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Normal sockets **$79.95**
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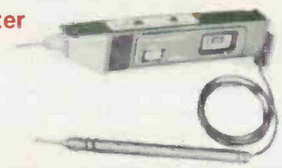

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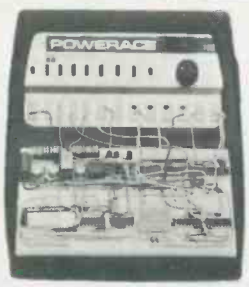

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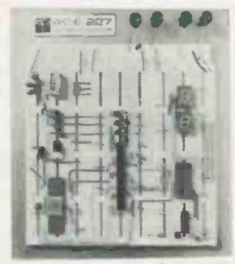

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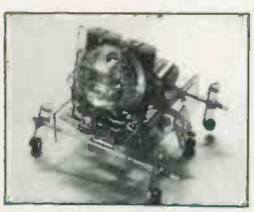

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Electronics Today INTERNATIONAL

Audit Bureau of Circulation

September 1984 Vol. 8. No. 9 ISSN 07038984

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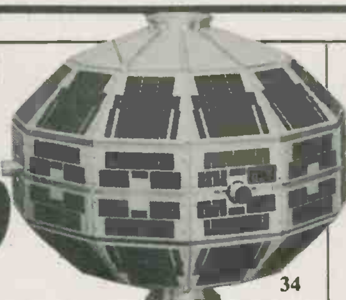

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Features

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Columns, News and Information

Our Cover

A new computerized Sony shortwave receiver is dwarfed by an RCA radio of yesteryear. The IBM PCjr is reviewed on page 26. Photos by Bill Markwick.

Electronics Today is Published by:
Moorshead Publications
Editorial and Advertising Offices
Suite 601, 25 Overlea Boulevard,
Toronto, Ontario, M4H 1B1
Telephone (416) 423-3262

Editor: **William Markwick**
Editorial Assistant: **Edward Zapletal**
Director of Production: **Erik Blomkwist**
Creative Manager: **Ann Rodrigues**
Production: **Douglas Goddard, Neville Willams, Naznin Sunderji**
Circulation Manager: **Lisa Salvatori**
Advertising: **Omar Vogt, Rick May, Claire Zyvitski**
Advertising (Que.): **John McGowan & Associates (514)735-5191**

Publisher: H.W. Moorshead; **Executive Vice-President:** V.K. Marskell; **General Manager:** S. Harrison; **Controller:** B. Shankman; **Accounts:** P. Dunphy; **Reader Service:** C. Wyatt, S. Halladay, H. Brooks, K. Adams; **Advertising Services:** D. Whitehead; **Dealer Services:** A. Nagels.

Newsstand Distribution:
Master Media, Oakville, Ontario

Subscriptions
$19.95 (one year), $34.95 (two years). For US add $3.00 per year, other countries add $5.00 per year. Please specify if subscription is new or a renewal.

Postal Information
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Circle No. 48 on Reader Service Card.

Component Tracer

Heathkit's IT-2232 Component Tracer allows a user to test individual components or entire circuits without the need of circuit power. On a 3-inch CRT, the Tracer displays the electrical characteristics of a component or a circuit under test. Dual displays allow comparisons between good and suspect devices for quick, easy and reliable checks. Two voltage ranges are provided for varying test situtations and are current limited to protect the circuit or component under test. Two sets of colour-coded test leads are supplied. The IT-2232 Component Tracer features two separate inputs that can be viewed as individual traces or together in a superimposed display. One channel is seen as a solid line, while the second is converted into a unique dotted line display by a special patent-pending circuit. In the A/B mode of operation, the superimposed solid- and dotted-line traces allow the user to compare good and suspect units. Any differences in electrical characteristics are clearly identified, providing a visual check of the condition of the circuit. Write to Heath Company, 1020 Islington Ave., Dept. 3100, Toronto, Ontario, M8Z 5Z3. Free catalogues are also available at 65 Heathkit Electronic Centers in the U.S. and Canada.

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Sparkomatic Canada, Inc., Markham, Ont., has added a 13-item accessory package program to its car stereo line. Included in the program are 3 noise filter kits, a universal in-dash car stereo mounting trim kit that fits Ford, Chrysler and GM cars for use with virtually any car stereo unit, a line of cable kits for high power car stereo systems and speaker wire kits, replacement speaker grilles, and other accessories.

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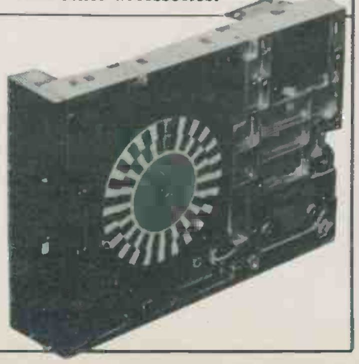

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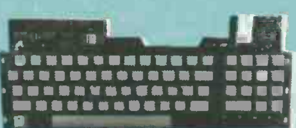

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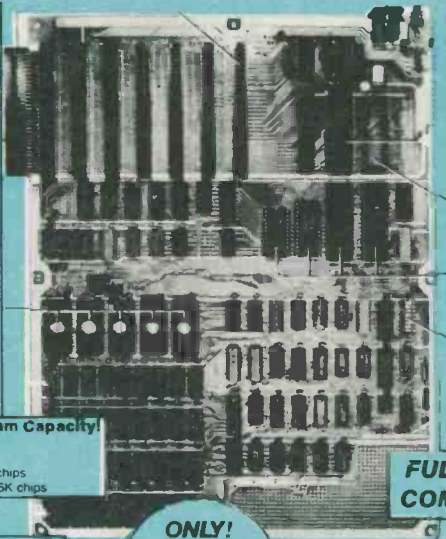

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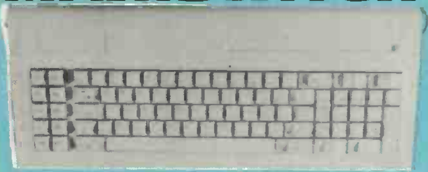

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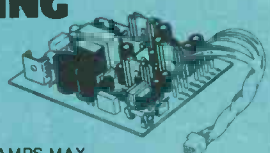

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What's Happening in Shortwave

Despite satellites and other hi-tech, shortwave broadcasting remains one of the most useful communications methods.

Computer Weather Maps

Fax, or facsimile, is the process of sending images by shortwave radio. It's like an extremely slow television broadcast, with the limited bandwidth restricting the printout speed to one frame every few minutes. In the case of weather maps, data from satellites is collected by various weather services and a map produced. The map is then scanned with a photocell; the resulting electrical impulses can then be re-transmitted via shortwave (or landlines) to mariners, airports, etc. The maps can then be reconstructed mechanically by beaming the received pulses onto a rotating drum of photosensitive paper, or electronically by decoding them via a computer/printer.

Electronics Today is investigating a project (and software) that will display weather maps using a shortwave receiver, a demodulator, and a micro. In the meantime, dedicated tinkerers may want to experiment with the broadcasts: you can find the map service from Washington, DC, on 3356, 4975, 8080, and 10865 KHz. If you'd like to try down-under reception, Australia broadcasts on 5100, 11030, 13920, and 19690 KHz. The maps are generally scanned at 120 lines per minute, though there isn't any international standard, and the rates may vary.

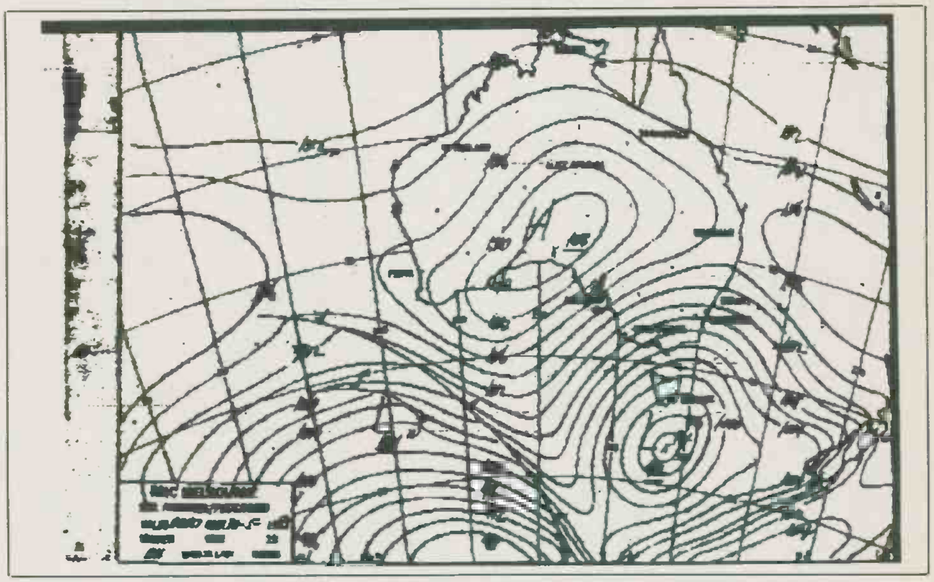

Fig. 1. A weather map from station AXM, Australia, decoded by microcomputer.

RTTY

Radio-teletype is used by news services to send text; the system is a bit antiquated, being designed around the mechanical teletypes of yester-year, but there's a lot of information on the airwaves if you care to experiment. Again, Electronics Today is considering a project and software to allow the display of RTTY text on a computer screen. Stay tuned, so to speak.

RTTY uses a frequency-shift-keying method to encode the stream of high and low bits; two audio tones are transmitted, one for a high and another for a low. The frequency shifting can be detected by a discriminator or phase-locked-loop and converting to serial bitstream. Teletypes use various standards for the encoding, from 45 to 100 baud. However, they don't resemble the usual 10-bit "byte" sent by computer modems; a 5-bit code called BAUDOT is used, giving 32 possible alphabetic characters. To send numbers, a special character is sent to let the equipment know that the next byte to be transmitted will represent a numeral.

Converting this to computer-readable form is a challenge, but until our PLL project is ready, diehards can find text on, for instance, 13779 KHz (Voice of America) or 16100 KHz (Chinese News Agency).

Commercial Shortwave

Despite all the publicity received by satellites, shortwave remains the simplest way to get broadcasts to remote areas. Canada's northland is served by several sources: the Canadian Broadcasting Cor-

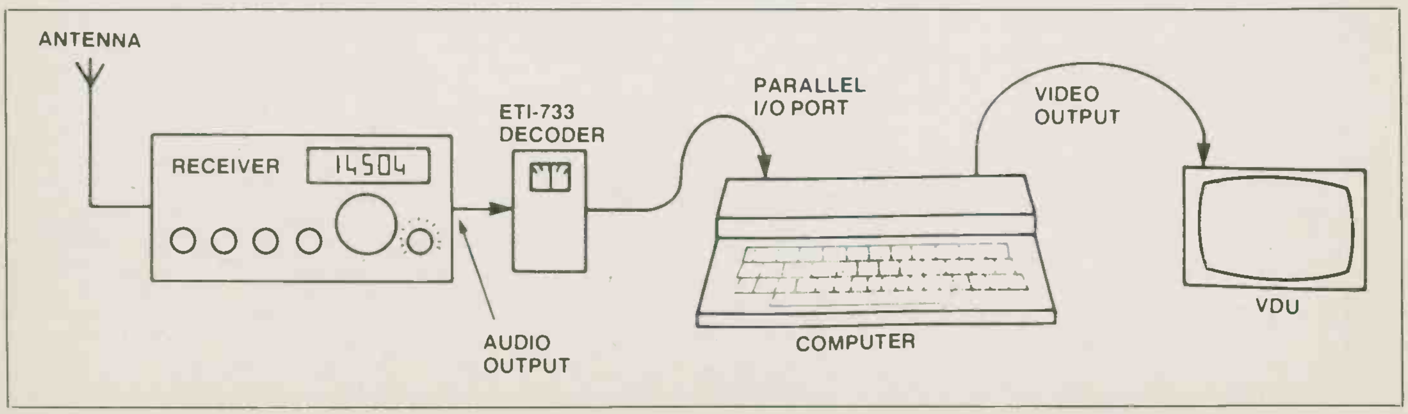

Fig. 2. A typical hookup for decoding radio-teletype via computer.

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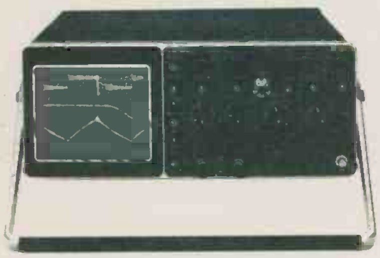

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poration's Northern Service, and a rebroadcast of various privately-owned stations.

The CBC's shortwave service is known as Radio Canada Internationl, and they broadcast on a wide number of frequencies between 6 and 21 MHz. Programming originates in Montreal and is relayed by microwave to transmitters at Sackville, New Brunswick. The broadcasts to Northern Canada are in English, French, Eskimo, and Cree; some of the frequencies are (in KHz): 9625, 6065, 6195, and 11720. As you'd expect from the name, there is wide international coverage in many languages. The Montreal signal is sent via undersea cable to transmitters in the UK and Portugal.

There are at least four shortwave rebroadcasts of privately-owned stations: Toronto's CFRB on 6070 KHz, Montreal's CFCF on 6005, Calgary's CFCN on 6030, and Halifax's CHNS on 6130. The transmitting power isn't much by commercial AM standards — 0.5 to 1 kW. However, under good atmospheric conditions, you should be able to tune in to a big-city broadcast as you put up your wilderness tent.

For a comprehensive listing of the world's broadcasters, we recommend the World Radio TV Handbook, available at specialist bookstores, or contact Billboard Publications, One Astor Plaza, New York, NY 10036. **ETI**

An Important Announcement To Advertisers and Readers of Computing Now! and Electronics Today

The October issue of Computing Now! and Electronics Today will feature the Directory of Microcomputer and Electronic Retailers in Canada.

This semi-annual update will not only supply name, address and telephone listings for a combined total of over 1200 outlets but will inform readers and advertisers of the product line offered by each outlet and whether catalogues are available on request.

For advertisers, these issues offer a special opportunity to display their message to not only the thousands of regular readers of Electronics Today and Computing Now! from coast-to-coast but also the many additional readers and companies who purchase these special issues for permanent record and for distribution to staff. For readers, there is the opportunity to find out about the many new outlets that have surfaced since the last update.

Additional copies of these issues will be available on a bulk copy basis and orders should be forwarded now to the Circulation Manager of each publication. For advertising space reservations contact should be made immediately with Omar Vogt, Rick May, or Claire Zyvitski at (416) 423-3262. Time is of the essence to avoid disappointment.

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Audio Recording

Linsley Hood enlightens us on the ins and outs of audio recording.

ALTHOUGH the tape recorder in its cassette form is almost taken for granted, in reality, recording on magnetic tape is beset with so many problems, and hedged around with so many restrictions and limitations, that it is surprising that it even works at all, let alone that it gives the superb results, which, when all is done well, it can!

Having said that, it is difficult to find any description of this technique which explains these problems and limitations in a way which is easy to follow. So before I proceed to look at the types of circuitry which are needed for tape recording, I propose to try to explain, as simply and lucidly as I can, just what it is that we need to do.

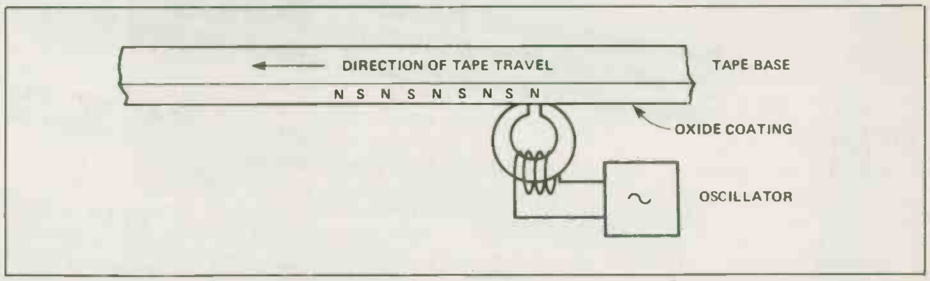


Fig. 1. The basic principle of tape recording.

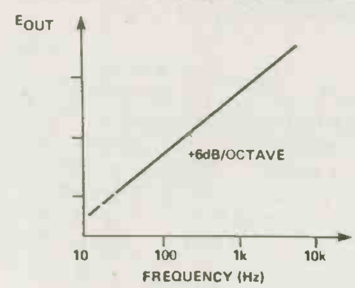


Fig. 2. The theoretical AC output from a tape replay head.

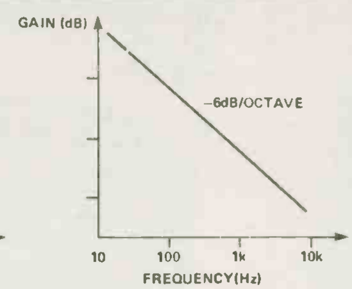


Fig. 3. An idealized replay amplifier characteristic.

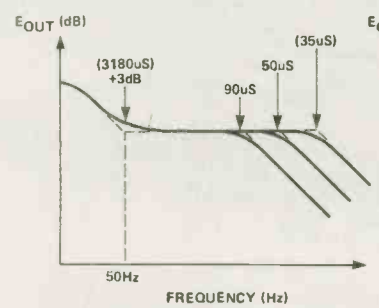


Fig. 4. NAB recommended record characteristics (effective).

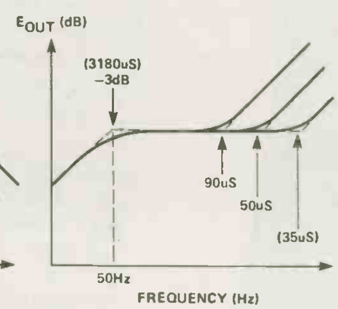


Fig. 5. NAB recommended replay response (effective).

The Process

If we pull a piece of unmagnetized iron oxide coated tape past a recording head, as in Fig. 1, and we apply an alternating current to the electrical winding on this head, we will leave a series of magnetized regions, as indicated by N-S-N-S-N-S..., produced by the magnetic field at the trailing edge of the record head gap. These will have a 'wavelength' along the tape given by λ = tape speed (ins/sec)/frequency (Hz). If we try to replay this, with a head having a gap length X, we will have zero output when X = λ , since both ends of the gap will be sitting on parts of the tape which are identically magnetized (i.e., both N or both S). This is **Problem No. 1:** the gap length of the replay head imposes an absolute limit on the upper frequency response.

It is a characteristic of magnetic induction that the voltage induced in a coil of wire is linearly proportional to the speed with which the magnetic flux through that coil is changed. In mathematical terms, this is expressed as $V = L.dB/dt$; where L is the inductance, B is the flux density, and t is time. (d/dt is the mathematical notation for a rate of change with time).

The result of this is that if we were to record at a constant remanent flux level on the tape, which we will assume will be given by a constant level of (RMS) current through the record head, we will end up with a replay characteristic as shown in Fig. 2, in which the output increases linearly with frequency. This will necessitate a replay characteristic such as in Fig. 3, if we are to get a level final frequency response; this, in itself, would not present any great circuitry difficulty.

In the same way in which an internationally agreed standard is employed in the manufacture and replay equalization used for 33 RPM and 45 RPM records, (the RIAA standard) there is an internationally accepted standard for record and replay equalization for tape and cassette recording (the NAB standard). This requires effective record and replay characteristics of the type shown, with the appropriate time-constants for the turnover points on the frequency scale, in Figs. 4 and 5. When the replay equalization curve is superimposed on the curve of Fig. 3, we get the practical replay equalization characteristic of Fig. 6, which is what we will hope to find if we do some measurements on the replay side of a commercial tape or cassette recorder.

To avoid the need for a replay gain characteristic, which continues to rise as frequency decreases, the NAB curve provides for an LF turn-over point of 50 Hz, expressed as a 3180 *u*s time constant, and an HF turnover point that depends on tape speed as listed in Table 1. Turn-over frequency, f, is given by $f = 1/2\lambda\pi CR$; the value of CR is the time constant, and this is normally expressed in microseconds (*u*s) so that Cs, in nanofarads and Rs, in kilohms, can be used directly for calculations, avoiding the need to throw in factors of 10^9, etc.

Problems

The above has assumed an ideal world; however there are a number of problems, as follows (this is not a complete list!).

1. Maximum replay frequency: As already mentioned, the size of the replay gap imposes an absolute limit on the upper frequency response.

2. Effect of replay head gap spacing: Since it is the trailing edge of the record head gap which leaves the remanent magnetic domains on the tape, to a first approximation the width of the recording head gap is not very important. However, this is not true of the replay head (as we've already seen). Below the maximum replay frequency, the HF response is very dependent on gap width, as I have shown in Fig. 7. Unfortunately, the output from the head also falls as the head gap-width is reduced, partly because there is less magnetic material in the gap, and partly because of the magnetic shunt effect, due to the proximity of the two sides of the head gap.

3. Effect of tape speed: The differing equalization characteristics, quoted above, tacitly recognize that the performance of the recorder, other things being equal, will be very strongly influenced by the speed at which the tape passes under the replay head. Not only will the output signal fall as the speed is reduced, but the HF performance will also be impaired, as I have shown in Fig. 8.

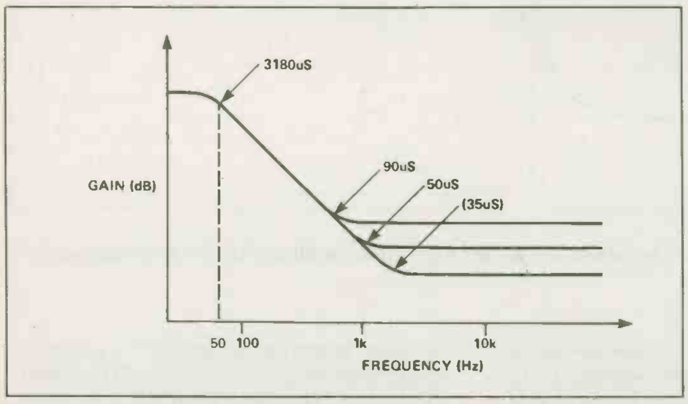


Fig. 6. A practical replay equalization characteristic for reel-to-reel recorders which conform to NAB recommendations (cassette replay to BSI/DIN specifications would use 70/120 us).

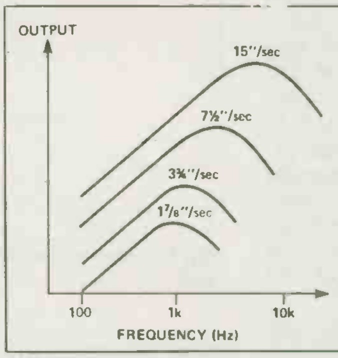


Fig. 7. (left) Output level versus frequency response for different tape speeds.

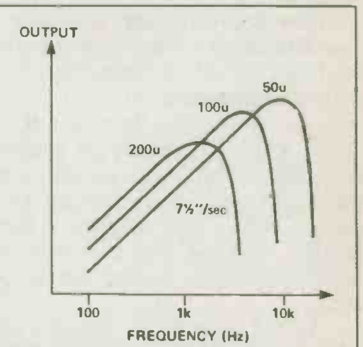


Fig. 8. (right) Output level versus frequency response for different head gaps.

Table 1

15 ins/sec 38 cms/sec	50/3180 NAB/BSI	35 DIN/CCIR
7.5 ins/sec 19 cms/sec	50/3180 NAB/BSI	70 DIN/CCIR
3.75 ins/sec 9.5 cms/sec	90/3180 BSI	140 CCIR
	70 or 120/3180 BSI & DIN/CCIR	(cassette only)

Equalization time constants of various standards; (NAB (or NARTB) — National Association of Radio and Television Broadcasters (USA); BSI — British Standards Institute; DIN — Deutscher Industrie Normenausschus (W. Germany); and CCIR — Comite Consultatif International des Radiocommunications (International Standards Organizations).

4. Tape, magnetic non-linearity: All of the above problems pale into insignificance in comparison with the high degree of non-linearity of the magnetic tape itself. The characteristics of this are shown in Fig. 9. If a small signal current is applied to the windings of the recording head (which is an electro-magnet with a small parallel gap held in contact with the tape, set as accurately as possible, perpendicular to the direction of motion of the tape), the remaining flux on the tape (B) will be related to the applied magnetizing force (H, which is proportional to the current flow through the winding on the head) in the way shown in Fig. 9a.

Clearly, this would not lend itself to hi-fi reproduction. At small signal levels, the recording would be very inefficient with hardly any remaining magnetism on the tape at all. At higher levels there would be the equivalent of a large amount of 'crossover' distortion, and at greater recording levels still, there would be a lot of 3rd and other high-order harmonics generated as the tape magnetization was pushed into the regions where the curve flattened again. Also, to add to the problems, if the tape is magnetized fully, there is a 'hysteresis' loop in its magnetic characteristic, as shown in 9b.

