENERAL RADIO
Unit Oscillator 1209C Freq 250-920MHz Accuracy 1% Drift 0 2% O pin to 50ohms = 150mW supplied with Power Supply Type 1201—CQ **£145**

HEWLETT PACKARD
10515A Frequency Doubler Extends the useable frequency range of signal generators Operating on unput frequencies 0 5MHz to 500MHz it provides a doubled output in the range of 1MHz to 1GHz The frequency response of this 50 ohm device is very flat (< ± 2dB typically) over the entire frequency range and undesired harmonics are well suppressed Brand
211A Square Wave Generator 1Hz-1MHz **£75.00**
F M /A M Signal Generator 202H F M A M C W & pulse coverage 54 to 216 MHz R F o/p 0 1u V-0 2V 50ohms Impedance **£450**
Audio Signal Generator 206A 20Hz-20KHz ± 2% accuracy Distortion ∠1% **£90**
612A-U H F Signal Generator 450-1230MHz 0 1uV 0 5V (50 ohms) A M internal & external Pulse mod facilities SUPERB CONDITION **£1250.00**

MARCONI INSTRUMENTS
TF1060 U H F Signal Generator 450-1250MHz Sine wave and pulse a m **£350.00**
TF867 Signal Generator 15KHz-30MHz O p volts 0 4μV-4V **£185.00**
TF2005R Two Tone Source The instrument comprises two identical low-distortion a f oscillators and a monitored attenuator unit to form a compact test set for the measurement of inter-modulation distortion using the methods recommended by S M P T E and C C I F Frequency range 20Hz to 20KHz in six bands (each oscillator can be adjusted and used independently) Harmonic distortion Less than 0 05% between 63Hz and 6KHz when using unbalanced output Generally less than 0 1% under other conditions Intermodulation Below −80dB with respect to the wanted signal Amplitude Reference Level Up to +10dBm from each oscillator Output attenuator 111dB in 0 1dB steps Output impedance 600Ω unbalanced, or 600Ω 150Ω or 75Ω balanced and centre-tapped **£485.00**
S H F Signal Generator 618C 2 8-7 6GHz ± 1 50 ohms **£500**
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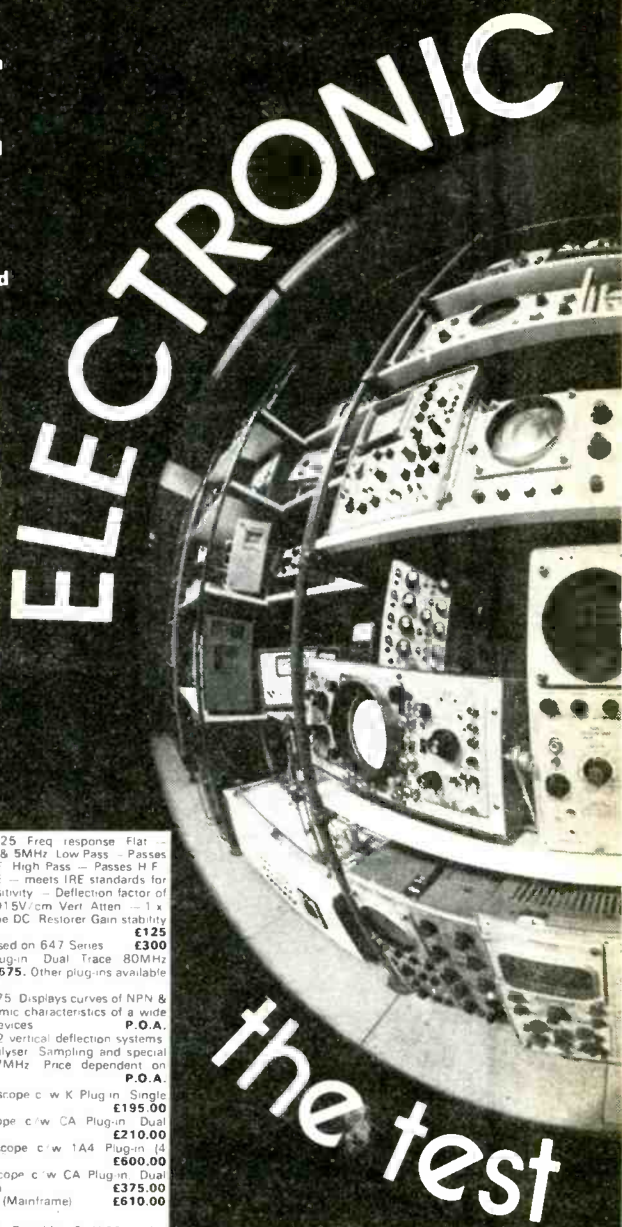

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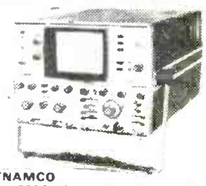

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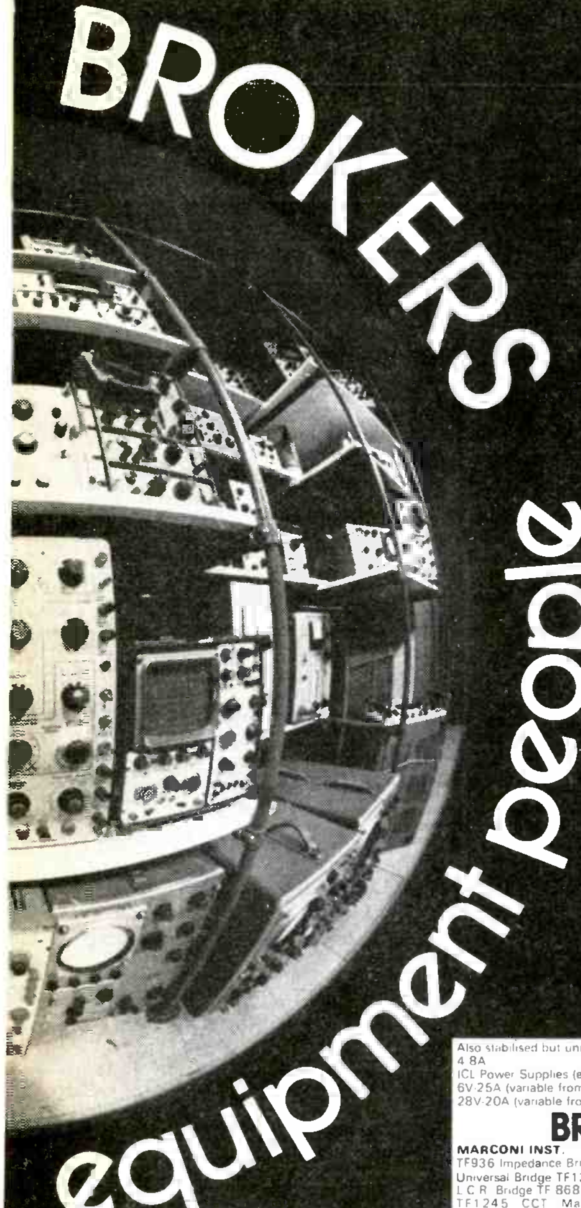