Fortunately, after a lot of early experimentation with this medium, a trick was found which would solve this snag. This scheme was known as 'HF bias', or in normal tape parlance simply as 'bias'.

5. Need for bias: If a suitable high frequency AC signal is simultaneously applied to the recording head with the signal which it is desired to record, and if this HF signal, which will typically be somewhere in the range of 30 kHz to 250 kHz, it is a good bit larger than the recording signal (typically 20 to 100 times) so that it sweeps the BH characteristics of the tape backwards and forwards across the non-linear region of the BH characteristic, one can, surprisingly, end up with a quite linear magnetization of the tape, as shown in Fig. 10a. However, as you will by now expect, there is another snag, and this is that the final recording characteristics of the tape depend on the size of the applied bias waveform. If we apply more, we get the curve shown in Fig. 10b, which is one of reduced recording sensitivity. Also, too much bias tends to 'erase' the higher audio frequencies which we are trying to record. Moreover, the 'correct' level of bias depends a lot on the actual tape being used at the time, and without previous experience, we cannot know what that will be!

6. Problems with bias: The dependence of recording characteristics on bias level is shown in the graph of Fig. 11. This curve (a) shows the relationship between recorded level and bias current at 1 kHz, and (b) the sme thing for an input recording signal at 10 kHz. Clearly, the bias setting has a large effect on the flatness of frequency response of the tape recorder. Curve (c) shows the effect on the distortion of the recorded signal of the bias level. Good HF response is not readily compatible with low THD. The effect of bias level on tape 'modulation' noise is shown in Fig. 11, curve (d). Here, happily, low noise levels fit in fairly well with other needs.

The actual frequency of the bias signal is not very important, though there is some evidence that the recorded noise level on the tape, and the distortion at the upper end of the audio spectrum, may both be lessened by the choice of the higher bias oscillator frequency. The snag here is that it is the current through the head which is important, and because the windings have inductance, a higher bias frequency will require a higher applied bias voltage. Also, the head will work progressively less efficiently at higher frequencies, which contributes to this effect.

7. Design of bias oscillator: The tape cannot distingush the source of the signal which is applied to it. It will therefore record small noise voltages present on the bias voltage waveform just as easily as it will record the noise components present on the incoming signal. So, if the bias voltage waveform is 20 times the size of the signal being recorded, its signal-to-noise ratio will need to be a lot more than 20 times better if it is not to degrade the S/N ratio of the incoming signal. You will note that I have referred to bias voltage, not to bias current. This is because the noise signal will be a wide band, and will not be restricted by the inductance of the head to the same extent as the HF bias waveform. Therefore, the higher the bias frequency, the better the S/N ratio which is demanded of the bias oscillator.

The actual waveform of the bias oscillator is not so important, provided that it is symmetrical. If it is unsymmetrical, it will have the effect of the B-H curve, which will reduce the available undistorted output. Also, an unsymmetrical waveform contains an implicit DC component, which will magnetize the head, greatly reducing its effectiveness, and possibly causing partial erasure of the tape.

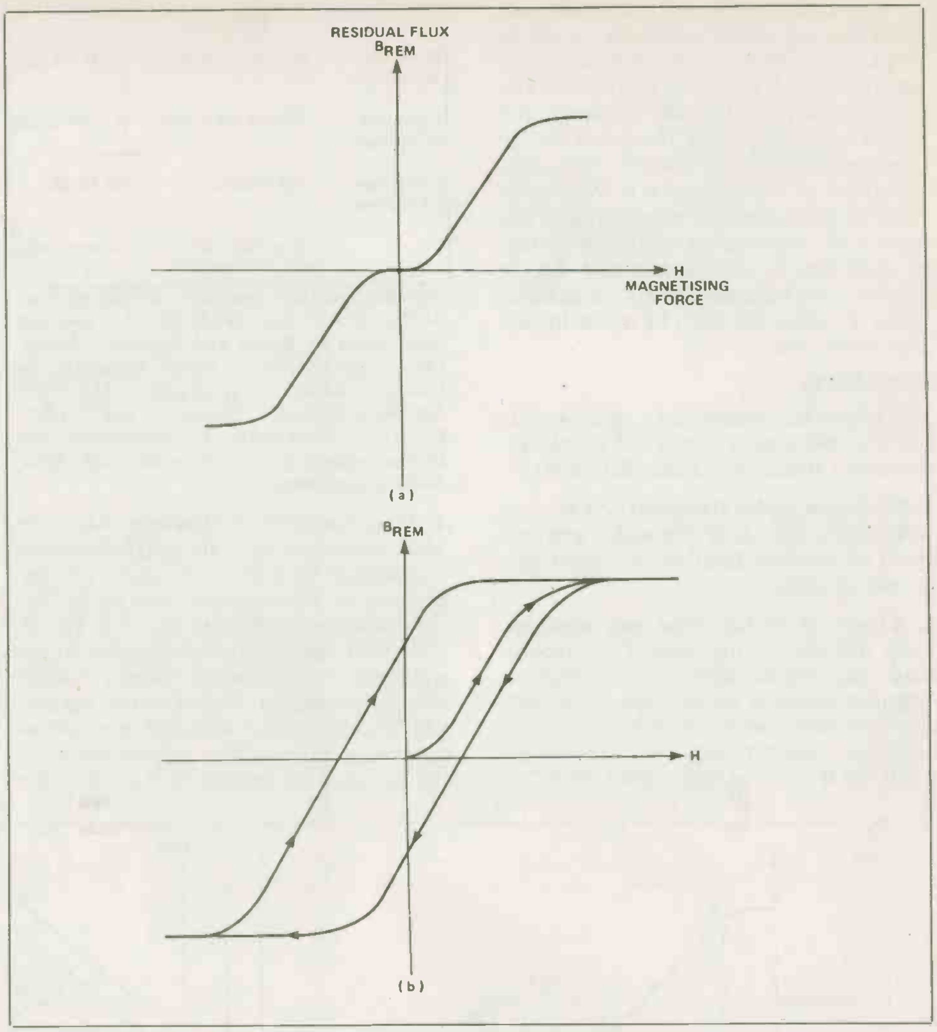


Fig. 9. Tape magnetization characteristics: (a) for small magnetizations; (b) for large magnetizations.

In the early 1970s, when I was very interested in cassette recording, I did some experiments with both square wave and sawtooth bias waveforms. Both worked, and the square appeared to be quite effective. However, for reasons of practical convenience, it is desirable that the erase oscillator should operate at the same frequency as the bias oscillator, and it is easier to get large voltages at a good S/N ratio from an LC sinewave oscillator. Square wave (RC) generators tend to have fairly poor S/N ratios, due to jitter on the 'flip' times.

8. Effect of head inductance: Our aim in recording, is to record all the frequencies in the audio band equally. However, the recording head has inductance, which will restrict the flow of current at higher frequencies. It is necessary, therefore, to find some way around this problem. Of the possible solutions, the simplest is to put a resistor, say 47k, in series with the output from the recording amplifier, to swamp the effect of the changing impedance of the record head with frequency. This also helps keep the bias HF voltage out of the recording amplifier. Bias voltage intrusions would probably do no harm provided that they did not push the record amplifier into a non-linear or overload condition.

Other useful solutions, which make lesser demands on the size of the signal output from the recording amplifier, are to design this amplifier so that it has a high output impedance, or to use a current NFB loop to make the amplifier look like a constant current source. All DC components must be rigorously excluded from the head windings to avoid head magnetization. If a DC blocking capacitor is used, it should be of good quality, and switch-on current surges through this must be prevented.

Head alignment: The way in which the width of the replay head affects the HF response of the recorder has been shown above (Fig.7). This presumes that the head is accurately aligned so that its gap is at right-angles to the direction of travel of the tape. If the gap is skewed, its effective length will be greater and the HF output will be less. The same applies if the record and replay heads to not have the same alignment. This may be less important if one records one's own tapes, but on pre-recorded tapes this is vital. Happily, alignment tapes are fairly easy to buy. On these, though a double-beam oscilloscope makes matters simpler, one can do quite a good job by just adjusting head azimuth for maximum HF output, usually by working upwards through the frequency test bands provided.

10. Noise and noise reduction: Because of the granular nature of the oxide coating deposited on the tape, all tape recordings will suffer from some degree of background noise. In addition to this, any parts of the record process which tend to clump or otherwise disturb the uniformly random distribution of the magnetic domains, will make this background noise worse. Erase oscillator systems are not perfect in this respect, as can be shown by

continued on page 24

AM Stereo Update

ET updates the AM stereo scene with a look at a broadcaster's position and a couple of new stereo receivers for AM.

by Edward Zapletal

FOR SOME time now we have had our ears pampered by the clean, rich sound of FM stereo broadcasts. The early seventies (technological middle-ages) brought us a much improved quality in the various listening media: LP records, home and portable stereo units, and AM/FM cassette car stereos. The shift in listener preference to FM began here, and with a few exceptions, AM radio's decline was signalled. Today, technological advances give us miniaturized home stereos not much bigger than car radios, 'computer controlled' gadgets to keep us amused, and now, AM stereo.

AM Stereo?

Don't run to your favourite AM/FM stereo sound box to see if you can catch a listen of it; and don't laugh, many unfortunate souls (this author included) diligently tuned their brains out without so much as a dB of separation to be heard. What you do get from your standard AM radio is an improved sound quality from AM stations broadcasting in stereo; this is because of the 'cleaning up' of the transmitted signal, a result of AM stereo stations upgrading their hardware all the way from the station to the transmitter. On a recent visit to CHUM radio's headquarters in Toronto, I was treated to my first real encounter with the new medium, and it was very impressive!

Industry Happenings

CHUM's Director of Industry Relations, Duff Roman, enlightened me on the goings-on to date, and without repeating too much of what's already been said, here's a recap:

At present there are four different systems available for broadcasters to chose from when they decide to take the big step of conversion to stereo. The manufacturers involved are: Kahn Communications of New York, Harris, Magnavox, and Motorola. On the opposite end of the scale there is the consumer who has a current choice of at least four known manufactures of AM stereo receivers: Sony, Sansui, Motorola, and Kahn Communications. At a glance there would seem to be no problem. The problem is though, that General Motors and their Delco components division have decided to go with the Motorola design for GM's AM stereo car radio. What's wrong with that? Well, lots. The signal produced by Motorola's AM stereo transmitter can only be decoded by a Motorola AM stereo receiver. The Japanese (Sony and Sansui) however, have developed a chip which will decode the above mentioned transmission systems, including Motorola's. With this in mind, we get into the intertwinings of why AM stereo is in limbo.

Sansui's CX-990 AM stereo/FM stereo cassette player with a suggested retail price of $720.

Who's On First?

Citing General Motors' share of the North American car market, it becomes clear as to why broadcasters are leery of sinking their fortunes into converting to stereo. With all those GM cars wheeling around with Delco radios (Motorola dedicated receivers) in them, AM stations would have to broadcast with Motorola transmitters if they wanted to be heard (in stereo that is). Freedom of choice in the marketplace becomes the foremost issue here. If a broadcaster feels that one of the four mentioned systems is better than another, he should be able to go with that choice, right? CHUM has taken this stand. After months of testing and comparing the systems, CHUM AM went online in September of 1983 with the Kahn system. Several other stations are also evaluating the various systems, but according to Roman, "...broadcasters are being extremely cautious with making a decision as to the system they choose in the event that they may end up with obsolete technology." It would seem that Motorola (and GM) are passively forcing AM broadcasters to adopt an industry standard which clearly benefits only those two players. Unfortunately, the one who is going to suffer the most from all this politicking is the consumer, who in reality is the end user of the radio product.

Tuning In

Already on the market are a small number of portable AM stereo receivers from Sony, as well as a car radio from Sansui. Duff Roman introduced me to the Sony SRF-A100 FM stereo/AM stereo mini-portable receiver, and it was a very impressive unit. The sound quality of the AM stereo equalled that of any FM stereo signal around. However, while taking the bus home from work, I decided to indulge in some of the new improved AM, and instead was treated to amplified noise from the electrical system onboard the bus. This is a minor point which will hopefully be overcome in the future. The unit sells for around $159 and is in short supply. Also, Sony has introduced another AM stereo/FM stereo receiver in the form of their popular Walkman radios and it is currently selling for around $100.

On the advice of Mr. Roman, I contacted the people at W. Carsen Co., distributor of Sansui products, and was introduced to the CX-990 car stereo. The AM stereo sound produced by this unit was excellent and above all, free from any interference. To date, this is Sansui's only entry in the AM Stereo market.

According to a pamphlet published by Kahn Communications, their subsidiary, Kahn Consumer Products, also manufactures an AM stereo receiver.

The important thing to note about the products mentioned above is: they are all capable of receiving signals from any of the four available transmitting systems.

General Motors will be offering the Motorola AM stereo receiver as an option in the 1984 Buick line. Remember, that could be the deciding factor for AM stereo's rise or fall.

The Future of AM Stereo

At this point in time, there is quite a bit of stagnation in the launching of AM stereo. Broadcasters are holding back, manufacturers of transmitters are vigorously trying to sell their individual systems, and the makers of AM stereo receivers are sitting back waiting to see if there is actually going to be a market for their product. Probably the most distressing point in all this is the lack of awareness of the existence of AM stereo. If the whole AM stereo issue continues to be veiled in secrecy, there is a danger that its fate may go the route of quadraphonic records. With more public awareness there is chance that this won't happen. **ETI**

Audio Test Set

An easy to build all-in-one test set designed for fault finding on audio circuits. With the addition of a simple multimeter, this project will cover just about every audio test and measurement situation.

IN ORDER to make comprehensive performance checks on audio equipment, a number of expensive pieces of test gear are needed, including such things as an AC millivoltmeter, a high quality signal generator, and filters for distortion measurements. Such an array of test equipment, even if home constructed, is probably not a practical proposition for most amateur electronics enthusiasts. But probably few people require such a sophisticated set-up anyway. For the majority of testing, all that is really needed is some sort of audio signal source, plus an audio signal tracer.

The unit featured in this article has a simple but very useful signal generator, plus an audio power amplifier for signal tracing. The signal generator covers a frequency range of under 10 Hz to over 100 Hz in four ranges: 10 Hz - 100 Hz; 100 Hz - 1kHz; 1k Hz - 10 kHz; and 10 kHz - 100 kHz. Three output waveforms are available: sinewave, triangular and square. The sinewave output is the one that is required for general purpose testing, such as frequency response measurements. The maximum output voltage with the sinewave signal selected is nominally three volts peak-to-peak, or in terms of RMS voltage, just over one volt.

The squarewave output gives a similar peak-to-peak output voltage level, but the figure for the triangle output is higher, at about five volts peak-to-peak. However, a variable attenuator control enables the output to be continuously adjusted down to zero, and an attenuator switch allows the otuput to be reduced by 40 dB (a factor of 100). The latter is useful when trying to set very low output levels, and makes accurate adjustments of the variable attenuator much easier.

The output level remains almost constant over the full frequency range of the unit, with variations being no more than about 1 dB. The unit has a low output impedance. The total harmonic distortion on the sinewave output is typically under one per cent, which is less than ideal for distortion measurement, but is more than adequate for most other testing, such as gain and frequency response measurements.

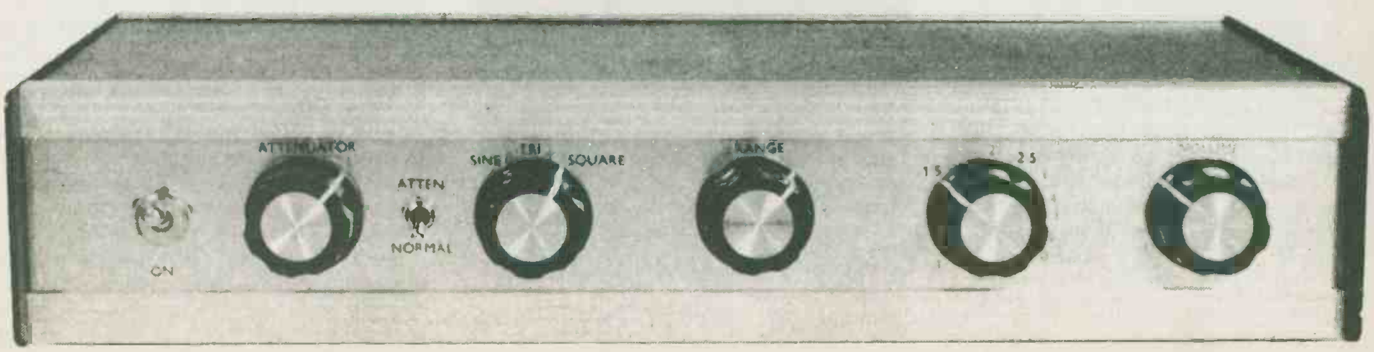
The audio amplifier section uses a very simple circuit based on a TBA820M integrated circuit, which is the only active device used in this part of the unit. The amplifier has a maximum output power of about one watt RMS into and eight ohm impedance loudspeaker, an input impedance of about 400k, and an input sensitivity of approximately 20mV RMS for maximum output power. This enables an output at reasonable volume to be obtained from even a low level signal such as the output from a microphone.

Function Generator

There are two basic systems that can be used in a signal generator. One is to use a high quality sinewave oscillator, such as the popular Wien type, with a clipping circuit normally being used to additionally provide a squarewave output. This system works well in practice, giving a very high quality sinewave signal, but it has the disadvantage of relatively high cost and complexity. The second method is to use a function generator, which is based on a system along the lines of the block diagram shown in Figure 1. This gives sinewave, triangular and squarewave outputs, but the oscillator at the heart of the system is a relaxation type that produces the triangular signal.

This signal is generated by charging and discharging a capacitor from a constant current source. As the current is constant, so is the rate at which the charge voltage on the capacitor rises and falls so that a triangular waveform of good linearity is generated. In a practical system, an electronic switch is used to control the charge/discharge cycle, and the charge/discharge currents are often controlled by separate circuits. A voltage detector is used to operate the electronic switch, setting it to the discharge mode when the charge voltage reaches a certain level, and then reverting to the charge mode when the voltage falls to a second threshold potential. In other words, a standard relaxation oscillator action.

The signal across the capacitor is at a fairly high impedance, and loading on the output could easily result in both a change in frequency and a degradation of the output waveform. A buffer amplifier is therefore included to ensure that excessive loading of the signal across the capacitor cannot occur. A variable resistor enables the charge/discharge current to be varied, and this acts as the fine frequency control. The operating frequency can also be changed by using different capacitor values, and using several switched capacitors enables several frequency ranges to be covered.



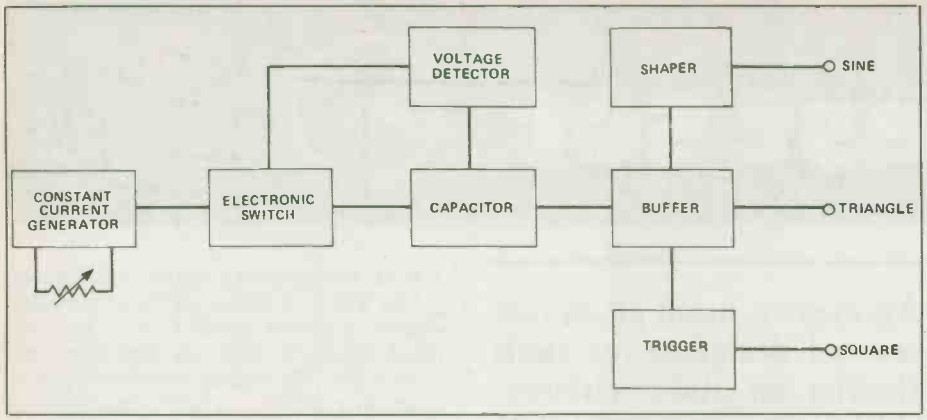


Fig. 1. Block diagram of the function generator — all this on one chip.

Sine, Triangle and Square

It is quite easy to generate a squarewave signal from a triangular one; and it is just a matter of using a trigger circuit to clip the triangular signal. Figure 2 shows the way in which this system operates. If the triangular input signal goes above a certain threshold voltage, the output of the trigger circuit quickly switches fully positive. If the input signal goes below the threshold level, the output of the trigger almost instantly reverts to the fully negative state. Provided the correct threshold potential is utilized, exactly half way between the maximum and the minimum voltages of the triangular signal, the output from the trigger circuit will be a squarewave having an accurate one-to-one mark space ratio.

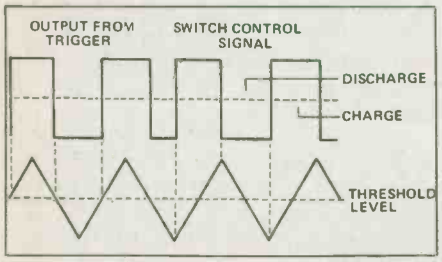
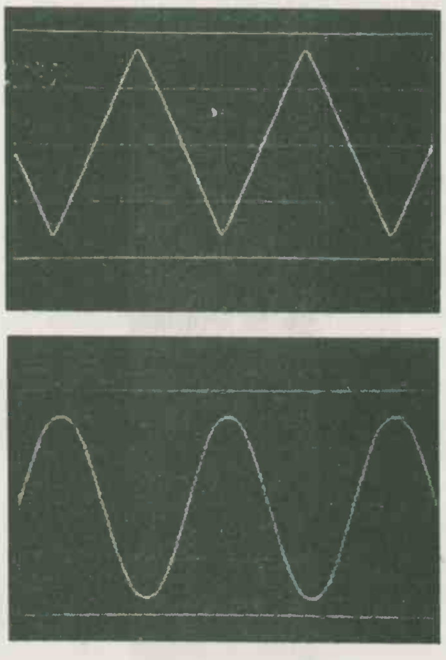


Fig. 2. Generating a square wave from a triangular signal is quite easy. As shown in the block diagram (left), a trigger circuit is used to square the triangle by switching rapidly between full positive and negative voltages whenever the triangle wave passes through a certain threshold voltage.

In many practical designs, rather than using a separate trigger circuit to provide the squarewave output, the signal used to control the electronic switch is used instead. This signal is high while the capacitor is charging, and low when it is discharging, giving an accurate one-to-one squarewave. Whether a separate trigger circuit is used or not, a high quality squarewave signal is easily generated.

Converting the triangular waveform to a sinewave is less straightforward, and gives a less accurate output waveform. The system normally used is a non-linear amplifier which has a level of voltage gain that reduces as the input voltage on each half cycle rises. This reduction in gain rounds off the sharp peaks of both positive and negative half cycles, to give a reasonable sinewave output signal. Even using a fairly sophisticated shaping circuit, the distortion on the output is far higher than that produced by a high quality sinewave oscillator; but a good shaping circuit will give less than one per cent total harmonic distortion, which is more than good enough for most purposes.

The amplifier obtains its non-linearity by the inclusion of diodes (or transistors connected as amplified diodes) in the feedback network. At low output voltages, the diodes fail to conduct and the amplifier exhibits its full closed loop gain. At higher voltages, the forward threshold voltage of one diode will be exceeded, it will start to conduct, providing additional feedback and a reduction in the voltage gain of the amplifier.



The output waveforms, while not perfect, are good enough for most purposes.

In a practical circuit, a fairly complex diode/resistor or transistor/resistor feedback network is needed in order to give good results, so that the input voltage increases as more diodes are brought into conduction. Furthermore, separate networks are needed to process negative and positive output half cycles.

The Circuit

From the above description, it will probably be clear that a function generator is a fairly complex piece of electronics. Fortunately, there are several function generator integrated circuits available, and a unit of this type can be constructed using one of these, plus a handful of discrete components. This unit is based on the XR2206 function generator integrated circuit, as can be seen from the circuit diagram of Figure 3.

The charge/discharge capacitor connects between pins 5 and 6 of IC1, and in this case four switched capacitors are used to give the unit its four frequency ranges. Variable resistor RV2 is the fine frequency control and C7 is a bypass capacitor for an internal circuit of IC1. The sinewave/triangular output is taken from pin 2 of IC1, and the output from this is normally the triangular waveform. The sinewave signal is obtained by connecting a resistor (R6) betwen pins 13 and 14 of IC1.

Rather than having separate amplifiers for the triangular output buffer and the sinewave shaping circuit, the XR2206 uses the same amplifier for both functions, and switching in R6 connects the shaping components into the feedback circuit of the amplifier. This resistor could be replaced with a preset resistor, which would then be adjusted to optimize performance, but results should be more than adequate using the specified (fixed) value.

The squarewave output is available at pin 11 of IC1, and R4 is used as the load resistor, which also reduces the amplitude of the squarewave signal to match that of the sinewave output. Switch SW1b provides the output waveform switching.