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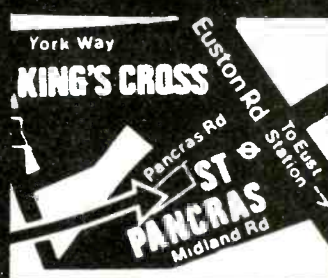

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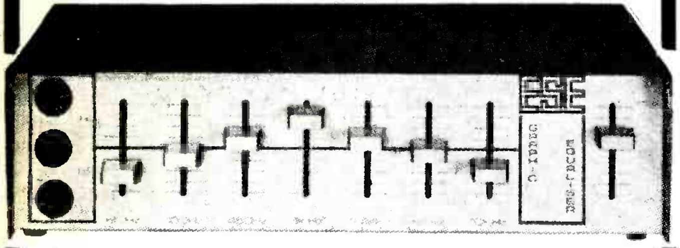

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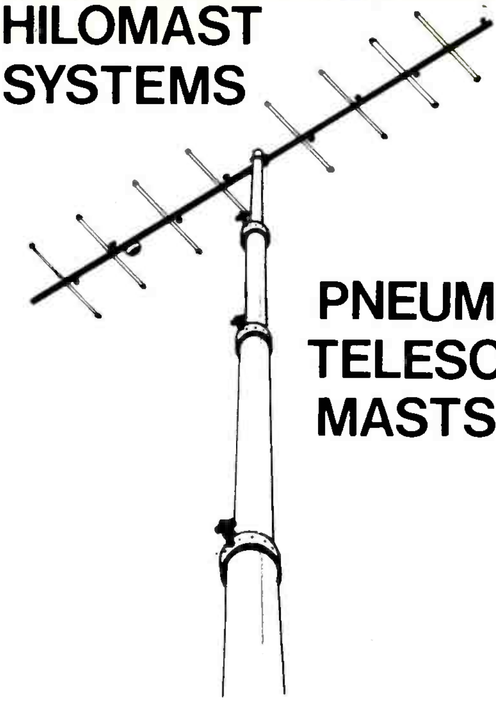

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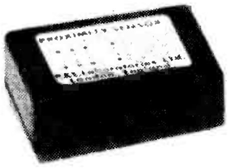

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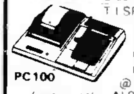
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T130 @ £15.95. T141 (Financial) @ **£28.45; 2550-11 @ £24.45;** 1650 @ **£16.45**

PC100 PRINTER FOR SR52/SR56—Prints out entire programme, print calculate mode results, prints instructions or results without halting programme execution, trace programme execution step for error detection @ **£175.** 4148 @ **£26.95,** 4190/5190R @ **£36.88.** CAS10 FX201P-II memories 127 steps (programmable) @ **£49.95.** 4 fraction calcs AL8 @ **£13.95,** AL10 @ **£16.40.** FX19 (6+2) @ **£16.95.** FX102 (8+2) @ **£18.40.** HEWLETT PACKARD 21 @ **£60,** 22 @ **£95,** 25 **£106.** 25C @ **£163,** 27 @ **£130,** 67 @ **£368.** 91 @ **£340.** 97 @ **£622.** NOVUS 4520 @ **£22.80,** 4525 @ **£34.90,** 6030 @ **£16.30.** REALTONE SC6010-13 memories 2 levels of brackets scientific statistical rechargeable @ **£45,** SC60 as SC6010 but with 3 memories @ **£34.** ROCKWELL 64RO @ **£22.42,** 44RD @ **£18.40.**


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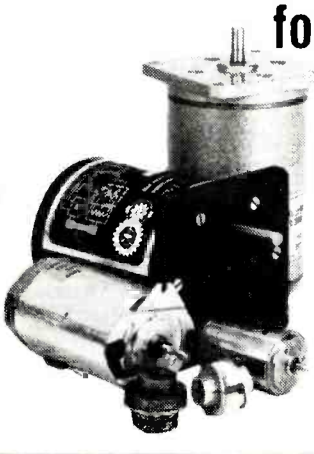

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WW — 105 — FOR FURTHER DETAILS

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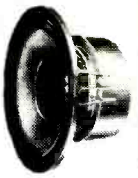
Wilmslow Audio



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Baker Major, 3, 8 or 15 ohm	£15.00
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Goodmans 10P 8 or 15 ohm	£6.95
Goodmans 12P 8 or 15 ohm	£16.50
Goodmans 12P-D 8 or 15 ohm	£18.75
Goodmans 12P-G 8 or 15 ohm	£17.75
Goodmans Audiom 200 8 ohm	£14.95
Goodmans Axent 100 8 ohm	£8.50
Goodmans Axiom 402 8 or 15 ohm	£22.00
Goodmans Twinaxiom 8" 8 or 15 ohm	£10.60
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Kef B110	£10.95
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Kef DN8	£2.75
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Richard Allan CG8T 8" d/c roll/s	£7.95
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Goodmans DIN 20, 4 ohm, each	£15.75
Helme XLK35, pair	£26.75
Helme XLK40, pair	£38.50
Helme XLK30, pair	£21.95
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Richard Allan Triple 8, each	£20.75
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Richard Allan Super Triple, each	£29.50
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Dept. WW

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Access and Barclaycard orders accepted by phone.

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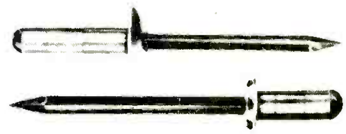
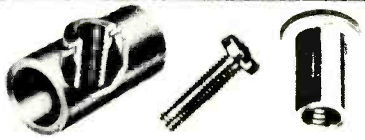
You will know about Blind Rivets



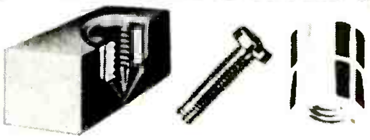
Interesting data and application notes on Blind Rivets—yours for the asking.

Blind Rivets, of course are for making permanent joints in sheets, chassis, corners. What if you need a detachable joint? Read on about Anchor Nuts, blind rivets with internal threads.

To fasten a lid or a panel that has got to come off, you need Anchor Nuts which are used with ordinary screws or bolts.



Anchor Nuts System J, the high strength threadad insert for sheets and sections up to 0.270" 6.86 mm.



Anchor Nuts System X, the threaded insert for sheets, plates, sections of unlimited thickness.

Anchor Nuts are placed in seconds!

It's quick and easy, done on the job with tools similar to riveters. You can buy a hand tool for around £10 or a

kit in a carrying case with a tool and an assortment of Anchor Nuts for about £22. Anchor Nuts cost around £2–£6 a hundred.

There are kits for all regular thread systems, BA, Metric, Whitworth, UNC, UNF.

Data and prices on request.

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MINIATURE PLUG-IN RELAYS (Siemens/Varley) with perspex dust cover and base.
6-12-24-48v D.C. In Stock
2 c/o **50p**: 6 make **60p**
4 c/o **75p**: P & P **10p**

S.T.C. MINIATURE (P.C. Mounting) with dust cover
2 c/o (18/24v) **45p** P.P. **10p**
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6 c/o (36/48v) **75p** P.P. **10p**

CLARE-ELLIOTT MINIATURE RELAYS (Hermatically sealed) 2 c/o 675 ohm
24v D.C. Coils (22 x 22 x 10 mm) **75p**

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3500 ohm coil 24v D.C. **50p**

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Type 2 (48 x 5 mm) 8 for **£1**

G.E.C. RATCHET RELAYS
310 ohm Red or Blue Cam. £1 P.P. **20p**

UNISELECTORS 25 WAY
5 Bank Full Wipe 75 ohm **£5.50** P.P. **50p**
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10lb Pull. 20 mm Stroke. Size 50 x 48 x 42 mm
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£2 P.P. **35p**

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DECADE INDICATOR SWITCHES with plus & minus Push Buttons. 6 mm digits **75p** each P.P. **10p**
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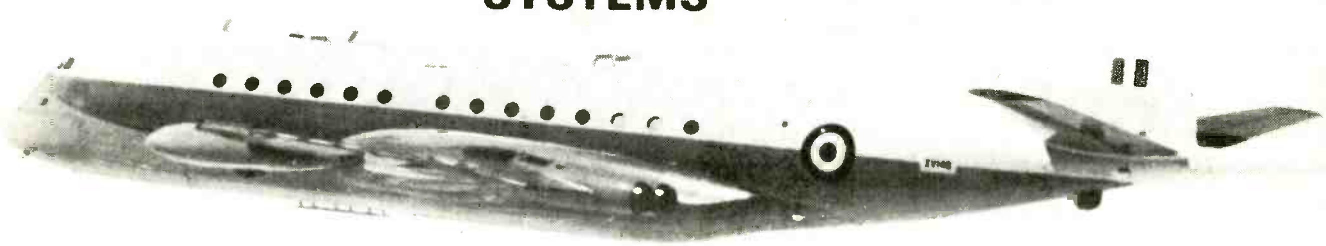

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(7030)

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(7035)

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GEC Computers Limited GEC

(7058)

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Please write to or telephone Richard Black, EMI Limited, Springfield Road Works, Hayes, Middlesex. Telephone 01-573 2701.

(7036)

University of Cambridge
Scott Polar Research Institute

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A vacancy exists in the S.P.R.I. for an experienced Technician to join an active research group engaged in studies of the Antarctic Ice Sheet using 10W frequency Radar backed up by specialist in house computer facilities. While the skills sought are primarily in Electronics, adaptability is important and knowledge of dark room work and machining would be an advantage. Field work is also involved and typically occupies two months a year. The appointment lasts until July 1979 and is at University grade R6 with a salary range of £2695-£3087 per annum. A shorter appointment without field work commitment may alternatively be available at the same salary level.

Applications enclosing curriculum vitae and names of two referees, should be sent to: The Director, Scott Polar Research Institute, Cambridge CB2 1ER.

(7057)

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DEPARTMENT OF ENGINEERING

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Graduate of equivalent required to assist with development work in the field of solid-state technology applied to the control of electrical machines. Some knowledge of electrical machine systems and digital techniques is required.

Suitably qualified applicants would be encouraged to register for a higher degree.

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(7060)

PIPCO
(S & W SERVICES)

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Telex Pipco Hounslow 935413

(6552)

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Cable and Wireless Ltd.,
Theobalds Road, London WC1X 8RX.
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Cable & Wireless

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Engineers are required in the following technical fields:-
Digital and analogue electronic circuitry design.
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Staff Appointments Officer,
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Please quote Ref. WW/1.

FERRANTI

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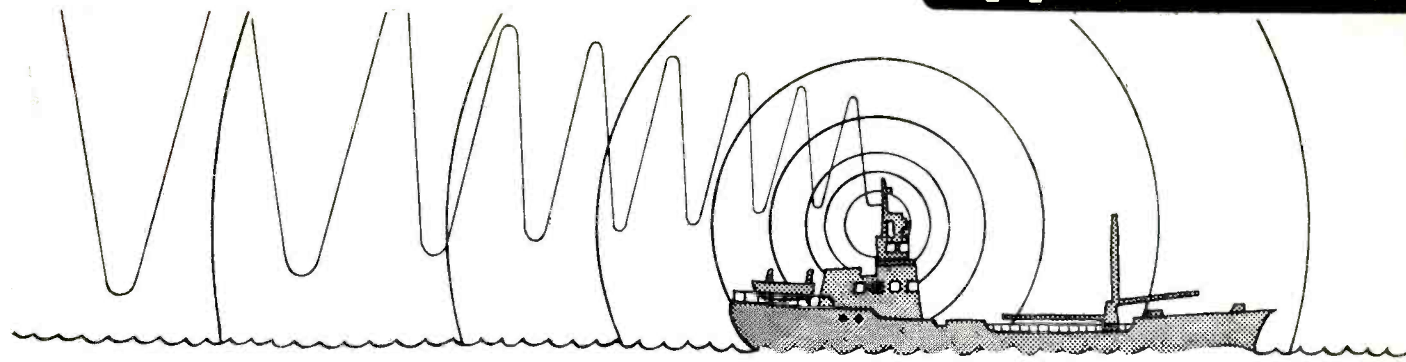

Radio Officers–now you can enjoy the comforts of home.