The purpose of R1 to R3 plus C2 is to provide a bias current to IC1. The output amplitude from the sine/triangular output can be controlled by using a variable resistor in place of R3, but this is not very useful in this case, as it does not give control over the squarewave output. This facility is therefore left unused, and the output level is adjusted by means of an ordinary volume control type variable attenuator, RV1.

The second IC, IC2, is used as a unity voltage gain buffer stage, which gives the circuit a reasonably low output impedance regardless of which output waveform is in use. C8 provides DC blocking at the output of the circuit, while R7,R8 and SW3 are the -40 dB attenuators.

Unfortunately, the XR2206 does not work well from a nine volt supply, and a supply potential of about 12 to 15 volts is needed. Power is therefore obtained from two nine volt batteries in series via a 12 volt regulator, IC3. This gives a well stabilized supply and consistent results from the circuit.

Audio Amplifier

Figure 4 shows the full circuit diagram of the audio amplifier section of the unit. RV3 is the volume control, and this also biases the non-inverting input of IC4 to the negative supply rail. C12 provides DC blocking at the input of the amplifier and prevents any DC component on the input signal from affecting the biasing of IC4.

Apart from RV3, all the biasing is provided by internal components. The additional socket at the input, SK3, is to enable an input signal coupled to the input to be taken out to another item of equipment if desired. This is not a second input and only one input signal should be coupled to the amplifier at one time.

Pin 2 is the inverting input of IC4, and there is an internal 6k2 feedback resistor between this and the output terminal of the device. Resistor R9 is a discrete feedback resistor, and the voltage gain of the amplifier is roughly equal to 6200 divided by the value of R9 (in ohms), or about 132 times with the specified value of 47 ohms. This represents about the highest voltage gain that can be used in practice, since higher gain could easily lead to instability and the audio output quality would probably be significantly reduced.

Capacitors C14,C16,C17, and R10 are all needed to prevent instability. The amplifier is powered from the stabilized 12 volt supply, like the signal generator section. It would be possible to have separate on/off switches for the two circuits, but as each one has a stand-by current consumption of a few milliamps, and most of the time both sections will probably be used together, this was not thought worthwhile and a single on/off switch is used.

Construction

A metal instrument case, measuring about 300 x 160 x 60mm, is used for the prototype, but this is somewhat larger than is really necessary. However, it would be difficult to make the unit very much smaller than this, since a fair amount of panel space is needed to take all the controls and sockets, and internally there are additionally the component pahel and two batteries to be accommodated.

The general layout of the unit can be seen from the photographs, and it is advisable to keep to roughly the same overall layout. The use of a metal case is strongly recommended as this will help to shield the audio amplifier from power hum and other sources of electrical interference. Details of the printed circuit board and component layout and wiring are provided in Figure 5.

Start by fitting the resistors, capacitors, and the single link wire. Close tolerance resistors and capaictors should be used where specified in the components list. Also C3,C4,C5, and C12 should be the specified polycarbonate (or subminiature polyester) type, if they are to fit onto the printed circuit board properly. Next, the four integrated circuits are fitted to the board; be careful to get them the right way round. IC1 is a fairly expensive device, and it is probably worthwhile using a 16 pin DIL IC socket for this, even if sockets are not used for IC2 and IC4. The audio amplifier IC3 does not have to dissipate much power and it does not require a heatsink.

Finally, Veropins are fitted to the board at the places where connections to offboard components will eventually be made, and it is then mounted on the base panel of the case. Spacers about 6mm long are used to keep the underside of the board clear of the metal case so that there is no danger of accidental short circuits here. With the board completed and installed, it then only remains for the point-to-point wiring to be added.

This is shown in Figure 5, and it is completed using ordinary multi-strand hook-up wire or ribbon cable if preferred. The only exceptions are the two leads from the board to SKT2/3 and it is preferable, although not essential, to use shielded cable here to minimize stary pick-up by the amplifier.

No ground connection to SK1 is shown, and in most cases this connection will be made via the case and the other sockets. Of course, if insulated sockets or a plastic case is used, it will be necessary to use an insulated lead to connect the ground tag of SK1 to the negative supply rail.

The unit is intended for use with an external loudspeaker, and a small, inexpensive, bookshelf type is ideal. Of course, if preferred, an internal loudspeaker can be fitted, but be careful to use a type which can take up an output of power of at least one watt RMS. Whether an internal or external loud-

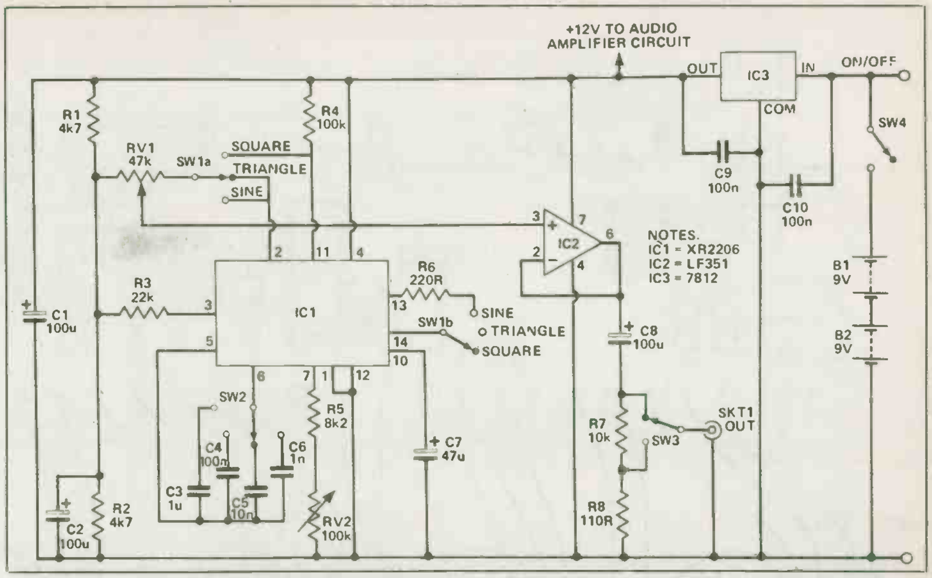


Fig. 3. Circuit diagram of the signal generator section, IC1 does almost all the work, with IC2 included as a buffer to give a low output impedance for all three waveforms.

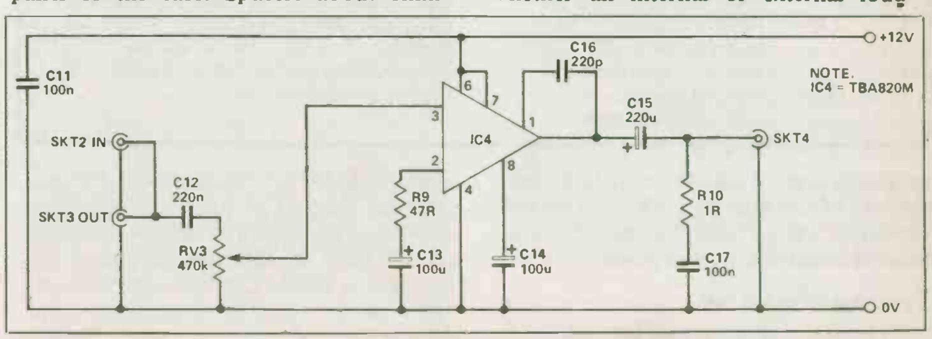


Fig. 4. The audio amplifier circuit. This section will prove useful for tracing signals, or testing small audio generator circuits.

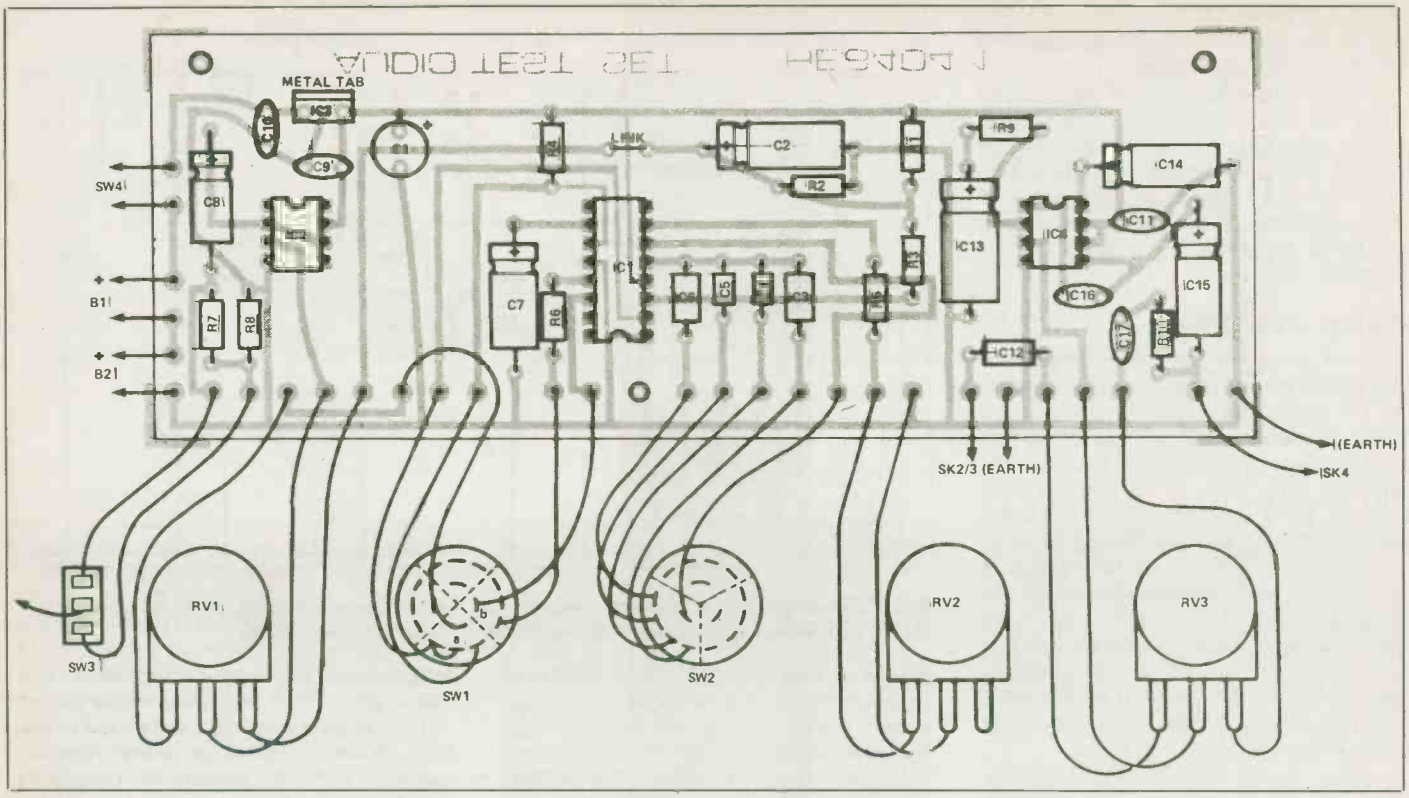


Fig. 5. All components, with the exception of panel mounted controls, fit onto a single small printed circuit board. Details of the connections from the PCB to the controls are also shown in the photographs below, and on the preceeding page.

PARTS LIST

Resistors (¼ W 5% carbon except where noted)

R1,2	4k7
R3	22k
R4	100k
R5	8k2
R6	220R
R7	10k 0.5 watt 1%
R8	11OR 0.5 watt 1%
R9	47R
R10	1R

Potentiometers

RV1	47k linear carbon
RV2	100k linear carbon
RV3	470k log. carbon

Capacitors

C1	100u 16 V radial electro
C2,8,13,14	100u 16 V axial electro
C3	1u polycarbonate, 5%
C4	100n polycarbonate, 5%
C5	10n polycarbonate, 5%
C6	1n polystyrene, 5%
C7	47u 16 V axial electro
C9,10,11,17	100n ceramic disc
C12	220n polycarbonate
C15	220u 16 V axial electro
C16	220p ceramic plate

Semiconductors

IC1	XR2206 Exar function generator
IC2	LF351 or TL072 JFET op-amp
IC3	uA7812 12 V 1A regulator
IC4	TBA820M audio power amp, Fairchild or SGS.

Miscellaneous

SK1,2,3,4	¼" jack sockets
SW1	3 way 4 pole
SW2	4 way 3 pole rotary switch
SW3	SPDT miniature toggle switch
SW4	SPST toggle switch
B1,2	9 volt

Case, about 300 x 160 x 60 mm; printed circuit board; five control knobs; battery connectors; 8 ohm 1W loudspeaker in enclosure plus lead and plug; 16 pin DIL IC socket, wire, solder, etc.

speaker is used, it should not have an impedance of less than eight ohms. A higher impedance can be used, but would give a reduced maximum output power.

Testing And Use

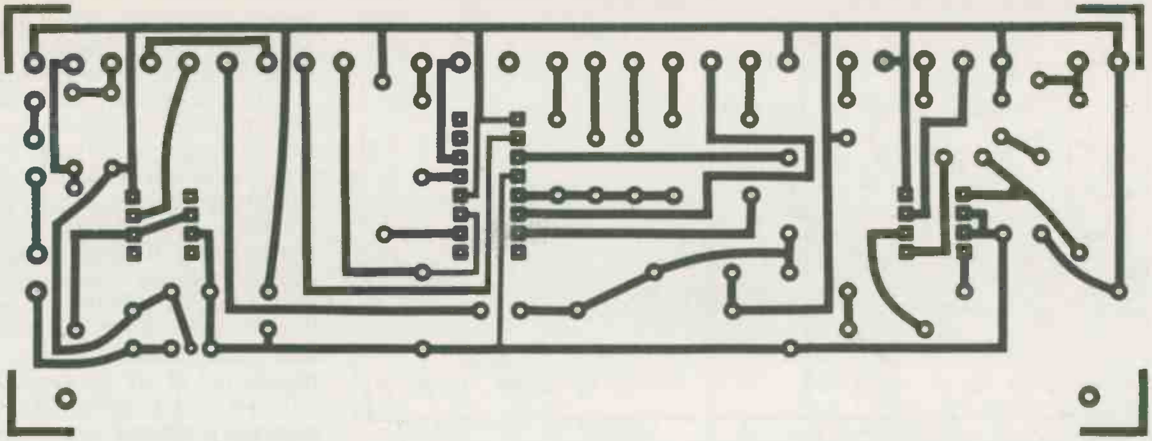
The obvious way of testing the unit is to couple the output from SK1 to the input of the amplifier at SK2. Start with the output level controls of the signal generator and the volume control of the amplifier set well back, so that overloading of the amplifier is avoided. A little experimentation with the output level, frequency, and volume controls should reveal whether they are all functioning properly.

If an oscilloscope is available, this can be used to check the output waveforms. If not, set the frequency controls to produce a low audio output frequency and set SW1 for sinewave output. A sinewave gives a pure tone which does not contain any harmonics (signals at multiples of the fundamental frequency). This gives a very distinctive sound which should become more harsh when the unit is switched for triangle output. A squarewave has an even stronger harmonic content and consequently an even harsher sound.

For the signal generator to be of maximum use, a simple frequency scale should be marked around the control knob of RV2. If a calibrated signal generator is available, this can be used to provide reference tones against which the unit can be calibrated. Similarly, the unit is easily calibrated if you can gain access to a frequency meter which is suitable for audio frequency use.

In the likely event of neither being available to you, an alternative is to use a musical instrument to provide reference tones. For example, the G below middle C is at a frequency of 196 Hz, which is close enough to 200 Hz for most practical purposes.

The frequency control of the generator is set at the correct frequency by simply listening to the output of the unit



and carefully adjusting the control for the same tone as that produced by the musical instrument. Anyone with a reasonably musical ear should not find this too difficult. Only one scale is required for all four ranges, since switching from one range to another simply alters the frequency by a factor of ten, and a scale of one range is easily used on any other range.

There is inevitably a small amount of breakthrough from the generator to the amplifier, and this will be most noticeable when the generator is set for a middle audio frequency. When the amplifier is connected to a single source, this breakthrough will almost invariably disappear completely, and it is not something that should be a problem when the equipment is in use.

In order to make frequency response measurements, some form of audio level indicator is required, and an AC millivoltmeter would normally be used for this. A simple alternative is to use an ordinary multimeter switched to a low AC voltage range, as most power amplifiers and preamplifiers can produce a high enough output signal level to drive a multimeter, most of which have a flat response over and beyond the audio frequency range. Beware of some digital instruments, though.

Use a sinewave signal for frequency response measurements. The square and triangle outputs are of most use in conjunction with an oscilloscope. A squarewave signal can be used to test equipment for instability on fast waveforms, and this instability usually shows up in the form of a high frequency signal modulated onto the output of the equipment under test. A low level triangle signal can be used to test for cross-over distortion in class B power amplifiers. This manifests itself as kinks in what should be the straight lines of the triangular signal.

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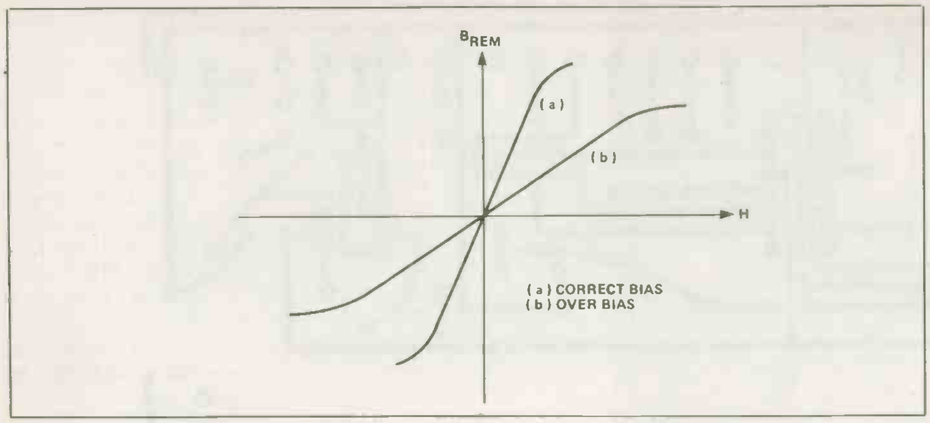


Fig. 10. The effect of HF bias on tape magnetization linearity.

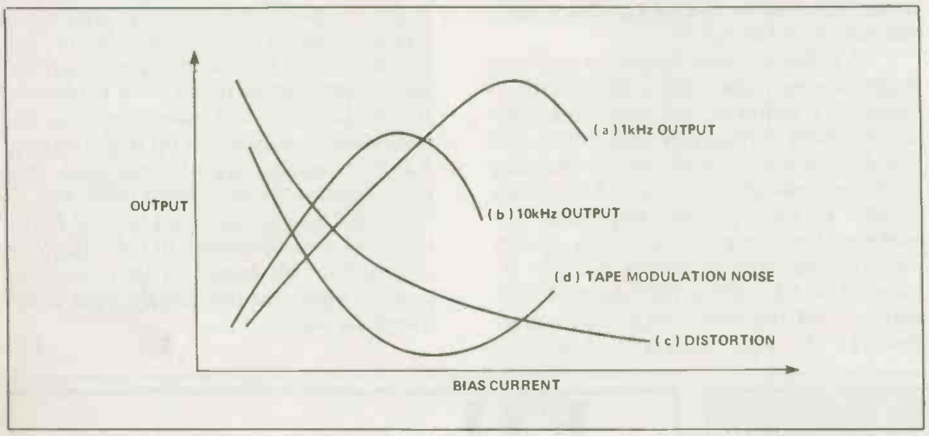


Fig. 11. How recording characteristics vary with bias current; note that only curves a) and b) are to the same scale.

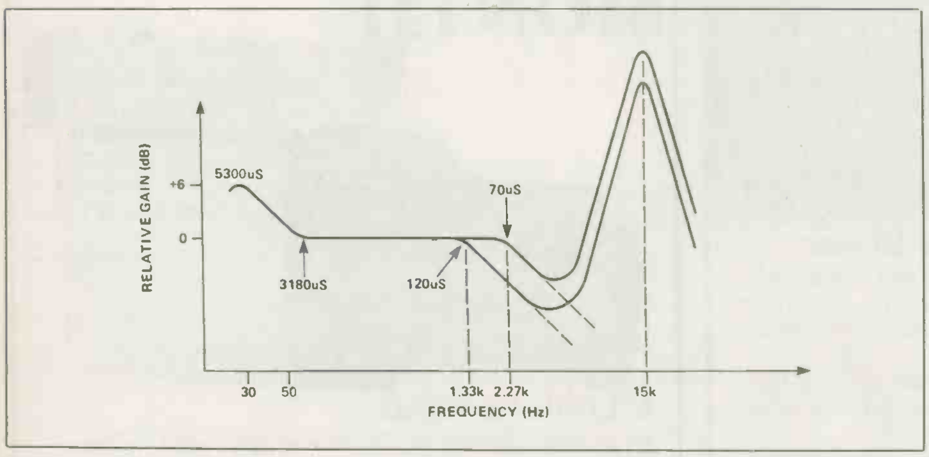


Fig. 12. Record pre-emphasis and de-emphasis for cassettes, showing additional compensation for head losses.

listening to the background noise on a bulk erased tape, as bought, and after it has been 'erased' by one's own recorder following the recorder of a zero signal.

The output from the tape recorder will depend on the tape speed and (although not discussed so far, this is a fairly logical extension of the arguments above) on the tape width at the head. So, the the lower the tape speed and the narrower the tape head width, the worse the signal to noise ratio will be. This becomes a particular problem with cassette recorders, where the tape creeps past the head at 1.875"/sec., and the track width is only 30 thou. or so anyway. The signal output from a cassette recorder replay head will be minute, and will demand a lot of skill in the design of the replay amplifier.

The poor basic S/N ratio of the reproduced signal from a cassette replay head, (though this is now improved by better heads and better tapes) has brought into prominence the various noise reduction schemes, of which the most common is the Dolby B system, used by most cassette recorder manufacturers under license from the Dolby Laboratories. In this, a degree of HF pre-emphasis is applied to the record signal, in which both the amount of HF pre-emphasis and the turn-over point above which this pre-emphasis is applied, is automatically adjusted in response to the measured level of the incoming signal. The reverse compensation is applied on replay to restore a flat frequency response.

There is a snag of course. This is that unless some means is provided for monitoring the tape output, which is only possible on relatively expensive three-head cassette machines, some assumptions must be made by the cassette recorder manufacturer, in setting up the Dolby B replay operating levels, about the actual signal level which his recorder will give on replay for a given input recording level. This will depend on the actual tape chosen by the user, and on the appropriateness of the bias setting. Nevertheless, in spite of these objections, the Dolby B system does work surprisingly well, even on simple machines, and can give a 6-10 dB improvement in overall S/N ratio.

In many commercial machines, the replay amplifier is muted while the tape is not moving, to avoid drawing the attention of the listener to the background hiss of the replay amplifier.

11. Head losses: We have assumed so far, that the recording and replay heads — which are often the same unit in cassette recorders — behave in a perfect manner. They don't. Mainly because of the finite gap width, their HF performance is poor. This means that some form of HF pre-emphasis has to be applied, during recording, to assist in achieving a satisfactory HF output. This recording pre-emphasis, of 15-25 dB magnitude, will be applied, as shown in Fig. 12, at the point where it is expected that the replay HF response will start to fall. This is not a good thing, since it will tend to cause HF overload, and increased distortion and intermodulation effects, but is feasible because signal amplitudes at HF are generally low.

Practical Circuit Design

We have seen from the above what some of the problems are in tape recording. Since these are exaggerated in cassette recorders because of the narrow low-speed tape tracks, a look at the design of the electronics in a cassette recorder — ex-

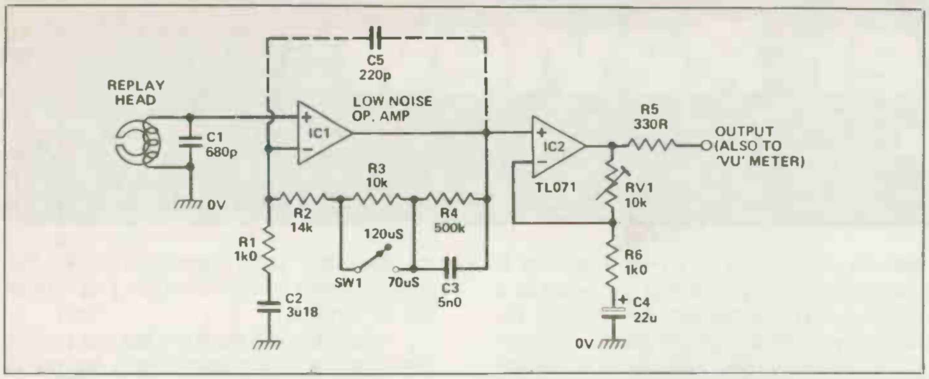


Fig. 13. A typical cassette replay amplifier giving the frequency response shown in Fig. 6.

cluding the Dolby processing — will show the types of circuit layout which will be needed in all these systems.