Working for the Post Office Maritime Services really makes sense. You still do the work that interests you, but with all the advantages of a shore-based job: more time to enjoy home life, job security and good money. To qualify, you need a United Kingdom Maritime Radiocommunication Operator's General Certificate or First Class Certificate of competence in Radiotelegraphy, or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic.

Starting salaries, at 25 or over, are £2905 rising to £3704 after three years service. Between 19 and 24, the starting salary varies from £2234 to £2627 according to age. In addition, a supplement of £312 p.a. is payable. You'll also receive an allowance for shift duties which at the maximum of the scale averages £900 a year and there are opportunities to earn overtime. There's a good pension scheme, sick pay benefits and prospects of promotion to senior management.

Right now we have a few vacancies at some of our coastal radio stations, so if you're 19 or over, preferably with sea-going experience, write to:
ETE Maritime Radio Services Division (L690),
ET 17.1.1.2., Room 643, Union House,
St. Martins-le-Grand, London EC1A 1AR.

Post Office Telecommunications

Senior Audio Visual Engineer

London Airport **C. £4,000 p.a.**

An opportunity exists for an Audio Visual Engineer to fill a senior position in the Heathrow Conference Complex.

The successful applicant will have experience in the operation and maintenance of CCTV and colour studio equipment including broadcast cameras and 1" helical scan VTR and will also possess both the ability and the willingness to train less experienced engineers.

This is a small, highly skilled team whose responsibility it is to present the most sophisticated conferences in the United Kingdom.

Please apply with brief personal and career details to the Personnel Dept., The Heathrow Hotel, Bath Road, Heathrow, Hounslow, Middlesex, TW6 2AQ, or telephone 01-897 6363/2419 for an application form. (7002)

The Heathrow Hotel

The only hotel on London Airport.

RADIO TECHNICIANS

Government Communications Headquarters has vacancies for Radio Technicians. Applicants should be 19 or over.

Standards required call for a sound knowledge of the principles of electricity and radio, together with 2 years experience of using and maintaining radio and electronic test gear.

Duties cover highly skilled Telecommunications/electronic work, indluding the construction, installation, maintenance and testing of radio and radar telecommunications equipment and advanced computer an analytic machinery.

Qualifications: Candidates must hold either the City and Guilds Telecommunications Part I (Intermediate) Certificate or equivalent HM Forces qualification.

Salary scale from £2,230 at 19 to £2,905 at 25 (highest pay on entry), rising to £3,385 with opportunity for advancement to higher grades up to £3,780 with a few posts carrying still higher salaries. Pay supplement of £313.20 per annum.

Annual Leave allowance is 4 weeks rising to 6 weeks after 27 years' service.

Opportunities for service overseas.

Candidates must be UK residents.

Further particulars and Application forms available from:

Recruitment Officer
Government Communications Headquarters
Oakley, Priors Road
CHELTENHAM, Glos GL52 5AJ
Tel. Cheltenham 21491 Ext. 2270
(STD 0242-21401)

(7028)

SCOTTISH HOME AND HEALTH DEPARTMENT

WIRELESS TECHNICIAN

Applications are invited for a post of Wireless Technician in Scottish Home and Health Department.

Location: Inverness.

Qualifications: Candidates must hold an Ordinary National Certificate in Electronic or Electrical Engineering **or** a City and Guilds of London Institute Certificate in an appropriate subject **or** a qualification of a higher or equivalent standard.

Experience: 3 years' appropriate experience.

Starting Salary: £2,010 (age 17) to £2,905 (age 25 or over), scale maximum £3,385.

In addition a supplement of £313.20 per annum is payable for staff aged 18 or over (£261.00 per annum for staff aged 17). Applicants should have sound theoretical and practical knowledge of Radio Engineering and Radio Communications equipment in HF, VHF and UHF bands. The work involves installation and maintenance of equipment located at considerable distance from headquarters. A clean, current driving licence and ability to drive private and commercial vehicles are essential.

Appointment is unestablished initially but there is prospect of an established (ie permanent) appointment after 1 year's satisfactory service.

Application forms and further information are obtainable from Scottish Office Personnel Division, Room 105, 22/25 Queen Street, Edinburgh, EH2 1LY (quote ref: PM(PTS)2/1/77) (031-556 9222, Ext 727).

Closing date for receipt of completed application forms is 24 February 1977

(7013)

ELECTRONICS OVERSEAS

Airport Systems
High tax-free salaries

International Aeradio Limited, a world leader in communications and aviation services, is offering immediate career opportunities overseas to experienced electronics engineers.
Vacancies exist in the following areas of operation:

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Including ILS, CADF, VOR, DME, NDB, Control Tower Installations.

ATC RADAR

Approach and long range surveillance equipment plus SSR, HF, VHF and UHF radio equipments.

Applicants should be qualified to ONC or C&G (Telecomms) with a minimum of five years' maintenance experience either in a military or civil environment.

Excellent tax free salaries are offered and other benefits include: Free Housing · Married accompanied status · Child/Education allowances · Pension/sickness schemes.

Write or telephone for an application form to: John Callow, Senior Recruitment Engineer, International Aeradio Limited, Aeradio House, Hayes Road, Southall, Middx. Tel: 01-571 1808.

IAL

Electronic Engineer

Sonarmarine — a member of the BP Group — is a new survey company, situated near London Airport, whose business is surveying for the offshore oil industry.

The company is looking for an Electronic Engineer, qualified to HNC standard or equivalent, to be responsible to the Equipment Maintenance Supervisor for marine survey equipment.

Candidates must have considerable practical experience and the ability to work down to component level on a wide variety of digital and analogue equipment used in marine surveys.

Salary is dependent on experience and the company has a non-contributory pension scheme. Please write enclosing a c.v. to The Manager, Central Recruitment, Britannic House, Moor Lane, London, EC2Y 9BU.

(7012)

SONARMARINE

RADIO TECHNICIANS

The Home Office requires Radio Technicians in its Directorate of Radio Technology in Central London, Stanmore, Middlesex and Baldock, Hertfordshire. Radio Technicians in London and Baldock carry out installation, maintenance, modification and construction of complex specialised radio communications equipment and systems. The duties at Stanmore include work on radio interference measurement; constructing prototype models (including the mechanical construction) from engineering sketches and circuit diagrams. Applicants should be familiar with commonly used electronic and radio components and with test equipment such as oscilloscopes and signal generators.

Qualifications and Experience

Candidates must possess either a City & Guilds Intermediate Telecommunications Technicians or Engineering Certificate, a relevant ONC or equivalent qualification. Candidates should also have had 1 year's practical workshop experience.

Salary

is £2,010 a year at 17, £2,450 at 25 or over on entry, rising to a maximum of £3,385 plus a pay supplement of £313.20 and a London Weighting Allowance of £465 a year for those employed in Central London and £275 a year for those employed at Stanmore.

A Secure Future

with a non-contributory pension scheme, prospects of promotion, generous leave allowance, further education facilities and a 5 day week of 41 hours.

Interested?

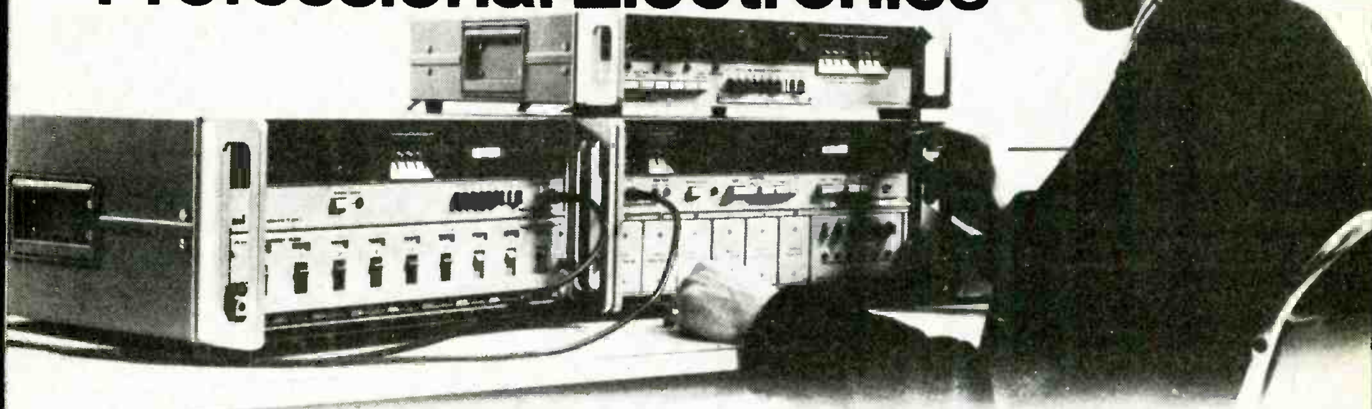
Then write or telephone for application forms (for return by 16th March, 1977) and further details to:— Mr J J Willis, Directorate of Radio Technology, Room 514, Waterloo Bridge House, Waterloo Road, London SE1 8UA. Telephone: 01-275 3006.

(7034)

Home Office

mi

Careers in Professional Electronics



Your experience could open the door to a range of interesting and rewarding opportunities in the Design, Production or Service departments of a Company whose products complement the most advanced modern electronic techniques.

For more information apply in confidence to :– John Prodger,

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Longacres, St. Albans, Herts. Tel: St. Albans 59292
A GEC-Marconi Electronics Company

(7055)

UNIVERSITY OF THE WEST INDIES — JAMAICA

SENIOR LABORATORY TECHNOLOGIST

A vacancy exists for a Senior Laboratory Technologist at the Electronics Laboratory of the University of the West Indies, Mona.

The successful applicant will be required to repair and maintain a variety of electro-mechanical and electro-optical instruments. He/she will also be required to provide technical support to two Electronic Engineers engaged in the maintenance and design of Electronic instrumentation.

Qualifications: Candidates must have a full Technological Certificate, (HNC, City and Guilds or equivalent) and at least five years' experience in bench fitting and small instrument making.

Salary Scale: J$6000-9372 per annum (£1 sterling = J 1.53).

Benefits include generous Superannuation Scheme, subsidised medical attention and 10% Marriage allowance for male married employees.

Applications should be addressed to the Personnel Officer, Registry, University of the West Indies, Mona, Kingston 7, Jamaica, West Indies, giving details of present qualifications and experience, together with the names of two referees acquainted with the candidates technical competence.

(7003)

Industrial Tape Applications require

ELECTRONIC and ELECTRO MECHANICAL ENGINEER

for design and development of equipment relating to the recording industry. An attractive salary is offered to the successful applicant who will be required to see projects right through to production.

Please phone
01-485 6162/7833

7007

Loudspeaker Technician/Engineer

Tannoy Products Limited, the international name in the field of audio electronics, are looking for an enthusiastic Technician / Engineer to join their Hi-Fi Laboratory at Tylers Green, High Wycombe, Bucks. The successful candidate will be responsible for the construction of experimental and prototype loudspeaker assemblies working with a dedicated design and development team under minimum supervision.

Candidates should have a self-motivated practical approach with attention to detail and possess some knowledge of modern materials, adhesives and current process technology. Experience with loudspeaker drivers and systems is desirable together with an understanding of their performance assessment.

Salary will be up to £4,000 per annum. Generous benefits include assistance with relocation expenses where appropriate, and 4 weeks' holiday. The company has recently moved its Design and Development Laboratories to a pleasant rural area and offers excellent conditions of employment.