Replay Amplifier

The overriding consideration here is of low noise in the amplifier, since the input signal will only be about 0.5 mV, and a 60 dB S/N ratio will demand an effective input noise of 0.5 uV, from the amplifier and input circuitry. Fortunately, the effective bandwidth of the replay amplifier, because of its downward slope with frequency, is only 1 to 2 kHz. Nevertheless, this necessitates an effective input resistance of only some few thousand of ohms. We must be careful therefore, that we do not needlessly include input resistive components, to add to the 300-600 ohms of the head winding resistance. The required equivalent input noise resistance required by the desired S/N ratio does put most of the audio ICs out of consideration; however, there are a few, such as the Signetics/Mullard NE5533/5534, the Precision Monolithic/Raytheon OP27, and the Hitachi 12017, which would be satisfactory electrically. Of these, the latter has a non-standard base connection, which would make it awkward to substitute, whereas the ICs with the standard 741 type connections could be upgraded as better devices appear.

In commercial units, for reasons of economy, it is customary to use the same amplifier for both record and replay, with appropriate component changes accomplished by multiple switching. However, from the point of view of the amateur constructor, and certainly for the ease of explanation, it makes life easier to show the record and relay circuits as separate entities. I have shown a suitable circuit design, based on a low-noise op-amp, in Fig. 13.

In this circuit, the output of the replay head (through suitable switching if it is combined with the record head) is taken directly to the input of IC1. The gain-frequency characteristics of this stage are determined by the RC network in its negative feedback loop. Referring back to Fig. 6, we see that the LF gain is rolled off at 50 Hz (a 3180 *u*S time constant), at a gain of 500. From this we can infer that the total resistance in the feedback path, from output to -ve in, must be 500K, if R1 is 1k0. Also, the time constant of R1C2 must be 3180sS. If R1 is 1k0, then C2 must be 3180 nF or 3.18*u*F. This shows how simple the use of 'time constants' makes the task of working out circuit component values.

Now, we require the gain to decrease linearly from 50 Hz to 1.33 kHz (in the case of the 120*u*S equalization) or 2.27 kHz (for 70*u*S). This we can accomplish by means of C3 and R2 and R3, switched by S1. If C3 is 5n0F — this must have an impedance greather than 500 k at 50 Hz, but we can't afford to go too high (Z_{c50} for 5n0 is 636k) — then the 120*u*S time-constant will be given for a value of R2 + R3 of 120/5 = 24k. Also, the 709*u*S time constant will require R2 on its own, to be 70/5 = 14k. So R2 = 14K and R3 = 10K.

IC2 is a simple output buffer stage, to give an adjustable gain of 1 to 11, depending on the setting of RV1. R5 gives some output isolation, and the value of C4 is chosen so that the LF response is adequate. Since 3.18*u*F gives a -3 dB point at 50 Hz, 22*u*F will give a -3 dB point at 7 Hz, which is low enough.

A small circuit refinement is the inclusion of C1 across the cassette head to tune the head, with its internal inductance, to some 15 to 18 kHz. The actual value will depend on the head inductance, and can be calculated from the formula f^o = ½ LC. A value of 680-820 pF will be in the right order. This limits the wide-band noise output from the head, and reduces the chance of noise being worsened by cross-modulation within the input IC amplifier.

C5 across the first amplifier stage performs a similar bandwidth limiting function. This may not be acceptable for the NE5533 or 5534, so regard it as an option.

Record Amplifier

This has to meet five design requirements. The output must be large enough to drive the cassette record head through the 47k swamp series resistance. A normal IC op-amp will do this quite well, with very low distortion, when operated from ± 12 or 15

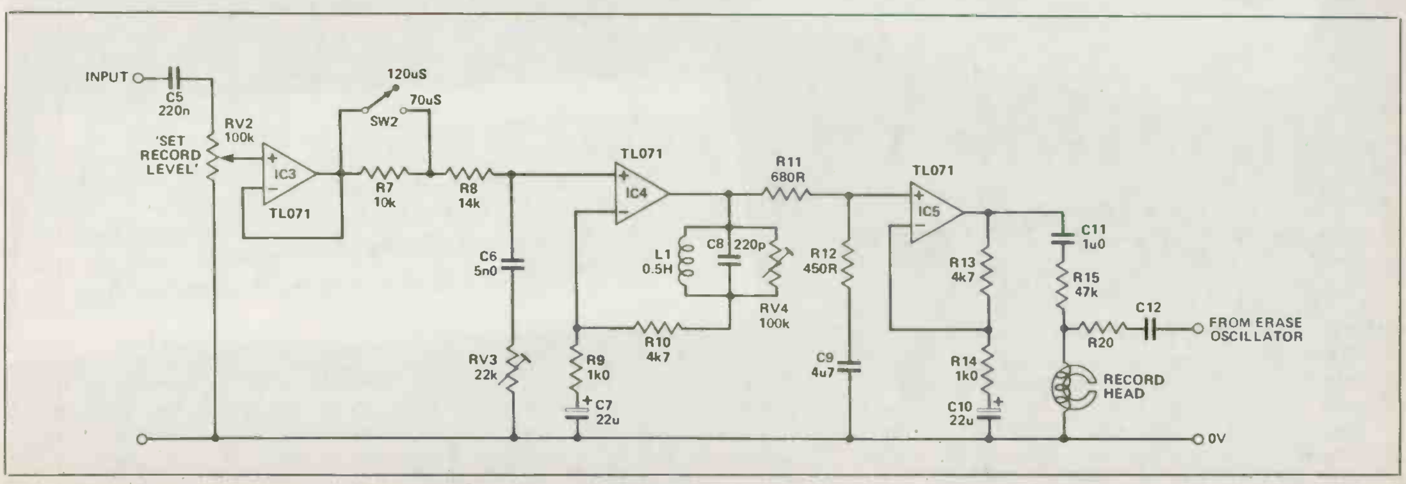


Fig. 14. A typical cassette record amplifier giving the frequency response shown in Fig. 12.

continued on page 52

Computer Review: IBM PCjr

The PCjr is being offered as a low-cost way to get into the world of 16-bit PC-DOS. ETI looks at the advantages and disadvantages.

By Bill Markwick

SEPTEMBER already? But summer just got here... Ah, well, in the fall your fancy may lightly turn to thoughts of buying a computer, particularly one for the back-to-school bunch, and you can't have missed the ads for the PCjr now that its price has been reduced. At the time of writing, you can get the enhanced version with 128K and a single disk drive for $1549; the basic model with 64K and cassette ports is $998, though using a cassette deck with a 16-bit machine is much like putting a Model T engine in a Corvette. The computer we received for review was the enhanced model, and arrived with some optional software: PC-DOS, Cartridge BASIC, and the Writing Assistant word processor. We also tried out the PCjr Compact Printer.

Unwrapping

The first thing you'll notice as it emerges into the light is the keyboard. It has no cable, being linked to the console with infrared beams, and it has keys that are only one step above the eraser types you find on bottom-of-the-line home computers. You may have read elsewhere that the keyboard is a real turkey, so let's get the pessimism over with right away: it's a real turkey. The key spacing is that of a full-sized keyboard, but the keys themselves are tiny and aren't sculpted to fit the human finger, which is what I generally use for typing.

The infrared remote feature is one of IBM's big selling points; they even call it the 'Freeboard'. It worked flawlessly and wasn't too fussy about angles, but the keyboard cable is last on my list of computer annoyances that need fixing up. Besides, you'll eventually have to buy four 'AA' cells or eliminate them by buying IBM's optional cable.

Another economy measure which may annoy some people is the use of various shift functions to minimise the number of keys required; for instance, many of the keys have three functions as selected by the Shift, Alternate, Control, or Function keys. If you're a slow typist, you'll find that these various combinations delay you even more.

August 1 — as we went to press, IBM Canada has announced changes to the PCjr: a proper keyboard, an "electronic disk" program, a speech synthesizer, and others. The enhanced version lists at $1569.

There. That's the nasties over with. Now for the good stuff:

Powering Up

The console is small and light; on the front is the 5 1/4 inch 360-kilobyte single-sided drive and two cartridge slots, along with a small hole for the infrared receptor. On the back are connectors for two joysticks, a lightpen, a keyboard cable (if used), an RF output, a video output, an audio output, a direct graphics output, and the power socket. There are also ports for a cassette deck, an optional modem, and a printer.

The power supply is a separate black box that sits on the floor and provides enough current for one disk drive; it has to be upgraded if you add another (IBM has no second drive available at the moment, but there are independent suppliers who do). When you power up, the start-up ROM looks for a disk or cartridge; if there isn't one, it boots up with the internal BASIC and announces that there are about 63 kilobytes free. The rest is used up by BASIC itself and by a comprehensive ROM; we'll get back to some of the built-in features. The RAM is expandable to 640K.

If the first key you press after booting is Escape, the PCjr's ROM starts a program called the 'Keyboard Adventure', a tutorial for children that lets them get used to operating the keys. Otherwise, you are now in cassette BASIC, written for IBM by Microsoft. Its syntax is similar to other Microsoft versions, except that it has wonderful full-screen editing; just cursor up and correct. There's even an 'Insert' key on the keyboard to eliminate the EDIT-I-ESC format beloved by Microsoft.

The cassette BASIC lacks many of the audio features and extended graphics available on the cartridge version. It's more than adequate for most programming needs, but for the real bells and whistles, you'll need to buy the optional plug-in.

Cartridge BASIC

Most computer makers caution you not to fool around with any cartridges if the power is on because dire things are said to happen. On the PCjr, they even encourage it; nothing happens but a system reset. The extended BASIC that comes on is comprehensive indeed. It has all the familiar commands, plus a graphics package of amazing flexibility. The sound functions include the usual PLAY and SOUND commands, but the notes generated can be held in separate buffers, allowing multiple voicings. Both the graphics and the sound functions are difficult to learn, but the payoff is in the remarkable quality of the programs you can produce.

The manual which comes with the cartridge is hard to understand and contains some typographical errors just to add to the fun; the typos got in because they have had the example listings typeset instead of photographing a computer printout.

Exploring

A demonstrator disk is included, called 'Your IBM PCjr Sampler'. It's a collection of twelve simple programs, such as an alarm clock, a typewriter, a monthly expense account, and so forth. You'll get to see some of the remarkable graphics capabilities of a 16-bit machine. Some of the games are fun, too.

Another included disk is 'Exploring the IBM PCjr'. This one should go a long way toward discouraging people about computers; it's basically a case of the computer programming the operator. The keyboard demonstrator, for instance, invites you to try changing the display via the cursor keys; nothing happens until the computer feels that it's good and ready. The graphics in the DOS explanation may appeal to some.

DOS

The Disk Operating System is like the steering wheel and foot pedals of a car: it gives you complete control over your disk files. Using simple commands, you can view, load, save, and delete files; these can be languages such as BASIC, games, text, or anything that fits on a disk. Using more complex commands, the experienced computer fan can rearrange parts of the computer's memory or disk files, write programs, shuffle files around, and more. The PCjr uses the same operating system as its larger cousin: PC-DOS, one of the implementations of MS-DOS. It's very similar to the workhorse CP/M, and most of the commands will look the same to the operator, but it's considerably enhanced over the 8-bit version.

The next obvious question will be: how compatible is the PCjr with IBM-PC software? It's difficult to pin anyone down on this, but the general answer is that any PC software will run within the limits of the installed RAM, assuming that it doesn't insist on dual drives. Much MS-DOS software is compatible as well. Keep in mind that you must purchase the DOS package before you can run a lot of software; many programs do not have DOS tracks on their disks. The DOS disk is run first, loading its commands into memory; the disk is then removed and replaced with the software program. IBM has a PCjr brochure which lists software compatibility and whether or not DOS is required.

The PCjr solves the problem of having only one drive by faking a dual system: if you type B: for the second drive, the B: actually appears on the screen. This is your cue to remove the first disk and replace it with another. CP/M users note: you can swap PCjr disks back and forth to your heart's content with nary a read-only message.

One of the great advantages to both CP/M and PC-DOS is ease of use for beginners. File handling becomes a breeze compared to the low-end micro systems. This isn't true as you delve deeper into the mysteries of programming, but you only need go as far as you want to; first-time users should get along fine with PC-DOS.

Computer hackers upgrading to 16-bit will be pleased to know that most of the Debug utility is virtually identical to CP/M's DDT (and you can write corrections to the disk!). Unfortunately, there was no assembler program included with the DOS package, though you can do a sort of mini-assembling using Debug in a way similar to the DDT 'A' command.

Back to BASICs

Before continuing with the operation of the software, let's have a look at some of the keyboard functions waiting for you in ROM. Lots of things are hiding in that 64K worth of chips. The first thing you'll notice when you boot either version of BASIC is five commonly used commands at the bottom of the screen (LIST, RUN, etc.). These, and five others, are selected with the function keys; to save on the number of buttons, IBM has used the numerical keys and the Function button to implement this feature. The screen listing of the functions can be suppressed with F9 and the word 'OFF'.

Some of the alphabetical keys have been assigned functions as well: PAUSE replaces the usual Control-S, BREAK replaces Control-C, and the Control-P printer toggle is now ECHO. There's also a key function to print the screen display. The cursor keys can be turned into end-of-file and page-at-a-time scrolling. All function keys can be user-defined using the KEY command; each key will hold a 15-character string.

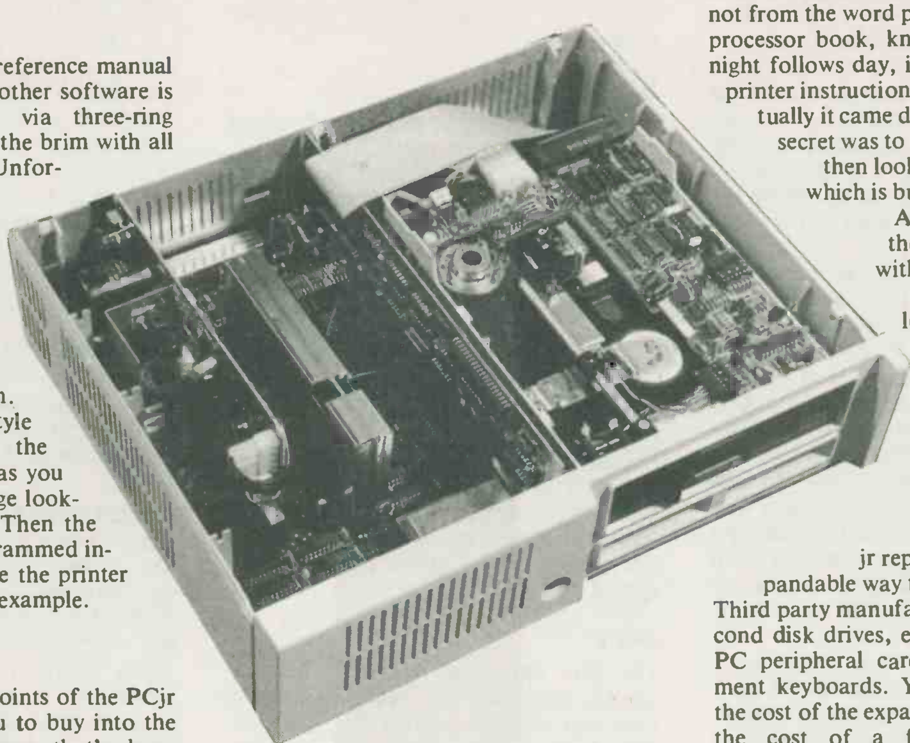
There's yet another: the ALT key. Its only purpose seems to be adding four punctuation marks, aside from its involvement in implementing a fail-safe RESET: this requires the Control-ALT-Delete keys to be pressed simultaneously; you really have to have your heart set on rebooting.

WIDTH 80 will give you an 80-column screen in BASIC. If there's a way to call this font with other software, such as the word processor, I couldn't find it.

Without kicking this poor keyboard while it's down, I'll point out once again that the rubbery action, the tiny keys, and the multiple functions make this a prize pain for typing. It's also designed for overlay sheets to suit various software, and therefore the legends are printed above the keys rather than on them; this makes for much peering over the edge.

DOCs

The PCjr comes with a reference manual and BASIC tutorial; all other software is extensively documented via three-ring binders crammed full to the brim with all sorts of information. Unfortunately, the value of documentation is not measured by the kilogram, and most users are likely to find themselves on quite a wild goose chase if they need to find a specific instruction. IBM's documentation style is to start off with the painstaking tediousness as you whip over page after page looking for something else. Then the complicated points are crammed into the last few pages; see the printer description below as an example.



Software

One of the best selling points of the PCjr is the ability it gives you to buy into the vast quantity of software that's been generated both by IBM and others. Our review model came with cartridge BASIC, the Writing Assistant word processor, and sampler disks for the Graphing and Filing Assistants.

The Writing Assistant requires you to load DOS first, and then the program disk. This takes about 60 seconds; the 8088 16-bit system is not particularly fast in either disk loading or screen refresh time. Once into the editing mode, you'll find a 40-column display with auto word-wrap. You can reset the margins to a maximum of 78 using the Define Page function, but only 40 characters display at once; horizontal scrolling is required.

The program certainly contains all the features required for fancy word-fiddling; the function (and shift/function) keys are reset to the commonly-used commands such as tabs, erase word, erase line, copy, append a file, and 13 others. There's the usual Search and Replace, and a spiffy Spelling Checker with a huge vocabulary and an unusual ability: on finding an unknown word, it can offer the possible spellings that it thinks might be correct. When it came to 'Plork', for instance, it offered the possibility that it might be 'Polar', 'Polka', or 'Porkers'. It can then replace the word in the text, or if you prefer, write your peculiar word into the dictionary for future reference. Lots of fun, if a bit slow.

The other software was on a par; the Graphing Assistant only required a list of categories and numbers to turn them into bar charts, graphs, or pie charts. Easy as, ah, pie. Filing Assistant is a database suitable for keeping track of information and generating reports.

The Printer

The IBM Compact printer is a suitable peripheral for the PCjr, being a 50 character per second unit that sells for $259. It prints with a dot-matrix on thermal paper; this eliminates the need for ribbons, and IBM's paper produces a nice high-contrast image with no problems caused by photocopier heat, although it's only coated on one side.

The printer had no controls other than Paper Feed, not so much as a roller knob; paper is poked into it, the Paper Feed is held down, and the paper trundles around the roller. There are four modes available: standard text, compressed text, double-width text, and underlining. How we found this out was a good example of IBM's frustrating documentation.

There were no instructions with the printer, so we dug through the computer's Guide to Operations, which contains the instructions for all sorts of optional equipment. Getting the paper in, seemed self evident, so the search was on for the procedure to make the Writing Assistant print in the various modes. However, IBM sees fit to use no less than 16 pages of text and diagrams on how to insert the paper. Then the control code explanation begins: it contains some garbled hints on how to change modes from BASIC, but not from the word processor. I opened the processor book, knowing that as sure as night follows day, it would say 'See your printer instructions,' and so it did. Eventually it came down to guesswork; the secret was to type an asterisk/P and then look up an ASCII number which is buried in the text.

Aside from these gripes, the printer works silently with sharply defined characters, though it does leave a high-gloss sheen on the paper where the printhead touches it.

Finally

With exception of the keyboard and the poor manuals, the PCjr represents a powerful, expandable way to get into PC software Third party manufacturers are offering second disk drives, expansion slots to hold PC peripheral cards, and even replacement keyboards. You'll have to tote up the cost of the expansions you want versus the cost of a full-size PC or PC-compatible.

Quick Reference
IBM PCjr, enhanced version

Price: $1595
CPU: 8088
RAM: 128K, expandable to 640K
ROM: 64K
Screen: 40 x 24 (80 x 24 in BASIC)
Graphics: 6 modes up to 640 x 200
Colour: 16 in low or medium resolution
4 in high resolution
Sound: internal speaker, external jack
Printer I/O: 1 serial port
Display Outputs: RF and video

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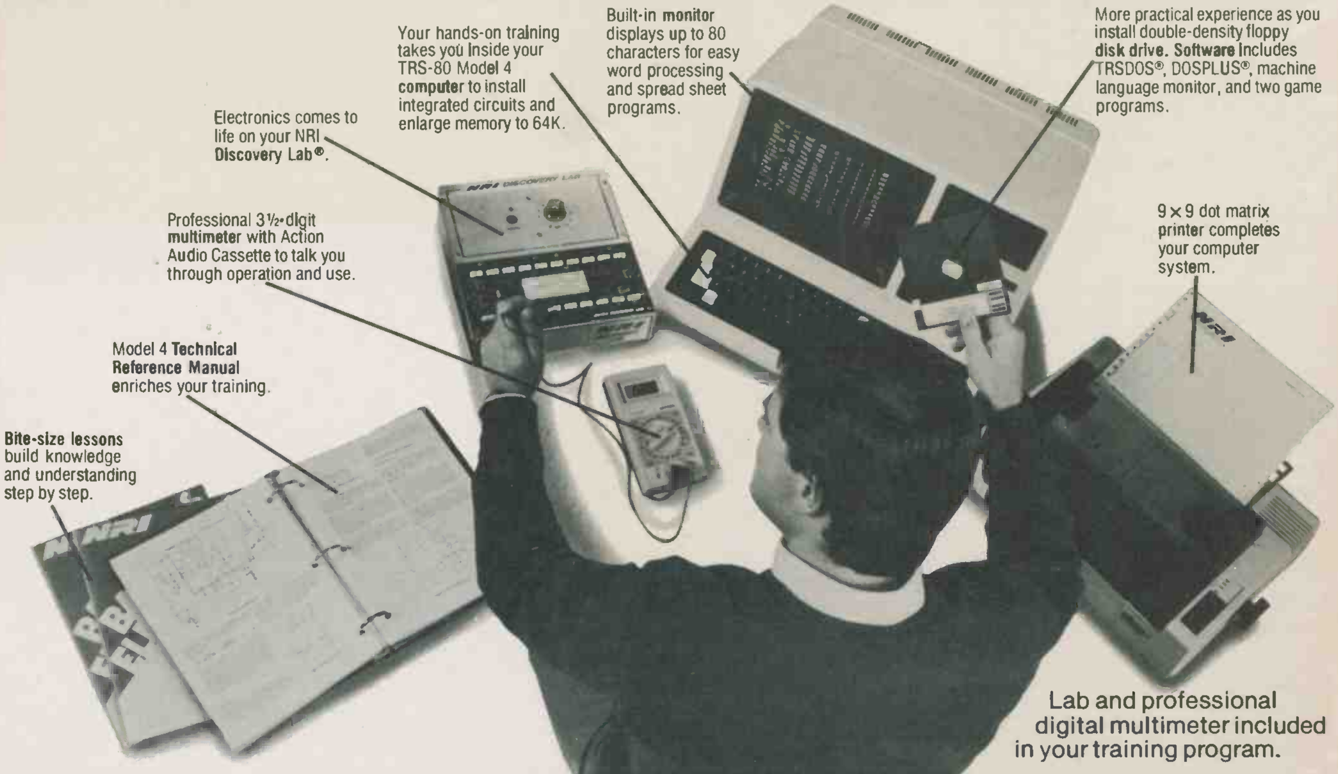

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Hot Ice

A short history of remote data sensing leads into a look at Canada's technology for tracking ice movements via satellites.

by Roger Allan

REMOTE sensing is customarily argued by those of us in the west to be traceable back to Signior Galileo Galilei's attempt to snow the Venetian Senate into granting him research money (for 'research' read 'grocery') by falsely presenting the Dutch discovery of the telescope as a product of his own fertile mind. While he intended to use the funds to subsidize his own work in astronomy (permitting him to make one of the most wonderful statements to an assistant ever: 'Do you know what the Milky Way is made of? I do.'), the Venetian Senators took a far more pragmatic view of the device, for it would permit them to spy the mast heads of unfriendly shipping before the unfriendlies could spy them.

A Bit of History

The permanent recording of remotely sensored data, however, has a far more ancient lineage. The classical Chinese developed an earthquake detector which took the shape of a bronze frog. Carefully balanced in a necklace arrangement around the frog's neck was a series of bronze balls, each about the size of a cherry. Located directly underneath these balls was a series of bronze cups, and the entire device was mounted on a heavy stone pedestal several feet off the ground. When an earthquake occurred, the frog would 'shudder' or 'sway' in a line parallel to the movement of the earth, knocking two balls on opposite sides of the frog off into the cups. By having two such devices some miles apart connected by Imperial despatch riders, the local governor could use triangulation to determine if the earthquake's epicentre was within his jurisdiction, and if so, rescue attempts could be sent to the afflicted area.

More recently, the development of the camera in 1822 provides a Modern Era start to the history of remote sensing with permanent data acquisition, though it was not until 1856 with the coupling of a camera and the hot air balloon that real remote sensing producing a permanent record can be said to have begun. The first such instance of balloon aerial photography occurred over the city of Paris. Nine years later, such methods became increasingly used, particularly by the Union Forces during the American Civil War.