For further details and application form, please contact the Personnel Manager, Mrs. D. Jennery, or the Chief Engineer, Alex Garner, at Tannoy Products Limited, St. John's Road, Tylers Green, High Wycombe, Bucks. Tel. Penn 5221.

(7023)

TANNOY

MEDIA ELECTRONIC HOLDINGS LIMITED
MERCURY MOBILES

PROJECT ENGINEER

Mercury Mobiles require project engineers for their television systems group. The work involves TV system design, implementation and commissioning, possibly on customers premises, of broadcast OB vehicles and studios.

Prospective candidates should have a formal engineering qualification and experience of broadcast television engineering. Overseas travel, occasionally for extended periods, could be involved.

Replies in writing to:

Mr. J. M. Gibson
Engineering Manager
Mercury Mobiles
Woodland Ind. Estate
Eden Vale Road
Westbury, Wilts.

(7047)

TELEVISION

and Film Unit to be a member of a team operating and maintaining television equipment of professional standards. Experience of VTR and Teleciné work an advantage.

Salary scale £2889-£3367. Ref. 65/C/.

Application forms from
Assistant Secretary
Personnel Office
University of Birmingham
P.O. Box 363
Birmingham B15 2TT

7018

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Applications in writing to

Stan Horobin
Chief Engineer
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Victoria Road
Gowerton
Swansea

(7051)

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KEF

ELECTRONICS TECHNICIAN

KEF Electronics is an expanding company specialising in the manufacture of high quality loudspeakers.

An Electronics Technician is required to build and maintain sophisticated analogue and digital audio test equipment for use in both factory and laboratory.

We are looking for someone with considerable relevant experience and proven practical ability.

The salary will be negotiable.

Please write initially, giving personal details including age, qualifications and experience, to Dr. J. M. Berman, KEF Electronics Ltd., Tovil, Maidstone, Kent. (7040)

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TECHNICAL AUTHORS
SYSTEMS PROGRAMMERS
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and BUYERS

Please write or ring- **CBS APPOINTMENTS**
224 Old Christchurch Rd., Bournemouth. Bournemouth 292155 or Wimborne 4891 after 7 p.m. (7052)

LABORATORY TECHNICIANS

BBC Engineering, Designs Department, requires Technicians for Central London Laboratories.

Duties include assisting Engineers with the development, construction and testing of sound and television broadcasting equipment.

The successful candidates will probably be in their twenties and have a keen interest in, and at least two years practical experience of, electronics. They will have at least ONC or City and Guilds Part II or equivalent.

Salary according to qualifications and experience in the range £2784 – £3318 rising to a maximum of £3696 per annum (plus from £10.86 to £17.38 per month Pay Supplement according to earnings under current Incomes Policy).

Good opportunities for promotion.

Pensionable posts. Good restaurant and Club facilities.

Write for application form to **Engineering Recruitment Officer, BBC, Broadcasting House, London W1A 1AA,** quoting reference number 77.E.4005/WW and enclosing a self addressed envelope at least 9″x 4″.

BBC

ITN

VISION ENGINEER

A vacancy exists in the Vision MaintenanceDepartment of our West End Studios for an engineer to work on a wide range of broadcasting equipment including Vision Mixers, Computers, Digital Character Generators, as well as conventional Colour Coding, Decoding and Distribution systems.

We hope to recruit someone aged around 30 with wide relevant experience and qualifications to HNC level but, failing such an applicant, we are prepared to consider those with lesser qualifications for engagement at trainee level.

For further information, please apply to the Personnel Department of Independent Television News Ltd. on 01-637 3144. (7032)

AUDIO ELECTRONICS ENGINEER

A vacancy exists for a junior technican working with a young team in a London-based professional recording studio.

Duties will include assisting in the service and maintenance of complex audio equipment, and the design and construction of electronic devices.

The position includes possibility of European travel.

For further details and application form, please apply to **Peter Smith, LA MAISON ROUGE, 388 Oxford Street, London, W.1. Telephone: 01-408 2075.** (7039)

CHARING CROSS HOSPITAL MEDICAL SCHOOL
(University of London)

ELECTRONICS TECHNICIAN

required in the Department of Physiology for the construction and maintenance of electronic equipment. The successful applicant will have the opportunity to assist in the neurophysiological research project.

Applicants should hold HNC or equivalent. Salary on scale £2,823-£4,050 plus £354 London Weighting Allowance. Further details and application forms obtainable from the Secretary, Charing Cross Hospital Medical School, The Reynolds Building, St. Dunstan's Road, London W6 8RP, quoting ref 014. Closing date March 7th. (7045)

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34, Percy St. London, W.1.

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MAINTENANCE ENGINEER to work within West London film dubbing complex duties include construction and installation of all types of recording equipment. Box No. W/W 7014.

SCANNING THE ADVERTS to see what's going? If you are, we could be offering the best opportunity you've seen yet. We need a technically knowledgeable person who has a flair for writing, to train as assistant editor for one of our hi-fi magazines — and good assistant editors can progress rapidly to editors in our organisation. The post will probably most appeal to someone already in the trade/customer liaison department of a hi-fi orientated company but could be equally suitable to someone finishing a course or involved in retailing. — Write to Hugh Johnstone, Haymarket Publishing Ltd., 54-62 Regent Street, London W1. (7050)

Iran Telecommunications

OSCO – The Oil Service Company of Iran, a Consortium of International Oil Companies engaged in the exploration and production of oil and gas for the National Iranian Oil Company have the following vacancies:

Head Telecommunications Special Projects

(US $30,000 per annum nett)

Responsible for the planning, co-ordinating and management of the telecommunication projects which include:- microwave, UHF, VHF and HF radio systems, trunk line and cable carrier systems, telegraph networks, telephone exchanges and local telephone line distribution.

Candidates should be graduates in Electronics/Telecommunications and have at least 10 to 12 years experience in telecommunication engineering and administration with at least 5 years at supervisory level.

Head Telecommunications Services

(US $25,000 per annum nett)

Responsible for all-over supervision and control of the drilling radio operation, maintenance of exchange and line, trunk telephone/telegraph network and all radio and electronic systems throughout the area of operations.

Candidates should be graduates in Electronics/Telecommunications with at least 10 years experience in all telecommunication engineering aspects including administration with at least 5 years at supervisory level. Must additionally have experience relating to radio band/frequency and a good background of radio, exchange and line maintenance.

Both appointments will be located in Ahwaz in South-West Iran and the tour of duty will be for two years with a possibility of extension.

In addition to a generous salary free of local Income Tax, the following benefits will apply:

1. Married accommodation available after short initial period of single status.
2. Free medical attention in Iran for staff and families.
3. Home leave earned at the rate of 4 days per month of foreign service.
4. Primary schooling available locally.
5. Financial assistance towards boarding school costs.
6. Additional school children's passages for children at boarding school in the country of origin.
7. Substantial terminal bonus on satisfactory completion of contract.

Iranian applicants will be considered under the regulations existing for the employment of Iranian staff.

Please forward full details of experience and qualifications to Brian Doyle, Selection Consultant, Ref. 8381/WW,
Whites Recruitment Limited,
72 Fleet Street, London EC4Y 1JS.

THE FASTEST GROWING AIRLINE IN THE MIDDLE EAST

Saudia, the airline of the Kingdom of Saudi Arabia, is seeking, as part of a planned programme of expansion, two thoroughly experienced technicians, aged under 45, to sustain the existing level of operations and also to work on new communications equipment which is currently being installed.

SENIOR TELEPRINTER TECHNICIAN

Starting salary c. £7,600 (income tax free)

Duties will include:

- routine and complex maintenance and repair of teleprinter equipment
- the installation of circuitry and teleprinter machines
- conducting periodic tests to check the quality of the teleprinter circuitry
- routine preventative maintenance on equipment and machinery
- the maintenance of service records for equipment in use
- maintenance and revision of technical manuals

Applicants should hold a certificate of training in the field of teleprinter/system maintenance and have 3-5 years practical experience. (Please quote reference A-503-762 when applying for this job).

SENIOR RADIO TECHNICIAN

Starting salary c. £7,600 (income tax free)

Duties will include:

- routine maintenance and troubleshooting on radio equipment– eg. UHF/VHF/HF mobile communications equipment, public address systems, etc.
- work on communications system installations including antennas, feeder lines, power lines and cables
- the maintenance of technical journals
- keeping up-to-date regarding state of the art procedures in electronics maintenance
- field trips
- the maintenance of service records on equipment and logs of the utilisation of spare parts
- participation in on-job training of Saudi National employees

Applicants should have completed a trade school course or have equivalent experience. 3-5 years experience of electronics equipment servicing is essential. (Please quote reference A-504-762 when applying for this job).

These jobs, which are for a 2 year (renewable) contract period, are based in Jeddah. Saudia offer excellent (income tax free) salaries together with free unfurnished accommodation for you and your families, free and reduced air tickets, 40 days leave per annum and a re-location allowance.

Please write, with full personal and career details, or telephone for an application form, quoting the appropriate reference, to:

Miss Connie Mulshaw,
Saudia's U.K. Personnel Representative,
Saudi Arabian Airlines,
Room 216, 93, Regent Street,
London W.1. Tel: 01-439 1661.

Closing date for completed applications 24th January 1977.

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- ★ EMI TR90 2 speeds, 1 track ½"
- ★ EMI BTR1, 1 speed, 1 track ¼"
- ★ EMI R301G, 2 speeds, 2 tracks ¼"
- ★ EMI RE321 ¼", 7½" 1 track
- ★ Ficord 1A ¼", 1¾", 7½", 1 track
- ★ Mincom CMP-100, 6 speeds, 7 tracks ¼, ½, 1"
- ★ Leevers Rich DA-2P, 2 speeds, 2 tracks ½"
- ★ Leevers Rich Console 2 track ¼", 2 speeds
- ★ Office Machines, various dictating

Prices of above £40 to £400

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★ 100 amp Belling Lee Interference Filters	£75
★ Solartron CD1014 Oscilloscopes	£60
★ Marconi TF2331 Distortion Meters	£120
★ AVO VT Voltmeters CT-471A	£75
★ Solartron Digital Voltmeters LM 1420/2	£175
★ Twin Notch Filters 500/1600 mcs	£12
★ Racal MA197 Pre-Selectors	£65
★ Marconi TF-888 Receiver Testers	£60
★ Collins 500 watt 2/18 mcs Transmitters	£1000
★ Collins KWT6 SSB 500w Transceivers	£1250
★ Collins KWT6 200 m/w AM Transceivers	£750
★ STC Rx5 2/25 mcs Receivers Diversity	£140
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★ Gaumont Kalee 564 Flutter Meters	£75
★ Hewlett Packard 618B Sig Gen 3.8/7.2 GHz	£120
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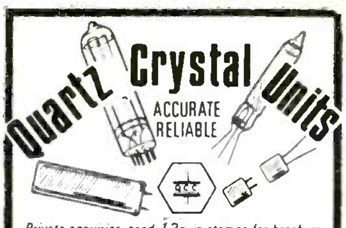

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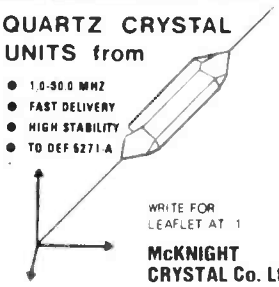