The next milestone came when Wilbur Wright photographed Rome from an airplane, predating by five years such a technique's widespread use by the military during the Great War.

A portion of a plot depicting the Labrador coastline with pertinent "hot ice" data in the form of isobars.

The intervening decades between the Great War and the 39–45 War saw a rise in the use of remoting sensing abilities, primarily based on the ever-increasing knowledge of the intricacies of electronics: radio direction finding, improved seismic detectors, and acoustic detection.

The German Kriegsmarine used a submarine to place a series of battery-operated wind, rain, temperature and barometric pressure devices on the coast of Labrador, automatically connected to Germany by radio. It marked the first major effort in remotely obtained and transmitted meteorological data over a prolonged period; it lasted for eight months until the batteries ran out. The Axis war effort also saw the first use of rockets in a remote sensing capacity, specifically for ground photography.

Remote Meets Hi-Tech

In the decades subsequent to the war, remote sensing has increased both in volume, quality and type. Its name, in fact, came from Evelyn L. Puitt of the US Office of Naval Research; she was one of the major forces behind the development of computers, work which was rewarded by her becoming the first woman admiral in any national navy. The development of satellites permitted large scale studies over prolonged periods, and just as importantly, there was the decrease in electrical requirements of components used to drive and control remote sensing devices (such as transistors, IC's, improved batteries and solar cells). While the vast majority of such efforts have been predicated on military requirements (see *Spy Satellites*, Electronics Today, April '83), civilian requirements such as logic processing and pure research have all played a role in this field's expansion.

Canada's Frontier

Canada is in an odd sort of position. We have the second largest national geographical mass (the Soviets beat us by a little bit, as in hockey), with by far the longest coastline of any nation. Vast areas are either underpopulated or not populated at all. Yet information derived from these frontier areas has enormous personal and economic use for those of us who live in more populated areas. Storm fronts in the Arctic will determine whether farmers should or should not seed their fields this week or next, ocean currents determine where our fishing fleets should steam, and snow fall in the mountains determines whether contingency plans should be formulated in cities and towns hundreds of miles down stream preparatory to the spring thaw.

Add to this the fact that Canada has enacted legislation to implement a 200-mile resource protection zone off our coasts; it has been named the "resource ribbon" by Dr. F. Bunn of York University, and encompasses an area half as large as Canada itself. We thus find ourselves in the unenviable position of requiring phenomenally vast amounts of remotely-sensored processed data, but lacking the financial or infrastructural capability to provide it. Not that Canadian scientists are unable to provide the processing ability, presupposing they can obtain the raw data in the first place, but rather there just isn't the money, either to put the remote sensors in place on a space platform, buoy, etc., or to pay for the processing of the collected data.

Solutions

There are, seemingly, ways around this problem, specifically via international co-operative efforts. But this is not always as clear cut as it seems. For example, it is not particularly secret that the United States maintains two enormous anti-submarine monitoring networks, CEASAR and SOSUS. Collectively, they and monitor millions upon millions of square miles of ocean, providing enormous quantities of data.From this information avalanche, the military only requires some ten percent of the volume. Within the ninety percent excess capacity is found vast quantities of information which could, relatively easily, be applied to the tracking of ice bergs, fish school migrations, etc. The US is quite prepared to let anyone have access to this data, providing that one pays 90% of the cost of data acquisition (since they use only 10% of it); this includes capital costs for putting the systems in place initially. Suffice to say, the costs of building and maintaining such a vast network of underwater listening devices is simply horrendous, so much so that no one can afford it.

But the need remains. One interesting element concerns marine navigation in Arctic waters, and in those areas such as off the east coast and the Hibernia oil field that are directly affected by icebergs. It has been calculated by Dr. Bunn, that by 1990 the value of being able to predict ice conditions will be worth several hundreds of millions of dollars a year to industry; knowing ice conditions could aid in the removal of iron ore concentrates from Arctic mines, the transportation of oil and liquified natural gas from frontier regions and the protection of oil rig platforms from the vagaries of errant icebergs.

Currently, such information is produced by Ice Central, a department in the Atmospheric Environment Service (AES). They are dependent for their information for producing their daily ice reports on data received from aircraft reconnaissance, history, and some meteorological work from satellites such as LANDSAT or GEOS (both of which operate effectively only in daylight and clear weather). Some information is received from passing ships, either merchant marine, which provide low quality data, or 'ships of convenience' such as military vessels, which provide data that is high quality but intermittent. Of the total Canadian coastline, only some 5% can be covered using these techniques within the restraints of the $10 million per year budget.

Hot Ice

There is, however, another way that this data can be obtained, processed and passed on to interested parties either in real time or a close approximation of it. It is dependent on the realities of physics, realities which result in 'hot ice'.

Until one reaches absolute zero, when all molecular motion ceases, there is no such thing as a 'cold' object. Everything radiates energy in one form or another. A hot stove element, for instance, glows red due to its radiating energy in the visible red wavelength region. As one passes further down the temperature scale, the wavelength of the radiation increases until it passes out of visible light's frequency range. By the time one reaches 'cold' levels, such as ice, the radiation is in the microwave region. The important point is that as long as radiation is emitted, it can be detected. Hence the concept of 'hot ice'.

In Canada, the idea of utilizing the microwave emissions of ice to determine its concentration, position and age, was first proposed by Drs. Rene Ramseier and Steven Peteherych, currently at Ice Central AES in Ottawa, and the Atmospheric Environment Service in Downsview, respectively. The trick was to get the raw data without bankrupting Environment Canada.

To The Rescue

Fortunately, the US Navy has a branch known as 'Fleet Numerical Oceanographic Service' in Monterey, Calif. It is here that data from US Navy Fleet satellites is decoded and processed. A deal was struck whereby the Navy, after processing the data for their own purposes, would produce as a side product semi-processed data which could be utilized in Canada for the determination of ice formations, including their ages (first year or multi-year), and movements. It was a simple situation; the Navy had the numbers, while Canada had the ice. With the exception of Goddard/NASA, Canada is the only recipient of this information.

The data is received in Canada at a company known as PhD Associates Inc., located at York University. Run by Dr. Frank E. Bunn and Dr. Frank W. Thirkettle, the company currently numbers about 22 persons: faculty, support staff, and students ranging from undergraduates to Ph.D candidates. This company is typical of York's increasingly successful attempt to provide an interdisciplinary approach to scientific problems that involve academia, government and industry.

Crunching the Numbers

The hot ice determination process is relatively straightforward, once the software to do the number crunching had been developed, a process that took some three years. The US maintains the NIMBUS-7 satellite in a near-polar orbit. On board are sensors tuned to the 18 and 37 GHz frequencies which detect the microwave emissisions of the ice, technically known as the temperature brightness. Every second day (due to power constraints) the recorded data is transmitted down at high speed to the tracking station at Gilmore Creek in Alaska. Gilmore then bounces the signals off a COMSAT to Monterey, where Fleet Numeric does the initial processing and the 'ice useable' by-product is roughly fleshed out. Ph.D Associates obtains the data over land lines, storing it on their Super Pet's disks. The major processing then involves sending the data to the university's IBM mainframe, which also produces large mylar pictures denoting the coastline and the relevant numerical data; this data is read as the temperature brightnesses at the two frequencies, the first year ice concentration and the multi-year ice concentrations. The data is then dumped back into the Super Pets, connected to an 8x11 plotter and re-plotted into smaller paper maps, four of which are equivalent to one mylar map.

Any one of a number of representations can be made: isobars between similar concentrations producing lines similar to height gradations, color representations, whatever. These maps are then sent to Ice Central in Ottawa over a data fax (facsimile) system and used to help determine the daily ice forecasts. Similarly, these smaller maps can be sent to individual ships via a radio facsimile system. This means that ship navigators and owners of oil rigs can receive ice information on a bi-daily basis. Its use in saving time and reducing hazards is therefore enormous.

Through Difficulty...

There are, however, some difficulties. The smallest pixel of information is some 30 square km, covering an area far larger than any iceberg. Some calculations are only arrived at with difficulty due to winds whipping up the water patches within expanses of ice (technically known as 'polynyas') which lowers the water's perceived temperature. Getting the information to the ships (due to their being out of range of a COMSAT) requires radio faxing, which in turn is derived from a data fax transmission, resulting in an overall degradation of signal quality. The passive system used is not as good as an active system which would send down a microwave beam and read the reflections.

...To Success

But nonetheless, while still on something of a shoe string (Ph.D has only spent about $1 million over the past three years), the operation does work and work very well. And matters seemingly will improve. In 1986 the US Defense Meteorlogical Satellite Platform (DMSP) will be launched, and will contain an SSM/I, a Special Sensor Microwave instrument. This will permit reception not only on the 18 and 37 GHz frequences that are currently available, but also on the 85 GHz band. The 85 GHz is expected to produce interesting results; the pixel resolution will be 12.5 km, which while still not showing individual icebergs, is better than the 30 km currently available.

And finally, Ice Central itself. On their current budget of $10 million per year they can only cover some 5% of our coastline. Due to the off-shore work that is increasingly being done, they are being asked to provide data that they simply don't have the money to generate. Using this system would only cost about $2 million per year and would provide coverage for all of Canada's coastline.

All in all, Ph.D's efforts seemingly give credence to a remark made by Dr. Bunn at a Space Science symposium held at York last fall, that "there's money in hot ice." **ETI**

Circle No. 12 on Reader Service Card

DXing: The Dying Hobby

C.M. Stanbury II explains what you can find on the standard AM broadcast band if you're patient.

FOR OVER 60 years, almost every radio listener has on occasion stumbled across distant signals on the standard AM broadcast band. In 1983, how many Expo fans kept track of the rival Phillies on WCAU 1210, the Pirates on KDKA 1020, and the Cardinals on KMOX 1120? Some radiomen, like myself, have even spent years collecting cards and letters ('QSLs') from stations verifying distant ('DX') reception of their signals. However, in a few years all of this may be over: the FCC and CRTC plan to squeeze in so many new stations that DX reception will require the most sophisticated of communications gear. Even following the baseball pennant races via an ordinary AM receiver might then be a thing of the past.

For those with an eye, or should we say ear, for memorabilia, now is the time to hunt down these far-off Medium Wave broadcasters. Here is a brief summary of what's still available.

A souvenir pennant from Radio Americas, also known as Radio Swan, received by the author to confirm reception.

Split Frequencies

There continue to be a few BCB transmitters in Latin America operating on frequencies between the regular 10-kHz-spaced channels assigned in Canada and the US. The most often heard of these are Radio Paradise at 825 kHz on new independent St. Kitts, Radio Belize at 834 kHz, 'Amiga' at 1125 kHz from San Jose, Costa Rica, Caribbean Lighthouse at 1165 kHz from Antigua, and Radio Caymen at 1555 kHz.

Clear Channels

There are still a few spots on the dial where no Canadians transmit at night and only one or two American 50 kilowatters (though not for much longer). Under certain conditions, primarily but not exclusively ionospheric disturbances, Latin American signals will top the US signals. Although they're mostly in Spanish, a little practice will allow the listener to pick out the station name and location, e.g., Radio Tiempo, 1200 kHz, Caracas, Venezuela. Other frequencies upon which similar reception can be expected include 650, 660, 670, 700, 720, 750, 760, 770, 780, 820, 830, 840, 870, 880,890, 1020, 1030, 1040, 1100, 1120 and 1210 kHz.

Cuba

Although the Cuba-US radio war set off by the Reagan Administration's Radio Marti will be a major source of increased interference, Cuban signals continue to be the most widely heard of all the distant signals; for instance, the high-powered Radio Progreso outlets on 640 and 1160 kHz. Prior to Radio Marti's appearance on 1180, a low-powered Progreso transmitter was on that frequency, as well as another relaying Radio Reloj Nacional. Both of these, to give readers an idea how well Cubans reach into Canada, had been heard in Southern Ontario despite the presence of the 50 kW WHAM in Rochester. With the debut of Radio Marti on 1180 kHz, it is anybody's guess what Castro may throw on the frequency. Other channels to watch in the Cuban-US spectrum war include 590, 600 and 1040 kHz.

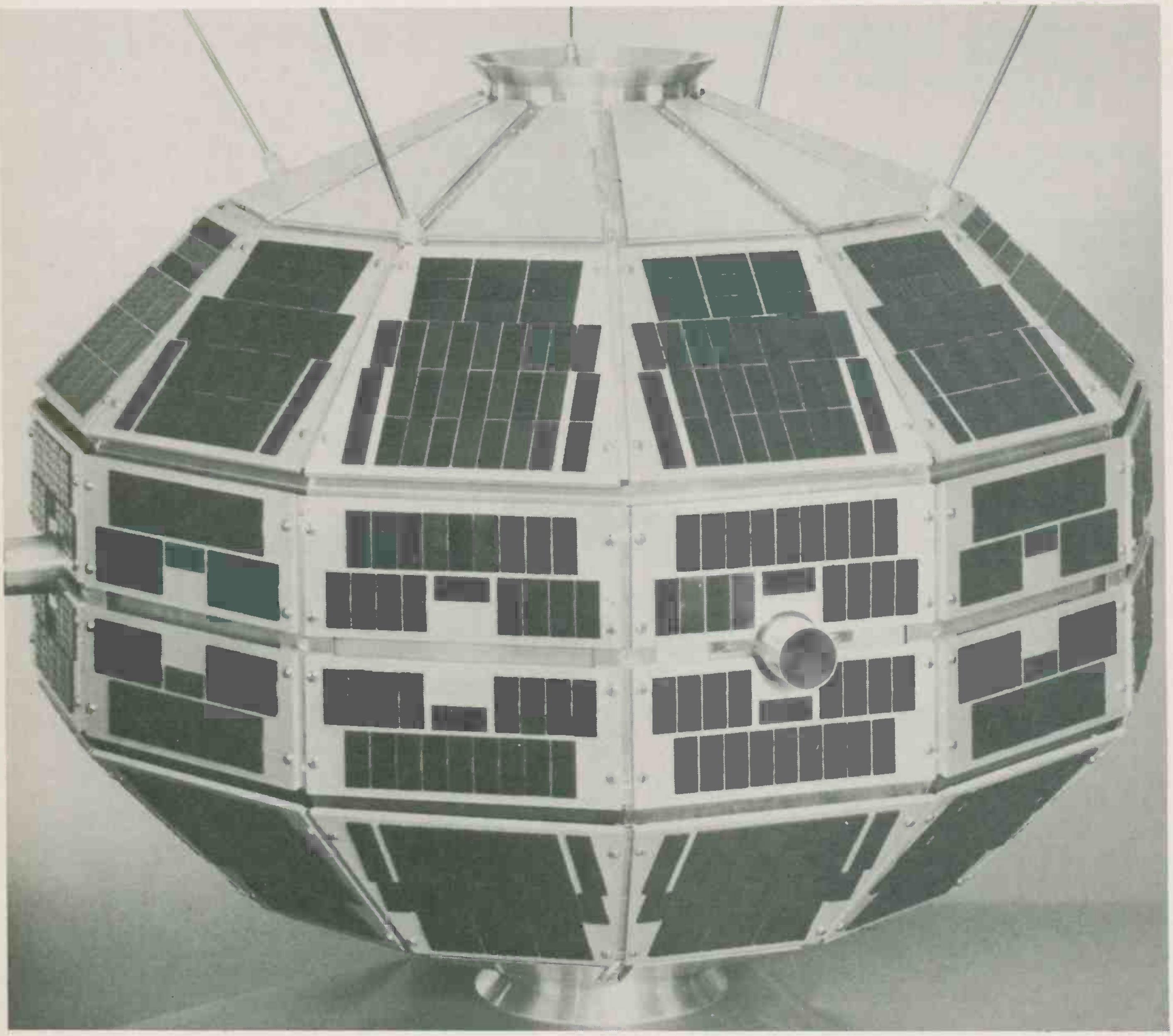
Coast to Coast

After Radio Progreso on 640 kHz signs off about midnight (assuming that they still do sign off by the time you read this), listeners in Eastern Canada should watch for KFI in Los Angeles. Listeners in the West will find east coast logging now almost impossible, although WHN at 1050 kHz, New York City, might make it. WWL at 870 kHz from New Orleans on the Gulf of Mexico is not too difficult.

Beyond the Edge

As noted in Spectrum Wars (ETI, Sept., 1983), plans are afoot to expand the broadcast band up to 1700 kHz, and already stations are broadcasting on 1610 kHz. By far the most widely heard of these is the English language religious Caribbean Beacon on tiny Anguilla in the eastern Antilles. Caribbean Beacon's US owners have persistently indicated an interest in becoming involved with the Radio Marti; thus 1610 kHz is a frequency which should be watched. **ETI**

Direct Broadcast Satellites



Roger Allan looks into the politics of DBS and its possible impact on the broadcast industry.

IN CANADA, government and broadcast interests have a distinct sense of deja-vu on the subject of direct-to-home or direct broadcast satellite (DBS) transmissions. This is due to the parallels that exist between current perceptions of television and radio transmissions and those that existed in the pre-TV days, to wit: the perceived need to offset the rapid encroachment of U.S. television services into Canada and to provide new opportunities to the domestic electronic equipment industry.

This perception has been heightened in recent years by the governmental policy steps taken to help negate the penetration of U.S. broadcasting signals (and therefore cultural mores) into the country. The matter has most recently come to a head due to over a dozen U.S. companies requesting authorization to proceed with 6/12 GHz DBS services, many of which will have spill-over in that geographic ribbon along our southern border which contains almost two-thirds of our population. While many of these applicants intend to use scrambling devices so that they can charge subscribers for their services, a

continued on page 39

Software Now!

Canada's Microcomputing Software Magazine $2.95

FIRST ISSUE OCTOBER 1984

- Up to the Minute Reviews
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The difference between we humans and the other inhabitants of the planet is our capacity for making tools. Civilization is often measured by its grasp of technology . . . it's through his use of tools that man has come to be able to manipulate his environment.

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Software Now! is the new magazine for people harnessing the power of the microcomputer. In its pages you will find the information which you will need to choose and apply the software that will dedicate your computer to your tasks. It will help you make sense of the miriad of similar software packages, translate the intricate complexities of software claims, understand the watershed breakthroughs in software development . . . and even have a bit of time left over to dematerialize a few aliens.

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Software Now! is published by Moorshead Publications, which also brings you Computing Now!, Electronics Today, Computers in Education and the Printout newsletter. It has been producing successful magazines in Canada since 1977.

Moorshead Publications is unique in the way it produces magazines. The expertise in applying microcomputers has allowed us to make virtually the entire process of publishing electronic. The editorial in the publications is created on word processing terminals and computer type set. All the financial planning is handled by computer, as is filing and list management. The company also maintains an on line telecommunications computer to communicate with its readers.

The Editor of **Software Now!** is Steve Rimmer, who also edits Computing Now! In the first year of its existence Computing Now! went from a standing start to having over twenty two thousand subscribers, making it Canada's largest consumer microcomputer publication.

Steve has had experience with a wide range of software, from word processors to sophisticated music and graphics packages. He uses a number of computers, including several CP/M based machines, an IBM, an Apple II+, a Commodore and a MacIntosh.

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Features In The Queue

This is some of the editorial we have lined up for the first few issues of Software Now! You can expect it to change a bit . . . new software springs up almost daily, and Software Now! will always feature the most important developments in this dynamic field. Articles being developed during the preparation for the magazine include:

Computer Aided Drafting On a Micro • Techniques in MacPaint • How to choose a Spreadsheet • Apple Software Crate • Getting to the Root of UNIX • The Digital Research Pantry • A Thousand and One Word Processors • IBM's Productivity Family • Can Mac Write? • Professional Software Roundup • Power Programs for the 64 • Approaching the C • Word Processing Support Programs • dBase II Enhancements • Will it Run Multiuser? • Concurrent CP/M •.

Reviews: 10 Base • Mighty Mail • WORDBASE • Easy Script • Computer Chef • Electronic Circuit Analysis Program • Superex Retailer • MAI Basic Four • The Print Shop • TK!Solver • Microsoft BASIC for the Macintosh • Sundog • Turbo PASCAL for the IBM • AutoCAD • MultiMate • Lexicheck and Word Juggler • Dataflex • Symphony • Omniterm 2 • DB Master • Paint Magic.

In addition to this look for these regular features:

The Library	(Our monthly survey of books)
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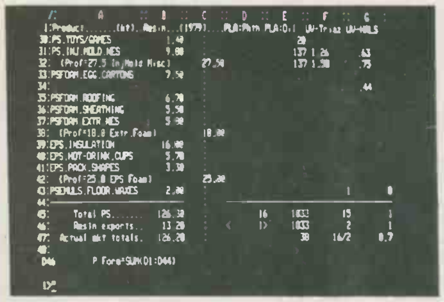

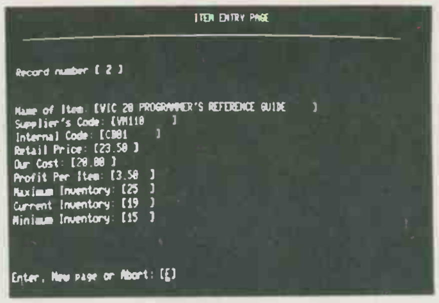

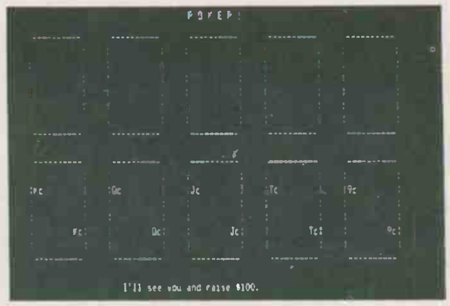

CalcNow

CalcNow is a fully capable spreadsheet package. It can manage a sheet sixteen columns across by twenty six rows deep. It allows for automatic and manual recalculation, full cursor movement, formulae, constants and labels, disk storage of your sheets and a full hard copy reporting function. Its syntax and behavior is very much like that of the popular packages and for models of the size usually used in small business and personal financial planning it's equivalent to professional . . . and very much more expensive . . . spreadsheet packages.

DataBox

Many commercial data base managers are extremely powerful, extremely expensive and, in fact, grossly over qualified for most tasks. DataBox can handle most of their routine tasks that data base managers are bought for. It is efficient of disk space, reasonably fast and very, very flexible. It can keep track of your files, your stock . . . or even your record collection. It features variable fields, hard copy reporting and flexible search parameters.

Poker!

We wanted to include a game on the disk and, after some deliberation decided that a good dimly lit, smokey card game would fill the bill best. This one simulates five card draw poker in the proper cowboy style. It can deal, draw, call, bet . . . do everything but cheat and pull its six gun on a really bad hand. POKER! features a graphic display of the cards being played.

Phone Jack

Most computers have telecommunications hardware built into them . . . it's a shame that they don't all have software available to drive it. This program does basic telecommunications and, while its features do vary a bit from system to system . . . based on what the operating systems allowed us to impliment . . . it does provide for the basic requirements of calling computer bulletin boards and dial up mainframes.

Utility Pack

Most revisions of the disk will also have a choice selection of utility programs. These vary a lot from system to system so it's a bit difficult to describe them all here. However, these are the little routines that make life so much easier when you sit down at the keyboard and switch on.

These programs will vary a bit from system to system . . . the following outlines the formats in which we can supply this software. You will need your own Microsoft compatible suitable BASIC Interpreter (e.g. GWBASIC, BASIC-80, MBASIC, APPLESOFT, RS BASIC, PET BASIC, Microsoft MacIntosh BASIC etc.)

For CP/M* users: CalcNow, DataBox, Poker!, Utility Pack, Phone Jack

For Apple][+DOS Users: CalcNow, Databox, Poker!, Phone Jack, Utility Pack plus Clef Hanger (An Apple Music Box), Skyhook (a teletype converter) and Fruit Crate (a BBS).

For IBM Users: CalcNow, Databox, Poker!, Utility Pack, Phone Jack plus Bandit (A slot machine simulator)

For MacIntosh Users: CalcNow, Databox, Poker, Phone Jack and Letterhead (a stationary generator).

For Commodore Users: CalcNow, Databox, Poker, Utility Pack and Phone Jack.

For TRS-80 Model III and 4: CalcNow, Databox, Poker

This software is available as a free gift to charter subscribers to Software Now! magazine. To be eligible to receive this disk your subscription order must be at our offices no later than September 30th, 1984.

*Available for Apple CP/M, Osborne single and double densities, Access Matrix, Kaypro II, Lobo max 80, Morrow Micro Decision, Olympia single and double, Superbrain, Systel/Olympia, DEC VT-180, Nelma Persona, Xerox/Cromemco, 3R Avatar, Casio FP-1000, Epson QX-10VD, Attache, Micromate, if800, Sanyo MBC 1000, Televideo, Zorba and on eight inch single sided single density disk.