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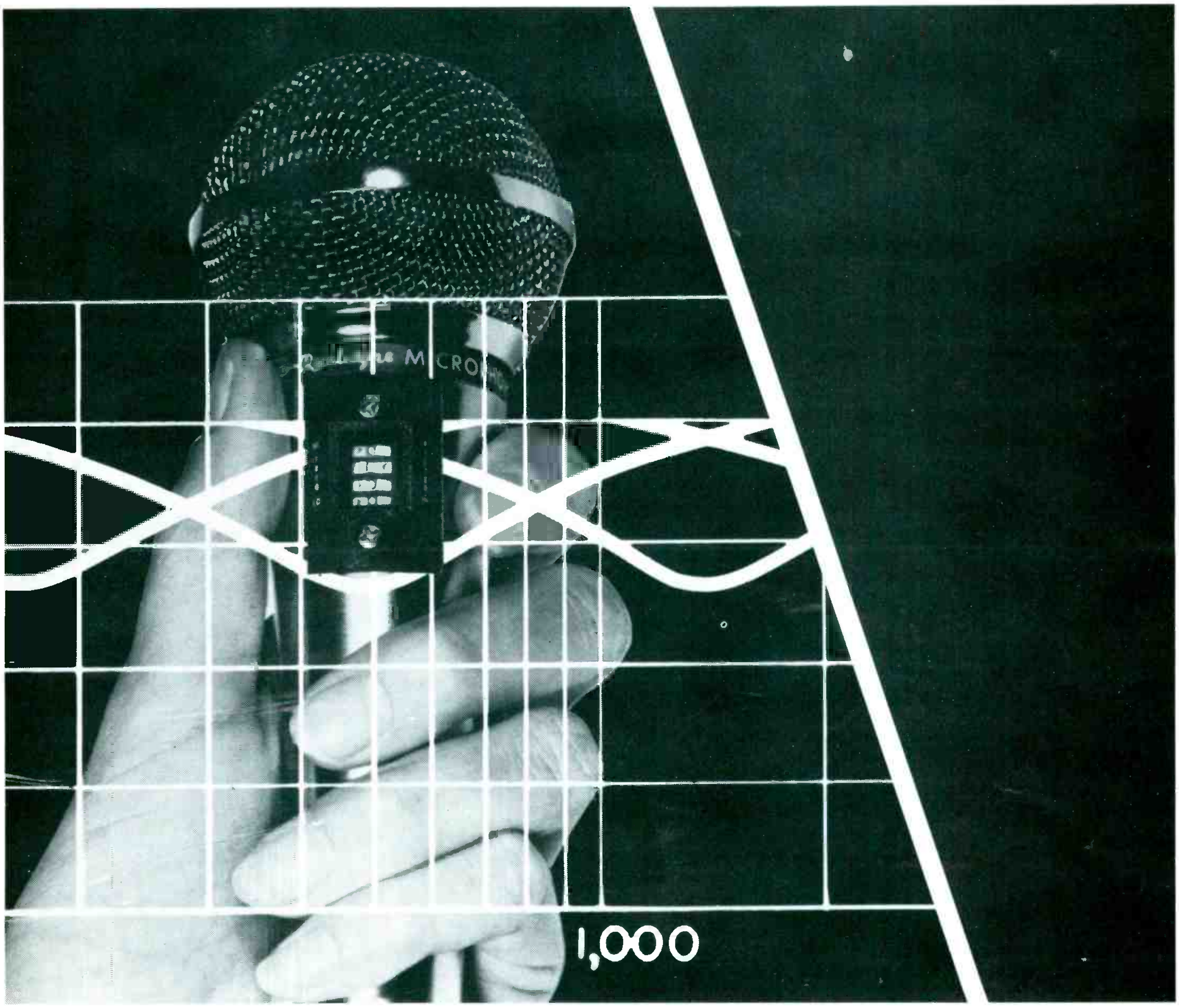
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Multicore–
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Most printed circuit soldering problems can be avoided by using quality products and seeking quality advice. Naturally, we suggest ours. First, let's talk about quality products.

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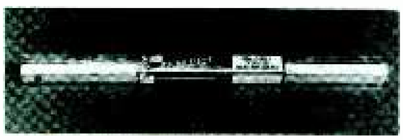
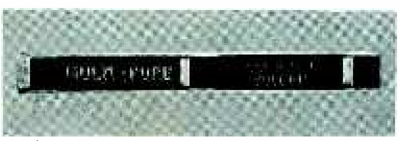
EXTRUSOL Extruded Bars and MULTI-PURE Cast Bars are made from specially processed ultra high purity solder. EXTRUSOL bars and pellets are protected by plastic film from the moment they are made to the moment they are used. And MULTI-PURE bars are probably the smoothest and brightest solder bars you will ever see.





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ERSIN Flux No.	Type	Solids Content w/w	Specifications
ROSIN BASE			
0360	non-activated	38%	MIL-F-14256D Type R; DTD 599A DIN 8527 F-SW 31
5381	mildly activated Chloride and Bromide free	25%	MIL-F-14256D Type RMA; DTD 599A
304D	mildly activated	10%	DIN 8527 Type F-SW 32
304W	Halide Free	25%	DTD 599A
PC.21A	activated	38%	DTD 599A; DIN 8527.F-SW 26
PC.26	activated (extra fast)	15%	DTD 599A; DIN 8527.F-SW 26
366	activated (extra fast)	38%	Meet DIN 8511 Type F-SW 26 and
366A-25	activated (extra fast)	25%	pass DTD 599A Corrosion Test
ORGANIC ACID			
PC.101	water base	12%	Water soluble residues must
PC.112	solvent base, fast drying	9.5%	be removed after soldering.
INORGANIC ACID			
ARAX	water base extremely active	40%	Used with most "very difficult to solder" metals. Not for electronics assembly joints.

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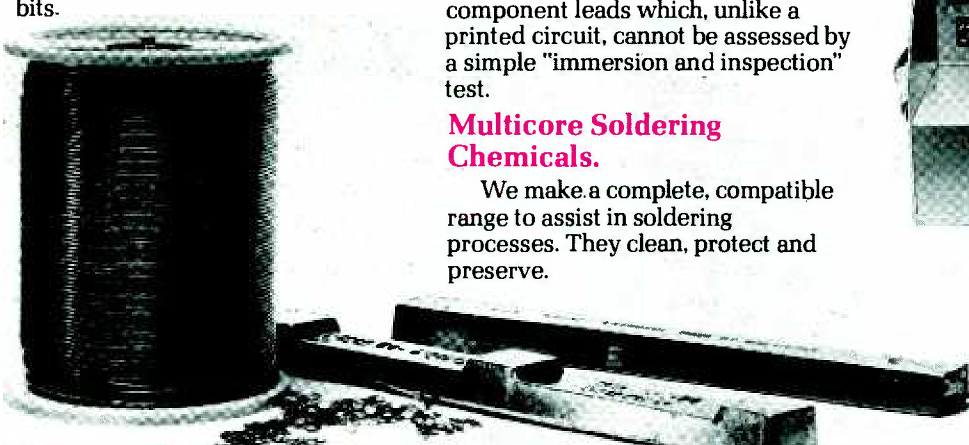

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