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CBM	Commodore Disk formats
ACP	Apple CP/M
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OS2	Osborne Double Sided
AMT	Access Matrix
KAY	Kaypro
LOB	Lobo max 80
MOR	Morrow Micro Decision
OL1	Olympia Single sided
OL2	Olympia Double sided
SBR	Superbrain
SYS	Systel/Olympia
DEC	DEC VT-180
NEL	Nelma Persona
XER	Xerox/Cromenco
3RA	3R Atavar
CAS	Casio FP-1000
EPS	Epson QX-10VD
ATT	Attache
MIC	Micromate
SAN	Sanyo MBC 1000
TEL	Televideo
ZOR	Zorba
IF8	if800
8"	8" Disk Single Sided, Single Density

number of them do not; they intend to let the signals land where they may and be picked up by anyone, income being derived from the sale of advertisements on the various channels.

As such, both Canadian broadcasters and the federal government have been quietly agitating to get something in the works other than the policy statements and recommendations that have been propounded (and until recently, largely gathering dust) by the Department of Communications and the Canadian Association of Broadcasters. Of the two, the broadcasters are particularly concerned; while about 45% of Canadian homes have direct off-air access to current U.S. signals (rising to 57% for those that have cable), U.S. DBS signals could penetrate as much as 85% of the available Canadian market. Recognizing that they are having enough difficulty with U.S. TV competition as it is, the thought of even more is not greeted with glee in the broadcasters' boardrooms.

Technical Equivalence

One of the prime considerations espoused by the broadcasting community is that the government not implement a system that is incompatible with that used by the Americans. They learned in the 1930s, when the government ordered all private AM radio broadcasting stations to operate at much lower power levels than was permitted in the U.S., that this can only result in a major erosion in the market, an erosion which is difficult to overcome when the government finally wakes up (in this instance, in the early 1940's) and permits technical equivalence between the two national structures. Specifically, as far as the Canadian Association of Broadcasters (CAB) is concerned, the question lies in the power strength of the transmission down-links from the satellites; make it any less than the U.S. DBS system and larger receiving dishes are required, along with a concomitant increase in cost to the consumer, and less likelihood of viewer acceptance.

This is borne out in the conclusions of a government-commissioned study by the Woods Gordon Company, which indicated that a reception system costing $600 in 1981 dollars (representing the cost of a 1.2 metre receiving dish) would only include about one-third of the market of a $400 dish (0.8 metres) and that the market would virtually cease to exist if the dish alone cost $1,200 (1.8 metres).

The initial question that must be asked, of course, is why one should bother. After all, as government studies indicate, the cost of implementing such as system is rather high (so high in fact, that CAB insists that it cannot be done without government financial intervention) and would require large portions of the consumer market to purchase new equipment.

Why?

The usual answer is twofold: the Americans are going to do it, so we had better do it as well; and secondly, we want to reach the 'underserved' consumers. While I wouldn't suggest that anyone in Canada should receive less mass media input than anyone else, the government's description of 'underserved' would make most of the world's population sit down and giggle. According to one government report, more than 16% of the Canadian population still has 'relatively limited' access to broadcast services, either television or radio, and this despite the use of relay satellites. While urban dwellers have on average access to twelve television channels (either picked up from antennas or piped through cable systems) there are some four million Canadians in rural or northern areas that receive an average of only three television channels. It is to serve this market that the DBS system would be created.

A further consideration is that High Definition television is on the horizon as a new technology. It requires improved television tubes and less transmission interference than current models. Should HDTV become a market reality (at the

moment it is similar to the way laser-read audio disks were ten years ago), then a DBS system would be the most cost-effective way of reaching the market. Further, there is some thought that an entirely new signal processing and transmission system might be used, such as the Multiplexed Angular Component (MAC) system developed and currently being field tested by the Independent Broadcasting Authority in Great Britain. Such an introduction would follow the historical developments in domestic television receivers. Initially they were equipped with front end tuners for the VHF channels (2-13), later designs included UHF tuners, and current models are cable compatible. The next logical step is a television set containing the additional circuitry necessary for satellite reception, and it may as well be based on a new broadcasting system such as MAC as any other.

Europe

Canada and the U.S. are not alone in actively considering DBS systems. France and the Federal Republic of Germany are planning to introduce DBS around 1985/6. Their considerations are similar to those of Canada and the U.S., with the added point that they each want to improve their respective audio-visual presence in the European market. In other words, rather than complaining about other nations affecting their culture, they are actively counterattacking by exporting their life styles via the media. This has not been mentioned either in Canadian government or CAB submissions as a reason for Canada developing a DBS system, though it is just as valid.

Surprisingly, one of the earliest and most ambitious undertakings in the realm of DBS was undertaken by the Scandinavian countries. Based on a satellite designated NORSAT, the system was to provide programming for all the countries. The initial discussions were predicated not on commercial considerations, but rather on the recognition that no single Scandinavian country could afford DBS by itself, and that any system would result in signal spillage over several countries, analogous to Canada's concern over cultural sovereignty. It was felt that any disputes over spillage and cultural transpositions should be dealt with first. The discussions are currently progressing slowly, with Sweden threatening to go it alone despite the enormously high cost per viewer reached.

Elsewhere

Britain announced in 1982 that it will compose a two satellite DBS system to commence operation in 1986. Operated by the British Broadcasting Corporation, it will provide either direct-to-home broadcasting or community reception. The two channels will consist of an amalgamation of BBC-1 and BBC-2 programming and a subscription-type channel.

According to Dominic Kelly, an officer from the Australian Broadcasting Corporation on secondment to the Canadian Department of Communications, Australia has many of the same time-zone, geographic and demographic difficulties with DBS as Canada does, and next year will be accepting delivery of two satellites known as AUSSAT 1 and 2. Their system will go into effect in October or November 1985, and will require 1.2 to 1.4 meter dishes for reception.

Techniques

The modelling of a proposed DBS system is dependent upon receiving dish sizes, the power of the satellite's Travelling Wave Tubes (see The Potent Helix, ETI, February/84), the satellite position, and the uplinks/downlinks.

While early satellites and a few contemporary ones utilized for specialized purposes fly within a couple of hundred kilometres of the earth's surface (see Spy Satellites, ETI, April/83), most communication satellites have a much higher circular orbit, some 36,000 kilometres, permitting them to have an orbital period of 24 hours. This makes them appear stationary with respect to the ground, simplifying tracking and reception. However, since these geostationary orbits lie only along the equatorial plane with a unique radius, the number of satellite slots available is not limitless. The number of slots is not dependent upon the physical volume to be filled, but rather the radio interference between neighbouring satellites. In the realm of DBS broadcasting, where high power satellites are required, there are only a very limited number of available slots, and hence DBS modelers have to start carefully juggling their system's technical parameters. The optimum arrangement would be for a very large number of satellites whose beams, or footprints, would only cover a small area, and being high powered, would require only small dishes for good reception. However, the limited number of slots would mean that high-powered TWTs would interfere with each other.

In Canada's case, covering a vast amount of area and a number of time zones as it does, there are really only two models which might work: the four-footprint and the six-footprint versions. While not optimum, they do take into account such mundane considerations as time zones, the need for regional/national programming, market characteristics and political considerations as well as costs. While a one-beam model covering all of Canada is technically feasible, it would not adequately address the above considerations, while a system with more than six beams would be prohibitively expensive.

The Four-Beam Model

In the four-beam model, two satellites (and one back-up) would send eight channels per beam and use circular polarization of the signal, decreasing interference with neighbouring satellites. It would produce an effective isotropic radiated power (EIRP is the signal's ground strength) of either 50 dBW or 54 dBW depending on the strength of the TWTAs on board (47dBW is considered the minimum for any such a system). The higher the EIRP, the more powerful the TWTs have to be and the higher the cost and difficulty of providing both the maneuvering engines and the electrical power from solar cells. Further, the actual physical size of the satellite becomes a consideration. A 57dBW system would need 20 super-high-powered TWTs, necessitating higher launching costs.

This four-beam model would result in the time zone coverage being split into four segments; one covering British Columbia and most of Alberta, one covering Manitoba, Saskatchewan and part of western Ontario, one covering most of Ontario and part of Quebec and one covering the rest of the country. While seemingly adequate in itself, it lessens the broadcasters' ability to introduce regional programming, and would provide scheduling problems for national broadcasts — the ten o'clock news coming in at nine o'clock, for instance. It is, however, relatively cheap, weighing in at some $652 million 1982 dollars for a 50 dBW version and $832 million 1982 dollars for the 54 dBW version.

The six-beam model would require three satellites (plus one back-up) and would allow ten channels per beam. As such, it would be more compatible with the country's time zones, as well as permitting increased regional and specialized broadcasting.

At present it appears to be the most likely candidate for acceptance by the powers that be, though its cost rings in at 920 million 1982 dollars for the 50 dBW version and 1,280 million 1982 dollars for the 54 dBW version. Polarization would likewise be circular.

Modulation

The modulation system for either version is favoured to be FM. While it would seemingly be more appropriate to use the AM system as is currently utilized by terrestrial carriers, the power of the TWTs required to transmit via this method are several orders of magnitude greater than for FM. Since bus space (that is, the volume and weight that can be orbited, either by the Space Shuttle or the European launchers) is limited, and the radiative power of the TWTs would interfere with neighbouring satellites, the situation really calls for a new satellite design. It also has the added benefit of providing far higher quality of audio reception, a factor in viewer acceptance for the system.

The Links

The determination of uplinks and downlinks is inextricably entwined with the seemingly endless discussion as to frequencies, along with considerations as to EIRP. Currently, the major Canadian communications satellites are the ANIK series, which operate on the 6/4 and 14/12 GHz bands. Since the 6/4 band is also used for microwave transmissions among terrestrial users, the TWTs used must have their power constrained within reasonably tight limits so that interference does not occur. When DBS experiments were conducted in 1979, receiving dishes of 3 metres or larger were required. While the experiments were considered a success, the initial cost of such large parabolic reflectors was considered far in excess of what the consumer market would be prepared to bear.

The 14/12 GHz frequency band has no such problem. It is not used by terrestrial information carriers, and the TWT power can be substantially increased, resulting in dishes of only 0.8 metres in diameter.

The difficulty arises in which frequency to use. A dedicated satellite for DBS operating on 14/12, while under active consideration by the Department of Communications, is well in the future and very expensive. If one waits, then the U.S. will get the jump on Canada, analogous to the reception power considerations in the 1930s mentioned above. If one doesn't wait, it means utilizing the 6/4 band, necessitating the large expensive antennae. Industry proposals are to use the 6/4 band as a stop-gap measure, but to have the reception undertaken by community groups or companies such as the cable systems, who would then feed the signals through their cables to subscribers. This is termed MATV, or Multiple Antenna system for Television.

The difficulty with this proposal is that one of the major features of a DBS system is to provide service to underserved areas. The underserved areas don't have cable, and hence any such DBS system would in the eyes of the government be virtually redundant from the start.

There is some thought that the ANIK C's currently in orbit could be used as a makeshift alternative, since they operate on the 14/12 GHz frequency. However, home viewers would require an antenna dish of 1.2 metres or larger. Nonetheless, both government and industry are of the view that cable companies, community groups and apartment dwellers would be prepared to share in the purchase of an adequate-sized dish. The single farmer out on the back forty would probably not be able to afford such a large dish, which rather negates the government's reasoning, but in industry's view, better something than nothing.

The Future?

As for the future, it appears as if Canada is destined to have a DBS system whether the consumer wants it or not. The government is increasingly firm in its stance that such a system should be put in place for political and cultural reasons, and to provide Canadian manufacturers with another product to sell. Broadcasters likewise are in favour of the system, though they are reticent in bearing the cost, have doubts as to its feasibility for anything other than providing downlinks to cable, and really aren't sure of its overall utility. While you might expect broadcasters to be anti-DBS because of their large investment in cable, and because they've been stung by the poor performance of another innovation (Pay TV), they may indeed have a point.

ETI

Electronics In Action

Two amazing video cameras, a camera that photographs heat, and an intelligent phone.

by Roger Allan

ONE OF THE engineering problems faced in industrial and robotics applications is the difficulty of seeing around corners or obtaining crystal-clear video images from hostile environments. The thumping and crunching of machinery, the whiplash effects of a robot's arm movements, the rapid increase and decrease of pressures and the effects of radiation all make the utilization of video tube cameras less than optimal. They break down regularly, and with particular note in industrial robotics, often times end up as a box full of junk.

In an attempt to deal with this problem, the Fairchild Company has developed a series of what they term 'automation cameras', designed for usage in industrial facilities where video tubes have difficulty operating. Their basic structure is based on the use of charge coupled devices (CCDs) permitting them to overcome the video tube type camera problems while still maintaining optical imagery quality close to that of commercial television.

Their top-of-the-line model is called the CCD4001. It can operate as a single unit or be separated into a camera control unit and a sense head connected by a twelve foot cable. This permits the sense head to be mounted, for instance, at the end of an industrial robot's arm and flung about with wild abandon without effecting the video quality.

Weighing in at a total of 1 kg (with the sense head a mere 227 g) its internal architecture is complicated but compact. The image detector used is a selected, monolithic 256 x 256 element CCD. The buried channel CCD minimizes noise and allows for high frame rates without sacrificing the charge transfer efficiency. It is designed with sufficient 'robustness' to withstand fairly severe hostile environments. The sense head contains the image sensor and the circuitry for generating the high frequency horizontal raster and sample pulse clock signals for the CCD control as well as providing a buffer for the sensor video. Light reaching the sensor is filtered through a 2.0 mm thick Schott glass lens in order to eliminate infrared content. This results in a near photopic spectral sensitivity.

The camera control unit (housed at the other end of the cable) contains three PC cards performing the functions of camera and sensor timing control, CCD drives and video processing. This unit receives the sensor video from the CCD in the sense head, clamps it, amplifies the signal and blanks it with composite blanketing from the logic boards. This rectifies the image to NTSC standards, thereby permitting its display on standard monitors or digital analysis by computer.

Command Dialer

One of the more intriguing possibilities presented by the memory storage and number crunching abilities of computers is the ability to recognize human speech, either for data entry or data retrieval. There are a number of devices on the market which utilize voice recognition to a greater or lesser extent; talking clocks come most quickly to mind. They customarily operate on the recognition of phonemes, the set of the smallest unit of speech that serves to distinguish one utterance from another in a language or dialect. The difficulty with a phoneme-based speech recognition system is that they are really only word recognizers; that is, they can only recognize words in isolation with a pause in between. In order to achieve reasonable recognition ability, words must be spoken distinctly one at a time. As such, before such a system can perform recognition the person has to train the system to recognize the words that are to be used.

In an attempt to overcome this problem, the Audec Corporation has investigated the use of a system that they term 'Rikphones'. It is similar to a phoneme-based system in that it recognizes vocal elements. However, it differs from the phoneme system in that the Rikphones are larger, require a smaller memory storage capacity and hence can be processed faster than phonemes, raising the eventuality of real time data entry capabilities.

In contrast to the other speech recognition processes which utilize frequency spectrum separation of the incoming audio signals via filter banks, this process employs all-digital time-domain waveform analysis, extracting the essential features of the incoming audio signal and comparing them to templates preparatory to processing.

Utilizing this voice recognition process, the Audec Corporation now manufactures several devices for the home and business market, the most interesting of which is the Command Dialer VRT-1200, a voice activated telephone dialing system. This phone has the capability to recognize spoken words and to match them with preprogrammed words and numbers. Its memory can store up to 16 frequently-called phone numbers, up to 30 digits each (permitting the automatic entry to the MCI or Sprint telephone systems in the United States). For each of the 16 numbers one assigns a code word, such as fire, police, John, whatever. To place a call one merely lifts the receiver (which contains the memory activation switch) speaks the code word and the device automatically dials the call.

Up to four telephone calls can be placed simultaneously in this fashion, with the device automatically calling them in sequence. If the line is busy, the device will continue to dial the numbers in ten minute cycles for an hour. When the connection is completed, this phone advises the user of the connection via an LED display. Upon conclusion of the call, the device will pick up the phoning sequence where it left off until the next call is completed.

There are a number of extra features built into the device: an Instant Notebook which enables one to enter numbers or other short pieces of alphabetical information through the keyboard for latter recall via the LED display during the phone call itself, a security lock to prevent unauthorized entry, and a battery-back up to eliminate re-programming after a power outage or a disconnection. There's also a built in digital alarm clock with snooze control (perfect for the harried business executive during office hours).

The unit is primarily designed for the business market; it can be connected to Audec's MLC-1200 multi-line console, converting it into a five line system, and has a two-way speakerphone for hands-free or conference calling. However, a similar device, the VRT-1100, is available for the home market; it possesses most of the above capabilities, with the exception of having only 16 pre-programmed 30-digit numbers. It was selected for inclusion in the CES Design and Engineering Exhibition in Chicago this June, and in the view of the selection committee represented 'one of the most innovative consumer products introduced in 1984'.

Heat Auditor

When Sheik Yamani and his OPEC cohorts decided to throw a spanner into the world's economy ten years ago by raising the price of oil, rightly or wrongly, they certainly didn't imagine that their decision's ripple effect would result in a small company in Massachusetts teaming up with the Polaroid company to produce a device capable of helping companies and individuals to reduce their dependence on off-shore energy supplies by reducing heat loss. But such is the case.

The device in question is the Exergram 120 Heat Flux Auditor. It is designed to provide a fast, quantitative heat auditing analysis with a permanent record of the readings.

Handheld and weighing in at about 5 lbs, the workings of the system are relatively straightforward. According to the company's president, Frank Pompei, a function thermopile measures the total radiation from a building, room, steam pipe or whatever, converts the signal into digital form, averages it over a specified time period, and then uses the averaged signal to drive an internal LED display. The optical energy produced by the LED then registers on Polaroid 600 Instant Film, giving an instant permanent photographic record of the heat transfer. From such a picture one can determine U and R values of insulations, solar loading, heat losses from equipment and buildings and heat transfer through surfaces, both radiative and convectional.

The number crunching involved in doing the arithmetic is via a number of methods. There are preprogrammed cards for the TI-59 calculator, as well as software listings for use on other mini and micro computers.

Among a number of peripheral devices to help the device calculate the radiation transfer rates are an ultrasonic transducer and rangefinder (Polaroid design), a flash attachment, a digital heat display system for non-photo scanning, and a digital mechanism for recording the time, date, surface temperature, net heat radiation, air temperature and scale factors on the bottom of the photograph itself.

With a field of view of 30 degrees, a radiation gain/loss range of -400 to 1999.9 BTU/HR/sq. ft., a radiation accuracy of 1%, and a speed of 1.5 photographic records per second, the device will find primary application in industry and among companies catering to the home insulation market.

JVC Video Camera

One of the major difficulties facing home video film makers arising from the video revolution, if revolution there be, is the inadequacy of most currently available equipment for use on location shoots. You only need to remember the last time you were in the park or at the beach and saw some poor dad desperately trying to film his kids' antics while bestrewn with paraphernalia reminiscent of a Royal Marine traversing East Falkland Island.

In an attempt to overcome the weight and size problem, the JVC company is now marketing a lightweight (less than 2 kg) video camera, recorder and tuner. Known as the GR-C1U, its innards involve the utilization of a smaller cassette (the VHS-C) which despite being one-third the size of a standard cassette (about the size of a pack of playing cards) is capable of recording 20 minutes of footage, and includes a newly designed pickup head. The head drum cylinder of this device, representing the largest single component of any video recorder, has been reduced by about 1/3 of the customary diameter. To maintain a signal recording pattern consistent with standard VHS specifications, a new parallel loading system was developed in which the tape is loaded around 270 degrees of the drum, which rotates 50% faster than is customary. Four video heads are used to produce tracks of the same length as those recorded by standard VHS recorders. This allows the tape to be viewed through a

half-inch built-in electronic viewfinder, or alternatively, by fitting the VHS-C into a special cartridge (analogous to the cartridges which permit cassette tapes to be played on 8-track units) the footage can be viewed via standard VHS playback units and a television set. The tape can also be played back through an A/V monitor or (via a built-in RF unit) directly through any television.

The pick up tube utilizes a half-inch Saticon design single-carrier frequency separation design with a reverse filter similar to those used in three-tube broadcast cameras. Its optics are an f/1.2 lens with 6:1 zoom, while comprehensive color temperature adjustment, employing a combination of filters and electronic circuitry, permits accurate reproduction of the full color spectrum; this can range from the indoors (subdued restaurant lighting) to full direct sunlight. Artificial lighting, either incandescent or fluorescent, is automatically compensated for. Audio recording is via FM. The viewfinder is reminiscent of something from the Space Shuttle, incorporating a surprisingly comprehensive warning system which includes an exposure meter, low battery power, tape-end alarm and five other indicators. It is through this viewfinder that one can view playbacks of newly-recorded footage for on-the-spot checks of 'program content'.

There are many standard features to this device, such as audio and video dubbing capability, automatic backspace editing, shuttle searching in both directions and still playback. However, it is the external add-ons that really expand this device, such as a plug-on 3-inch color video monitor, and most intriguingly, the CG-P5OU character generator which permits the automatic superimposition of titles, dates and lap times on any recorded scene. Further, this character generator incorporates a 14-page memory and can create titles in four character sizes with scrolling and zoom effects. **ETI**

Addresses

Fairchild Camera and Instrument Corp., 3440 Hillview Ave., Palo Alto, Calif., 94304, USA

Exergen Corporation, 307 West Central Street, Natick, Massachusetts, 01760, USA

JVC Canada Limited, 21 Finchdene Square, Scarborough, Ontario, M1X 1A7

Audec Corporation, 299 Market Street, Saddle Brook, New Jersey, 07662, USA

Offbeat Metronome

A very basic rhythm box for musical practice and improvisation, with a tuning device built in.

by Andrew Armstrong

THIS IS a metronome with a difference. The initial requirement was for a simple metronome which would enable the musician or musicians to practise playing to an even rhythm, instead of succumbing to the inevitable temptation to play faster and faster until collapse from exhaustion ensues. The project became more ambitious when we decided to add a rhythm accent or offbeat to give a variety of rhythm 'feels' to play against. What was wanted, obviously, was a very simple substitute for a drummer.

The other primary motive was to devise an electronic rhythm device which costs less than the $100 or so demanded for even the cheapest commercial device.

The required variable offbeat was achieved by inserting another note between the regular beats, which can be adjusted to fall anywhere between the two beats, or in unison with one beat to give a stronger accent on that beat, or not to occur at all.

The final embellishment was the addition of a pure "A" tone for tuning purposes.

Offbeat Circuits

Figure 1 shows the basic functional blocks of the circuit. The oscillator on the top left is one that may be used in any simple metronome project. Next to it is drawn an offbeat comparator block. This is specially designed to add an extra beat between the *tock* and *tick*, so that with the offbeat, the sound is something like *tick-bok-tock, tick-bock-tock*.

In order to have a tuning aid available, an accurate sine wave oscillator is included, with the aid of the mode switch the oscillator can be stopped from oscillating and instead used to provide a slighly resonant sound on the signal from the offbeat comparator.

Pull And Twist

The controls (see photograph) are a pot governing the speed of the main rhythm, a small switch which pulls to turn the unit on, and rotates to control the volume; the pot which alters the relative position of the offbeat, and a two position switch which selects either the metronome or the "A" tone. The pull switch for on/off was chosen on the basis that pull switches don't wear out as fast as rotary switches with continual use, but an ordinary rotary on/off pot will do just as well.

First of all, the detailed functioning of the tuning oscillator: in order for a circuit to oscillate, it must receive feedback to its input with a phase shift on it, such that the phase change around the entire loop is 360 degrees. In this circuit, the 360° phase shift is achieved by one inversion and two 90° phase shifts. The integrator provides both the inversion and 90° phase shift over a wide range of frequencies. The low pass filter has a phase shift which depends on frequency, so it will only provide a 90° phase shift at one specific frequency.

So that the filter and the integrator can function without clipping, the feedback is taken via a clipper. The distortion produced by the clipper is filtered out by both the filter and the integrator, so that as long as neither the filter nor the integrator themselves clip, the output sine wave is very pure. Similarly, because the circuit is working in a linear mode, the frequency is stable and little affected by battery voltage.

IC1a (see Fig. 2) forms the filter, which is an ordinary low pass design, and IC1b forms the integrator. The clipping action is performed by a pair of back-to-back diodes, D2 and D3, with capacitor C4 preventing DC current through the diodes from upsetting the bias point of the op-amps.

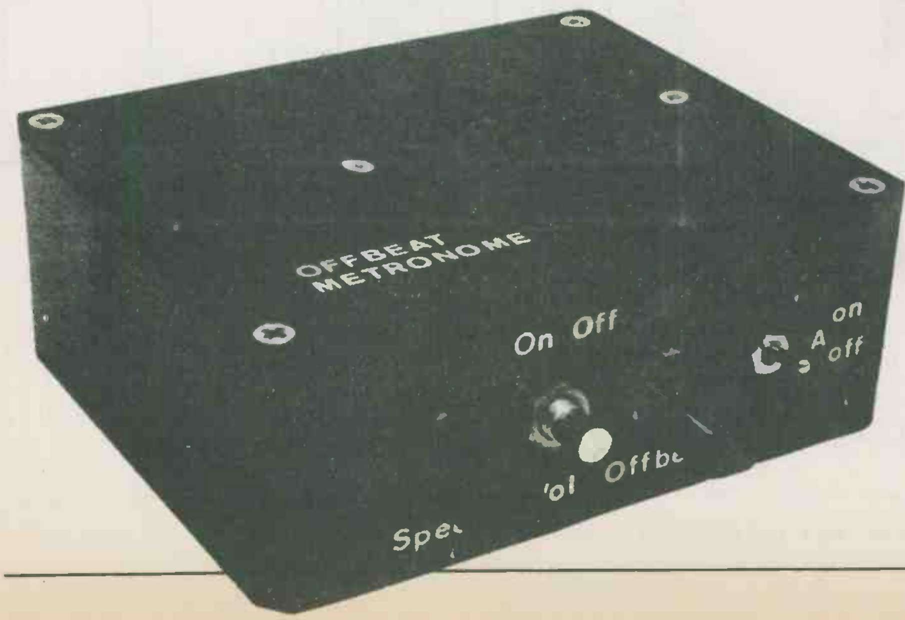
The gain of the integrator is switched by switch SW1b. In the low gain position, where some signal is fed into the integrator from the offbeat comparator, the loop gain of the oscillator is insufficient to permit oscillation. However, when the circuit is excited by a sharp pulse, it will ring slightly, producing a somewhat hollow and resonant sound rather like striking a guitar body. In the metronome mode, this resonsnt sound is mixed with the basic metronome tone. Resistors R7 and R8 determine the proportion of signals used.

Time Constant

The metronome oscillator itself uses IC1d. Postitive feedback is applied to the op-amp; negative feedback is also applied, delayed by the time constant of C1 and the resistance of RV2 in series with R3.

The time per half cycle of the oscillator is set by the time required for C1 to charge between the voltages, which can be obtained on the positive terminal of IC1d, with the output in either of its two states.

This is shown on the waveform diagram, Figure 3. Also illustrated on the waveform diagram is the fact that the output stage of the IC used, an LM324, cannot pull equally as close to its positive power supply as to its negative power sup-



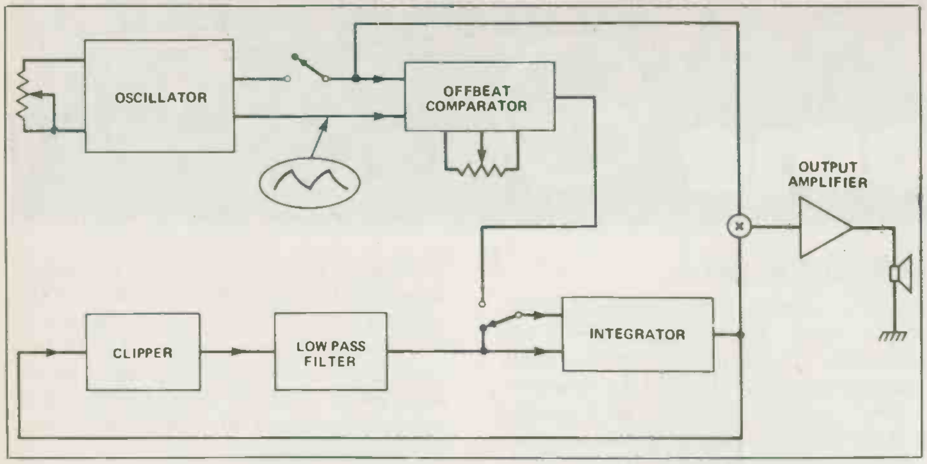


Fig. 1. The block diagram of the Offbeat Metronome.

ply. Thus, in order to maintain symmetry, to keep each half cycle of the oscillator the same length, a symmetry adjustment pot has been incorporated.

The waveform on C1 is also fed to IC1c's positive input. This part of the IC works as a comparator to insert the offbeat. When the output of IC1d is high, and C1 is therefore charging towards a positive voltage, and when the voltage on C1 crosses over the voltage set by the offset pot, the output of IC1c switches in a positive direction.

If the offbeat pot is set to a high voltage so that this switching does not occur before the output of IC1d switches low, then the output of IC1c will switch high at this moment. If the output of IC1c has switched high at all, it will switch low at the same moment that the output of IC1d switches high. Thus the return stroke of this comparator does not insert an extra offbeat, it merely modifies the sound of tick slightly. If the offbeat comparator is set at a lower voltage than that attained by C1, then the offbeat comparator will not switch at all, and in this mode an unaccented metronome sound is produced.

Output Amplifier

The only part of the circuit not yet described is the output amplifier. This very simple circuit uses a complimentary pair of transistors as emitter followers, to increase the output drive avialable from a 741 op-amp. These transistors are not biased into class A/B, so a certain amount of distortion is produced on the output. This distortion is not significant for the use to which the circuit is put. However, it does give rise to an interesting waveform on the output of the 741 itself, as the output voltage frantically attempts to compensate for the distortion being introduced by the transistors (see Fig. 4). As a result of this, the distortion produced is not very severe.

The volume control is of a linear type, and the way in which it is used produces an acceptable control law. Resistors R9 and capacitor C8 are included to prevent the possibility of self-oscillation of the circuit due to stray capacitance of the output stage, causing pickup on the wire from the wiper of RV4.

Construction

First of all, build up the PCB as shown in Figure 5, inserting the ICs last. Connect the controls to the PCB using suitable lengths of wire. Take great care to make sure that both halves of the mode switch are wired up in the correct sense. Failure to do so could result in the metronome and the tuning note to be heard simultaneously! Note that the speed control of the

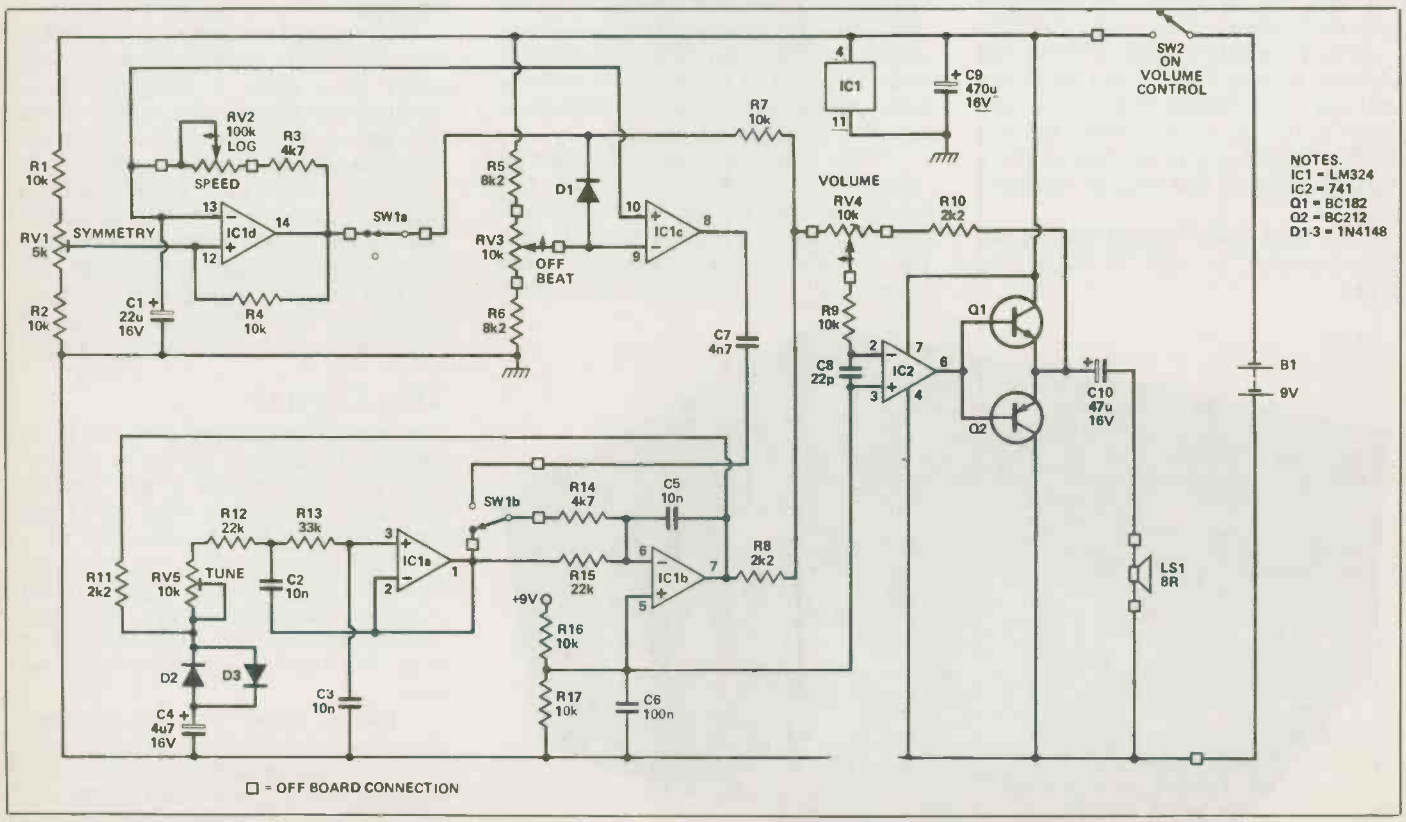


Fig. 2. The circuit. The tuning oscillator also modifies the sound from the offbeat comparator.

metronome is a logarithmic pot, wired up so that counter-clockwise rotation increases the speed. This is done in order to give finer control at the higher speeds.

Once all the controls are connected, the battery should be attached. Care should be taken to ensure that the polarity is correct! The unit should then be switched on, and then either a metronome beat or a tuning note should be heard. If the unit does not work properly, first check for badly soldered joints or solder bridges. If no such problems are found and the unit still does not work correctly, then try this list of remedies for likely problems:

1. Metronome does not work at all: check connections to RV2; check that C1 is in the board the right way around; check that the wiring to switch SW1a is correct.

2. Metronome works but offbeat function does not: check connections to RV3; check polarity of D1; check wiring to switch SW1b.

3. Tuning note will not work: check connections to switch SW1c; check polarity of C4; also check polarity of D2 and D3; check that half the battery voltage can be measured with an ordinary multimeter on IC1 pin 5; if not, check the *bias voltage* track for short circuits.

PARTS LIST

Resistors (All ¼ watt 5% carbon)

R1,2,4,7,9, 16,17	10k
R3,14	4k7
R5,6	8k2
R8,10,11	2k2
R12,15	22k
R13	33k

Potentiometers

RV1	5k horiz. preset
RV2	100k log pot.
RV3	10k lin. pot.
RV4	10k lin. pot. with SPST switch
RV5	10k horiz. preset

Capacitors

C1	22u 16V radial electro.
C2,3,5	10n polyester
C4	4u7 16 V tantalum
C6	100n polyester
C7	4n7 ceramic disc
C8	22p ceramic disc
C9	470u 16 V radial electro
C10	47u 16 V radial electro

Semiconductors

IC1	LM324
IC2	741
Q1	2N5825 etc.
Q2	2N6015 etc.
D1-3	1N4148

Miscellaneous

LS1	3½" 8R speaker

PCB; case approximately 120x100x45 mm; nuts & bolts; wire, solder, etc.

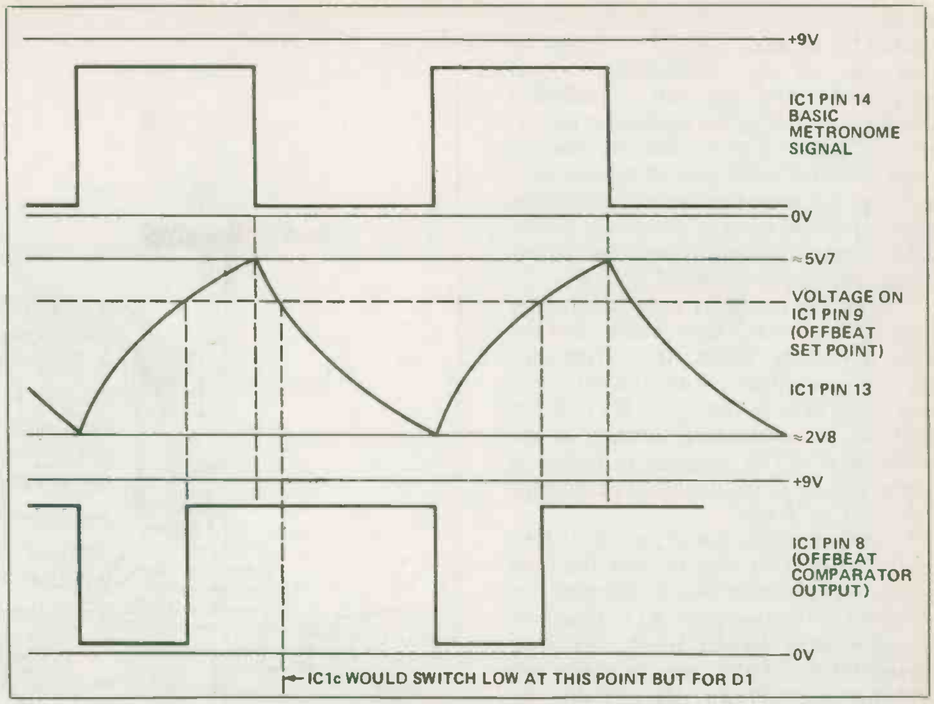


Fig. 3. The waveform diagram. The symmetry pot is included to compensate for the unequal positive/negative swing of the metronome signal.

4. No sound is heard at all: check wiring to battery and switch SW2; check wiring to RV4; check wiring to loudspeaker.

Hopefully, having carried out the checks, any fault will be identified, and you will now be faced with a working unit. The next job is to adjust the symmetry control to make sure that the time between the *tick* and the *tock* and the *tock* and the *tick* on the metronome is the same.

First, set the offbeat control fully clockwise or fully counter-clockwise, so that the offbeat is not heard. If you have an oscilloscope, then connect the probe to IC1 pin 14, advance RV2 to maximum

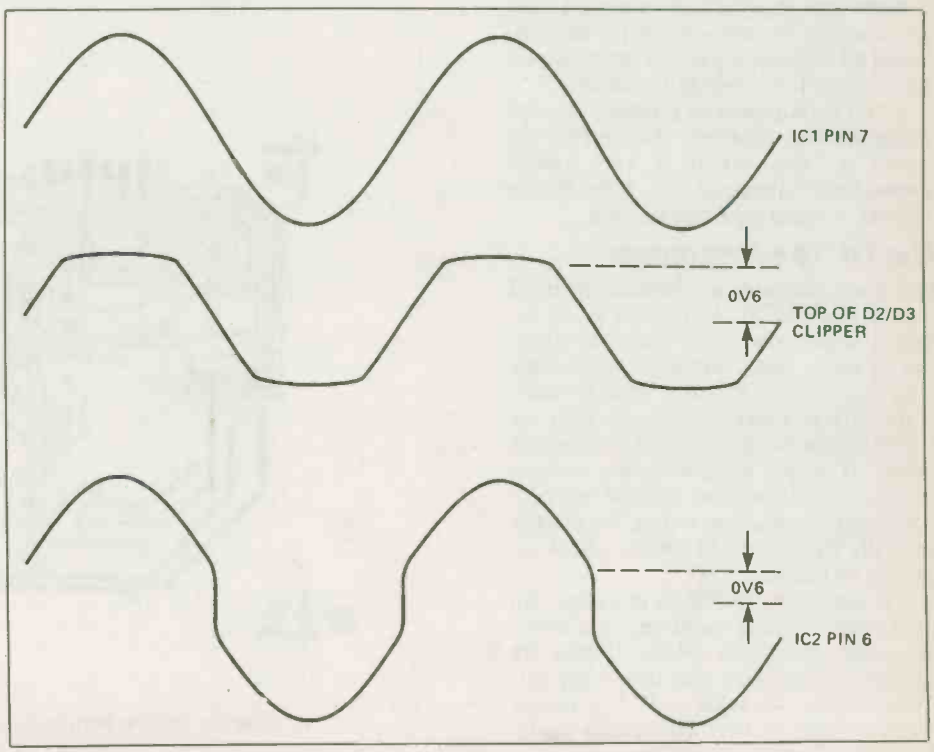


Fig. 4. The waveform at the output of IC2 (a 741) as it compensates for distortion produced by the transistors Q1 and 2.

speed and temporarily connect a 1k resistor in parallel with R3. You should now see on the oscilloscope a fast squarewave, and this can be adjusted visually by turning the symmetry pot. If an oscilloscope is not available, then instead turn the speed control to minimum and time the operation of the metronome with the second hand of a watch or the second count of a digital watch and adjust the symmetry pot for equal timings.

Now it is necessary to set the tuning tone. Switch to the "tune" mode, and the tone should be heard. If a frequency counter is available, then the note can very easily be adjusted to 440 Hz (concert pitch A). If a frequency counter is not available, it will be necessary to borrow a tuning fork or to use a musical instrument known to be in tune.

Adjust the tune preset pot till a "zero beat" is heard. It may be that the tone cannot be calibrated due to tolerances of C2 and C3. In this case, R13 should be altered to bring the oscillator to within the correct range. If the frequency was too low, decrease R13 one step at a time. If the frequency was too high, increase R13, again one E12 step at a time.

The unit is now calibrated, and final assembly can be carried out. A row of four holes needs to be drilled in the front of the case to fit the potentiometers. Four holes should also be drilled in the base of the unit to fit the mounting bolts of the PC board. The loudspeaker should be mounted on the lid behind a grid of holes, drilled to let the sound out. The best way to make sure that the holes are neatly laid out is to lightly centre-punch the material of the lid through a piece of graph paper; 2.5 or 3mm holes should be suitable.

Our prototype uses a plastic case for cheapness and lightness; this muffles the sound a little, so if a very robust metronome is wanted, or a maximum volume, a metal case can be used.

Use Of The Metronome

For some purposes a so-called accented beat is required. If the offbeat is not required at the same time, then the offbeat can be set to occur immediately after the *tick*, thus turning it into a 'double' beat. If the offbeat function is in use, then the *tick* is automatically accented to a certain extent. If only a basic metronome function is required, without offbeat but with very slight accent, then setting the offbeat pot fully clockwise will cause a slight accent to be heard.

If the tuning tone does not stop with the switch in either position, first check the wiring to switch SW1b. If you are completely confident that this is correct, try increasing the value of R15 to reduce the loop gain in the metronome mode. This should cure the problem.

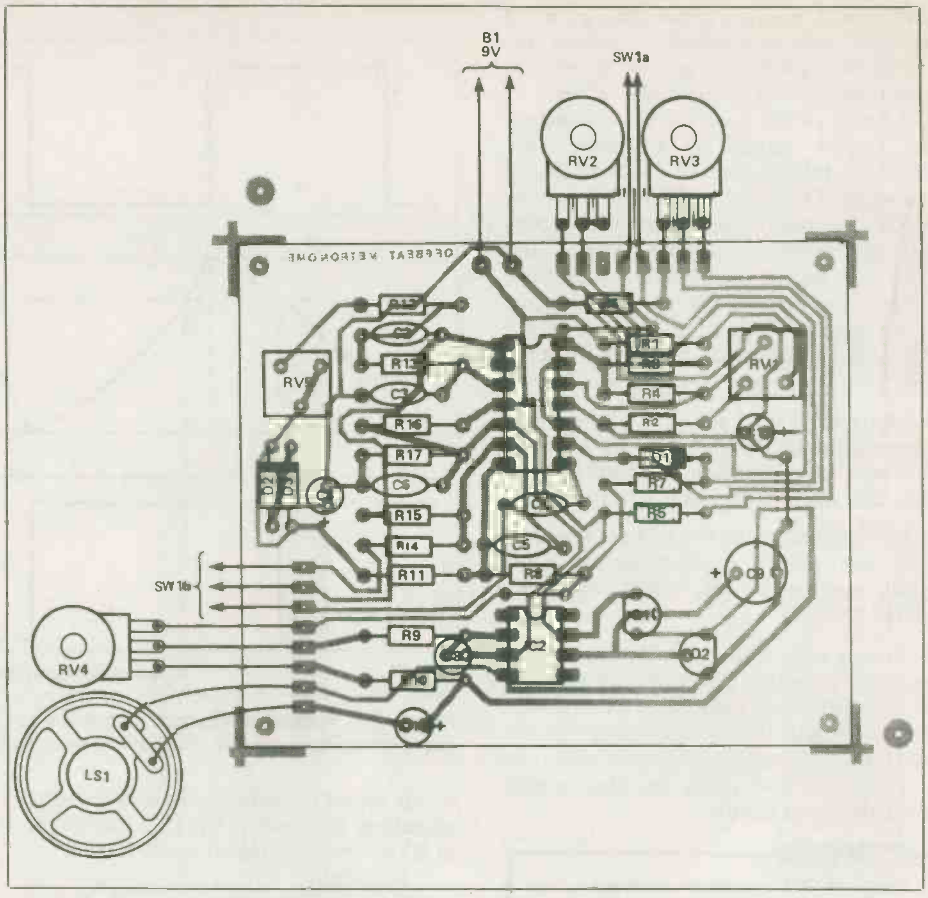
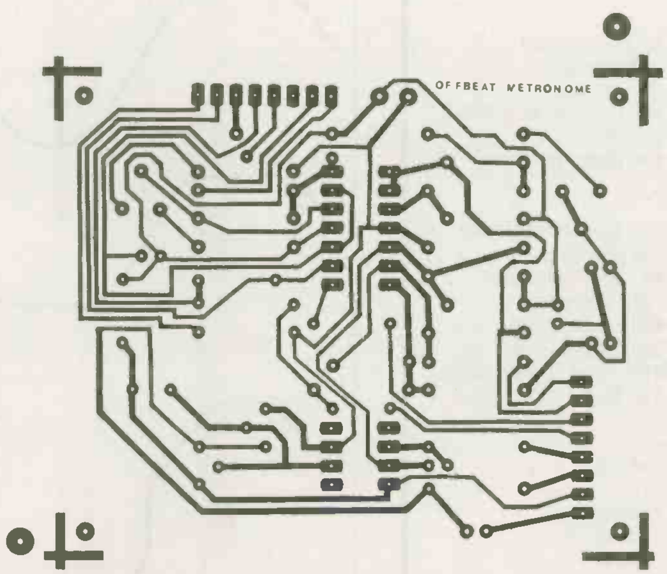


Fig. 5. The PCB overlay. The longer lengths of wire used to connect the switches make the mounting less fiddly, while not being so long as to be untidy.



PCB for the Offbeat Metronome.

ETI

Electronics Today Bookshelf

Top 10 Electronic Books

Based on sales from Moorshead Publications Book Service

1 BP73: REMOTE CONTROL PROJECTS — $8.10
OWEN BISHOP
This book is aimed primarily at the electronics enthusiast who wishes to experiment with remote control. Full explanations have been given so that the reader can fully understand how the circuits work and can more easily see how to modify them for other purposes, depending on personal requirements. Not only are radio control systems considered but also infra-red, visible light and ultrasonic systems as are the use of Logic ICs and Pulse position modulation etc.

2 BP90: AUDIO PROJECTS — $7.60
F.G. RAYER
Covers in detail the construction of a wide range of audio projects. The text has been divided into preamplifiers and mixers, power amplifiers, tone controls and matching and miscellaneous projects.

3 The GIANT HANDBOOK OF ELECTRONIC CIRCUITS
TAB No.1300 — $27.95
About as twice as thick as the Webster's dictionary, and having many more circuit diagrams, this book is ideal for any experimenter who wants to keep amused for several centuries. If there isn't a circuit for it in here, you should have no difficulty convincing yourself you don't really want to build it.

4 ELECTRONIC TROUBLESHOOTING HANDBOOK
AB019 — $11.95
This workbench guide can show you how to pinpoint circuit troubles in minutes, how to test anything electronic, and how to get the most out of low cost test equipment. You can use any and all of the time-saving shortcuts to rapidly locate and repair all types of electronic equipment malfunctions.

5 BP74: ELECTRONIC MUSIC PROJECTS — $7.20
R.A. PENFOLD
Although one of the more recent branches of amateur electronics, electronic music has now become extremely popular and there are many projects which fall into this category. The purpose of this book is to provide the constructor with a number of practical circuits for the less complex items of electronic music equipment, including such things as a Fuzz Box, Waa-Waa Pedal, Sustain Unit, Reverberation and Phaser-Units, Tremelo Generator etc.

6 BP44: IC 555 PROJECTS — $7.75
E.A. PARR, B.Sc.,C.Eng., M.I.E.E.
Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer is such a device. Included in this book are Basic and General Circuits, Motor Car and Model Railway Circuits, Alarms and Noise Makers as well as a section on the 556, 558 and 559 timers.

7 BP37: 50 PROJECTS USING RELAYS, SCR's & TRIACS — $7.75
F.G.RAYER, T.Eng.(CEI),Assoc.IERE
Relays, silicon controlled rectifiers (SCR's) and bi-directional triodes (TRIACs) have a wide range of applications in electronics today. This book gives tried and practical working circuits which should present the minimum of difficulty for the enthusiast to construct. In most of the circuits there is a wide latitude in component values and types, allowing easy modification of circuits or ready adaptation of them to individual needs.

8 BP79: RADIO CONTROL FOR BEGINNERS — $6.80
F.G. RAYER, T.Eng.(CEI),Assoc.IERE.
The aim of this book is to act as an introduction to Radio Control for beginners to the hobby. The book will commence by dealing with the conditions that are allowable for such things as frequency and power of transmission. This is followed by a "block" explanation of how control-device and transmitter operate and receiver and actuator(s) produce motion in a model.

Details are then given of actual solid state transmitting equipment which the reader can build. Plain and loaded aerials are then discussed and so is the field-strength meter to help with proper setting up.

The radio receiving equipment is then dealt with which includes a simple receiver and also a crystal controlled superhet. The book ends with the electro-mechanical means of obtaining movement of the controls of the model.

9 99 TEST EQUIPMENT PROJECTS YOU CAN BUILD
TAB No.805 — $15.95
An excellent source book for the hobbyist who wants to build up his work bench inexpensively. Projects range from a simple signal tracer to a 50MHz frequency counter. There are circuits to measure just about any electrical quantity: voltage, current, capacitance, impedance and more. The variety is endless and includes just about anything you could wish for!

10 BP76: POWER SUPPLY PROJECTS — $7.75
R.A. PENFOLD
Line power supplies are an essential part of many electronics projects. The purpose of this book is to give a number of power supply designs, including simple unstabilised types, fixed voltage regulated types, and variable voltage stabilised designs, the latter being primarily intended for use as bench supplies for the electronics workshop. The designs provided are all low voltage types for semiconductor circuits.

There are other types of power supply and a number of these are dealt with in the final chapter, including a cassette power supply, Ni-Cad battery charger, voltage step up circuit and a simple inverter.

See order form in this issue.

ELECTRONIC THEORY

ELEMENTS OF ELECTRONICS — AN ON-GOING SERIES
F.A. WILSON, C.G.I.A., C.Eng.,

BP62: BOOK 1. The Simple Electronic Circuit and Components	1.70
BP63: BOOK 2. Alternating Current Theory	$ 8.55
BP64: BOOK 3. Semiconductor Technology	$ 8.55
BP77: BOOK 4. Microprocessing Systems And Circuits	$11.70
BP89: BOOK 5. Communication	$11.70

The aim of this series of books can be stated quite simply — it is to provide an inexpensive introduction to modern electronics so that the reader will start on the right road by thoroughly understanding the fundamental principles involved.

Although written especially for readers with no more than ordinary arithmetical skills, the use of mathematics is not avoided, and all the mathematics required is taught as the reader progresses.

Each book is a complete treatise of a particular branch of the subject and, therefore, can be used on its own with one proviso, that the later books do not duplicate material from their predecessors, thus a working knowledge of the subjects covered by the earlier books is assumed.

BOOK 1: This book contains all the fundamental theory necessary to lead to a full understanding of the simple electronic circuit and its main components.

BOOK 2: This book continues with alternating current theory without which there can be no comprehension of speech, music, radio, television or even the electricity utilities.

BOOK 3: Follows on semiconductor technology, leading up to transistors and integrated circuits.

BOOK 4: A complete description of the internal workings of microprocessor.

BOOK 5: A book covering the whole communication scene.

PH247: DIGITAL TECHNIQUES — $29.00
Covers logic circuits, Boolean Algebra, flip-flops, registers, combinational logic circuitry, and digital design.

PROJECTS

BP48: ELECTRONIC PROJECTS FOR BEGINNERS — $7.75
F.G. RAYER, T.Eng.(CEI), Assoc.IERE
Another book written by the very experienced author — Mr. F.G. Rayer — and in it the newcomer to electronics, will find a wide range of easily made projects. Also, there are a considerable number of actual component and wiring layouts, to aid the beginner.

Furthermore, a number of projects have been arranged so that they can be constructed without any need for soldering and, thus, avoid the need for a soldering iron.

Also, many of the later projects can be built along the lines as those in the 'No Soldering' section so this may considerably increase the scope of projects which the newcomer can build and use.

221: 28 TESTED TRANSISTOR PROJECTS
R.TORRENS — $5.00
Mr. Richard Torrens is a well experienced electronics development engineer and has designed, developed, built and tested the many useful and interesting circuits included in this book. The projects themselves can be split down into simpler building blocks, which are shown separated by boxes in the circuits for ease of description, and also to enable any reader who wishes to combine boxes from different projects to realise ideas of his own.

BP71: ELECTRONIC HOUSEHOLD PROJECTS — $7.20
R. A. PENFOLD
Some of the most useful and popular electronic construction projects are those that can be used in or around the home. The circuits range from such things as '2 Tone Door Buzzer', Intercom, through Smoke or Gas Detectors to Baby and Freezer Alarms.

Electronics Today Bookshelf

BP49: POPULAR ELECTRONIC PROJECTS $7.75
R.A. PENFOLD
Includes a collection of the most popular types of circuits and projects which, we feel sure, will provide a number of designs to interest most electronics constructors. The projects selected cover a very wide range and are divided into four basic types: Radio Projects, Audio Projects, Household Projects and Test Equipment.

BP94: ELECTRONIC PROJECTS FOR CARS AND BOATS
R.A. PENFOLD $7.60
Projects, fifteen in all, which use a 12V supply are the basis of this book. Included are projects on Windscreen Wiper Control, Courtesy Light Delay, Battery Monitor, Cassette Power Supply, Lights Timer, Vehicle Immobiliser, Gas and Smoke Alarm, Depth Warning and Shaver Inverter.

BP95: MODEL RAILWAY PROJECTS $7.60
Electronic projects for model railways are fairly recent and have made possible an amazing degree of realism. The projects covered include controllers, signals and sound effects: striboard layouts are provided for each project.

BP93: ELECTRONIC TIMER PROJECTS $7.60
F.G. RAYER
Windscreen wiper delay, darkroom timer and metronome projects are included. Some of the more complex circuits are made up from simpler sub-circuits which are dealt with individually.

BP113: 30 Solderless Breadboard Projects-Book 2
R.A. Penfold $8.85
A companion to BP107. Describes a variety of projects that can be built on plug-in breadboards using CMOS logic IC's. Each project contains a schematic, parts list and operational notes.

BP104: Electronic Science Projects
Owen Bishop $8.85
Contains 12 electronic projects with a strong scientific flavour. Includes Simple Colour Temperature Meter, Infra-Red Laser, Electronic clock regulated by a resonating spring, a 'Scope with a solid state display, pH meter and electrocardiograph.

BP110: HOW TO GET YOUR ELECTRONIC PROJECTS WORKING $7.60
R.A. PENFOLD
We have all built circuits from magazines and books only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

BP84: DIGITAL IC PROJECTS $7.60
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
This book contains both simple and more advanced projects and it is hoped that these will be found of help to the reader developing a knowledge of the workings of digital circuits. To help the newcomer to the hobby the author has included a number of board layouts and wiring diagrams. Also the more ambitious projects can be built and tested section by section and this should help avoid or correct faults that could otherwise be troublesome. An ideal book for both beginner and more advanced enthusiast alike.

BP67: COUNTER DRIVER AND NUMERAL DISPLAY PROJECTS $7.05
F.G. RAYER, T.Eng.(CEI), Assoc. IERE
Numeral indicating devices have come very much to the forefront in recent years and will, undoubtedly, find increasing applications in all sorts of equipment. With present day integrated circuits, it is easy to count, divide and display numerically the electrical pulses obtained from a great range of driver circuits.

In this book many applications and projects using various types of numeral displays, popular counter and driver IC's etc. are considered.

BP99: MINI – MATRIX BOARD PROJECTS $7.60
R.A. PENFOLD
Twenty useful projects which can all be built on a 24 x 10 hole matrix board with copper strips. Includes Doorbuzzer, Low-voltage Alarm, AM Radio, Signal Generator, Projector Timer, Guitar Headphone Amp, Transistor Checker and more.

BP103: MULTI-CIRCUIT BOARD PROJECTS $7.60
R.A. PENFOLD
This book allows the reader to build 21 fairly simple electronic projects, all of which may be constructed on the same printed circuit board. Wherever possible, the same components have been used in each design so that with a relatively small number of components and hence low cost, it is possible to make any one of the projects or by re-using the components and P.C.B. all of the projects.

BP107: 30 SOLDERLESS BREADBOARD PROJECTS — BOOK 1 $8.85
R.A. PENFOLD
A "Solderless Breadboard" is simply a special board on which electronic circuits can be built and tested. The components used are just plugged in and unplugged as desired. The 30 projects featured in this book have been specially designed to be built on a "Verobloc" breadboard. Wherever possible the components used are common to several projects, hence with only a modest number of reasonably inexpensive components it is possible to build, in turn, every project shown.

BP106: MODERN OP-AMP PROJECTS $7.60
R.A. PENFOLD
Features a wide range of constructional projects which make use of op-amps including low-noise, low distortion, ultra-high input impedance, high slew-rate and high output current types.

CIRCUITS

How to Design Electronic Projects
BP127 $8.95
Although information on standard circuit blocks is available, there is less information on combing these circuit parts together. This title does just that. Practical examples are used and each is analysed to show what each does and how to apply this to other designs.

Audio Amplifier Construction
BP122 $8.95
A wide circuits is given, from low noise microphone and tape head preamps to a 100W MOSFET type. There is also the circuit for 12V bridge amp giving 18W. Circuit board or stripboard layout are included. Most of the circuits are well within the capabilities for even those with limited experience.

Electronic Circuits for Model Railways
BP213 $4.50
Lots of circuits including three types of controllers including one with simulated inertia and one with high power. Signalling and lighting systems are discussed at length and the superession of RF interference. There are also 4 "steam whistle" and "chuffer" circuits.

BP80: POPULAR ELECTRONIC CIRCUITS — BOOK 1 $7.75
R.A. PENFOLD
Another book by the very popular author, Mr. R.A. Penfold, who has designed and developed a large number of various circuits. These are grouped under the following general headings; Audio Circuits, Radio Circuits, Test Gear Circuits, Music Project Circuits, Household Project Circuits and Miscellaneous Circuits.

BP98: POPULAR ELECTRONIC CIRCUITS, BOOK 2 $8.85
R.A. PENFOLD
70 plus circuits based on modern components aimed at those with some experience.

BP39: 50 (FET) FIELD EFFECT TRANSISTOR PROJECTS $6.75
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
Field effect transistors (FETs), find application in a wide variety of circuits. The projects described here include radio frequency amplifiers and converters, test equipment and receiver aids, tuners, receivers, mixers and tone controls, as well as various miscellaneous devices which are useful in the home.

This book contains something of particular interest for every class of enthusiast — short wave listener, radio amateur, experimenter or audio devotee.

BP87: SIMPLE L.E.D. CIRCUITS $5.40
R.N. SOAR
Since it first appeared in 1977, Mr. R.N. Soar's book has proved very popular. The author has developed a further range of circuits and these are included in Book 2. Projects include a Transistor Tester, Various Voltage Regulators, Testers and so on.

BP42: 50 SIMPLE L.E.D. CIRCUITS $5.75
R.N. SOAR
The author of this book, Mr. R.N. Soar, has compiled 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components — the Light Emitting Diode (L.E.D.). A useful book for the library of both beginner and more advanced enthusiast alike.

THE ACTIVE FILTER HANDBOOK
TAB No.1133 $13.95
Whatever your field — computing, communications, audio, electronic music or whatever — you will find this book the ideal reference for active filter design.

The book introduces filters and their uses. The basic math is discussed so that the reader can tell where all design equations come from. The book also presents many practical circuits including a graphic equalizer, computer tape interface and more.

MASTER HANDBOOK OF 1001 PRACTICAL CIRCUITS
TAB No.800 $26.50
MASTER HANDBOOK OF 1001 MORE PRACTICAL CIRCUITS
TAB No.804 $23.95
Here are transistor and IC circuits for just about any application you might have. An ideal source book for the engineer, technician or hobbyist. Circuits are classified according to function, and all sections appear in alphabetical order.

BP88: HOW TO USE OP AMPS $8.85
E.A. PARR
A designer's guide covering several op amps, serving as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

BP65: SINGLE IC PROJECTS $6.05
R.A.PENFOLD
There is now a vast range of ICs available to the amateur market, the majority of which are not necessarily designed for use in a single application and can offer unlimited possibilities. All the projects contained in this book are simple to construct and are based on a single IC. A few projects employ one or two transistors in addition to an IC but in most cases the IC is the only active device used.

BP117: PRACTICAL ELECTRONIC BUILDING BLOCKS BOOK 1 $7.60
Virtually any electronic circuit will be found to consist of a number of distinct stages when analysed. Some circuits inevitably have unusual stages using specialised circuitry, but in most cases circuits are built up from building blocks of standard types.

This book is designed to aid electronics enthusiasts who like to experiment with circuits and produce their own projects rather than simply follow published project designs.

The circuits for a number of useful building blocks are included in this book. Where relevant, details of how to change the parameters of each circuit are given so that they can easily be modified to suit individual requirements.

223: 50 PROJECTS USING IC CA3130 $5.00
R.A.PENFOLD
In this book, the author has designed and developed a number of interesting and useful projects which are divided into five general categories: I — Audio Projects II — R.F. Projects III — Test Equipment IV — Household Projects V — Miscellaneous Projects.

224: 50 CMOS IC PROJECTS $5.25
R.A. PENFOLD
CMOS IC's are probably the most versatile range of digital devices for use by the amateur enthusiast. They are suitable for an extraordinary wide range of applications and are also some of the most inexpensive and easily available types of IC.

Mr. R.A. Penfold has designed and developed a number of interesting and useful projects which are divided into four general categories: I — Multivibrators II — Amplifiers and Oscillators III — Trigger Devices IV — Special Devices.

THE MASTER IC COOKBOOK
TAB No.1199 $17.95
If you've ever tried to find specs for a so called 'standard' chip, then you'll appreciate this book. C.L. Hallmark has compiled specs and pinout for most types of ICs that you'd ever want to use.

BP118: PRACTICAL ELECTRONIC BUILDING BLOCKS - Book 2
R.A. PENFOLD $7.60
This sequel to BP117 is written to help the reader create and experiment with his own circuits by combining standard type circuit building blocks. Circuits concerned with generating signals were covered in Book 1, this one deals with processing signals. Amplifiers and filters account for most of the book but comparators, Schmitt triggers and other circuits are covered.

BP24: 50 PROJECTS USING IC741 $6.75
RUDI & UWE REDMER
This book, originally published in Germany by TOPP, has achieved phenomenal sales on the Continent and Babani decided, in view of the fact that the integrated circuit used in this book is inexpensive to buy, to make this unique book available to the English speaking reader. Translated from the original German with copious notes, data and circuitry, a "must" for everyone whatever their interest in electronics.

BP83: VMOS PROJECTS $7.70
R.A. PENFOLD
Although modern bipolar power transistors give excellent results in a wide range of applications, they are not without their drawbacks or limitations. This book will primarily be concerned with VMOS power FETs although power MOSFETs will be dealt with in the chapter on audio circuits. A number of varied and interesting projects are covered under the main headings of: Audio Circuits, Sound Generator Circuits, DC Control Circuits and Signal Control Circuits.

BP50: IC LM3900 PROJECTS $5.40
H.KYBETT,B.Sc., C.Eng.
The purpose of this book is to introduce the LM3900 to the Technician, Experimenter and the Hobbyist. It provides the groundwork for both simple and more advanced uses, and is more than just a collection of simple circuits or projects.

Simple basic working circuits are used to introduce this IC. The LM3900 can do much more than is shown here, this is just an introduction. Imagination is the only limitation with this useful and versatile device. But first the reader must know the basics and that is what this book is all about.

ELECTRONIC DESING WITH OFF THE SHELF INTEGRATED CIRCUITS
AB016 $12.95
This practical handbook enables you to take advantage of the vast range of applications made possible by integrated circuits. The book tells how, in step by step fashion, to select components and how to combine them into functional electronic systems. If you want to stop being a "cookbook hobbyist", then this is the book for you.

See order form in this issue.

Electronics Today Bookshelf

RADIO AND COMMUNICATIONS

BP96: CB PROJECTS $7.60
R.A. PENFOLD
Projects include speech processor, aerial booster, cordless mike, aerial and harmonic filters, field strength meter, power supply, CB receiver and more.

222: SOLID STATE SHORT WAVE RECEIVERS FOR BEGINNERS $7.60
R.A. PENFOLD
In this book, R.A. Penfold has designed and developed several modern solid state short wave receiver circuits that will give a fairly high level of performance, despite the fact that they use only relatively few and inexpensive components.

BP91: AN INTRODUCTION TO RADIO DXing $7.60
This book is divided into two main sections one to amateur band reception, the other to broadcast bands. Advice is given to suitable equipment and techniques. A number of related constructional projects are described.

BP105: AERIAL PROJECTS $7.60
R.A. PENFOLD
The subject of aerials is vast but in this book the author has considered practical designs including active, loop and ferrite aerials, which give good performances and are reasonably simple and inexpensive to build. The complex theory and math of aerial design are avoided.

BP125: 25 Simple Amateur Band Aerials
E.M. Noll $7.60
Starting from simple dipoles through beam, triangle and even mini-rhombics (made from TV masts and 400ft of wire) this title describes several simple and inexpensive aerials to construct yourself. A complete set of dimension table are included.

BP46: RADIO CIRCUITS USING IC's $5.40
J.B. DANCE, M.Sc.
This book describes integrated circuits and how they can be employed in receivers for the reception of either amplitude or frequency modulated signals. The chapter on amplitude modulated (a.m.) receivers will be of most interest to those who wish to receive distant stations at only moderate audio quality, while the chapter on frequency modulation (f.m.) receivers will appeal to those who desire high fidelity reception.

BP92: ELECTRONICS SIMPLIFIED—CRYSTAL SET CONSTRUCTION $6.80
F.A. WILSON
Aimed at those who want to get into construction without much theoretical study. Homewound coils are used and all projects are very inexpensive to build.

BP70: TRANSISTOR RADIO FAULT-FINDING CHART $2.50
CHAS. E. MILLER
Across the top of the chart will be found four rectangles containing brief descriptions of various faults; vis: — sound weak but undistorted; set dead; sound low or distorted and background noises. One then selects the most appropriate of these and following the arrows, carries out the suggested checks in sequence until the fault is cleared.

AUDIO

205: FIRST BOOK OF HI-FI LOUDSPEAKER ENCLOSURES $3.75
B.B. BABANI
This book gives data for building most types of loudspeaker enclosure. Includes corner reflex, bass reflex, exponential horn, folded horn, tuned port, klipschorn labyrinth, tuned column, loaded port and multi speaker panoramic. Many clear diagrams for every construction showing the dimensions necessary.

HOW TO BUILD A SMALL BUDGET RECORDING STUDIO FROM SCRATCH. . .
TAB No.1166 $15.95
The author, F. Alton Everest, has gotten studios together several times, and presents twelve complete, tested designs for a wide variety of applications. If all you own is a mono cassette recorder, you don't need this book. If you don't want your new four track to wind up sounding like one, though, you shouldn't be without it.

BP51: ELECTRONIC MUSIC AND CREATIVE TAPE RECORDING $7.75
M.K. BERRY
Electronic music is the new music of the Twentieth Century. It plays a large part in "pop" and "rock" music and, in fact, there is scarcely a group without some sort of synthesiser or other effects generator.

This book sets out to show how electronic music can be made at home with the simplest and most inexpensive of equipment. It then describes how the sounds are generated and how these may be recorded to build up the final composition.

BP81: ELECTRONIC SYNTHESISER PROJECTS $6.80
M.K. BERRY
One of the most fascinating and rewarding applications of electronics is in electronic music and there is hardly a group today without some sort of synthesiser or effects generator. Although an electronic synthesiser is quite a complex piece of electronic equipment, it can be broken down into much simpler units which may be built individually and these can then be used or assembled together to make a complete instrument.

ELECTRONIC MUSIC SYNTHESIZERS
TAB No.1167 $10.95
If you're fascinated by the potential of electronics in the field of music, then this is the book for you. Included is data on synthesizers in general as well as particular models. There is also a chapter on the various accessories that are available.

TEST EQUIPMENT

BP75: ELECTRONIC TEST EQUIPMENT CONSTRUCTION $6.80
F.G. RAYER, T.Eng. (CEI), Assoc. IERE
This book covers in detail the construction of a wide range of test equipment for both the Electronics Hobbyists and Radio Amateur. Included are projects ranging from an FET Amplified Voltmeter and Resistance Bridge to a Field Strength Indicator and Heterodyne Frequency Meter. Not only can the home constructor enjoy building the equipment but the finished projects can also be usefully utilised in the furtherance of his hobby.

THE POWER SUPPLY HANDBOOK
TAB No.806 $15.95
A complete one stop reference for hobbyists and engineers. Contains high and low voltage power supplies of every conceivable type as well mobile and portable units.

REFERENCE

BP85: INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE $11.75
ADRIAN MICHAELS
This book will help the reader to find possible substitutes for a popular user-orientated selection of modern transistors. Also shown are the material type, polarity, manufacturer selection of modern transistors. Also shown are the material type, polarity, manufacturer and use. The Equivalents are sub-divided into European, American and Japanese. The products of over 100 manufacturers are included. An essential addition to the library of all those interested in electronics, be they technicians, designers, engineers or hobbyists. Fantastic value for the amount of information it contains.

BP108: INTERNATIONAL DIODE EQUIVALENTS GUIDE
ADRIAN MICHAELS $8.95
This book is designed to help the user in finding possible substitutes for a large user orientated selection of the many different types of semiconductor diodes that are available today. Besides simple rectifier diodes also included are Zener diodes, LEDs, Diacs Triacs, Thyristors, Photo diodes and Display diodes.

BP1: FIRST BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES $5.75
B.B. BABANI
This guide covers many thousands of transistors showing possible alternatives and equivalents. Covers transistors made in Great Britain, USA, Japan, Germany, France, Europe, Hong Kong, and includes types produced by more than 120 different manufacturers.

BP14: SECOND BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES $6.75
B.B. BABANI
The "First Book of Transistor Equivalents" has had to be reprinted 15 times. The "Second Book" produced in the same style as the first book, in no way duplicates any of the data presented in it. The "Second Book" contains only additional material and the two books complement each other and make available some of the most complete and extensive information in this field. The interchangeability data covers semiconductors manufactured in Great Britain, USA, Germany, France, Poland, Italy, East Germany, Belgium, Austria, Netherlands and many other countries.

TOWER'S INTERNATIONAL OP-AMP LINEAR IC SELECTOR
TAB No.1216 $17.95
This book contains a wealth of useful data on over 5,000 Op-amps and linear ICs — both pinouts and essential characteristics. A comprehensive series of appendices contain information on specs, manufacturers, case outlines and so on.

CMOS DATABOOK
TAB No.984 $12.50
There are several books around with this title, but most are just collections of manufacturers' data sheets. This one, by Bill Hunter, explains all the intricacies of this useful family of logic devices . . . the missing link in getting your own designs working properly. Highly recommended to anyone working with digital circuits.

See order form in this issue.

ROBOTICS

THE COMPLETE HANDBOOK OF ROBOTICS
TAB No.1071 $15.95
All the information you need to build a walking, talking mechanical friend appears in this book. Your robot can take many forms and various options — light, sound, and proximity sensors — are covered in depth.

HOW TO BUILD YOUR OWN SELF PROGRAMMING ROBOT
TAB No.1241 $13.95
A practical guide on how to build a robot capable of learning how to adapt to a changing enviroment. The creature developed in the book, Rodney, is fully self programming, can develop theories to deal with situations and apply those theories in future circumstances.

BUILD YOUR OWN WORKING ROBOT
TAB No.841 $10.95
Contains complete plans — mechanical, schematics, logic diagrams and wiring diagrams — for building Buster. Buster is a sophisticated experiment in cybernetics you can build in stages. There are two phases involved: first Buster is leash led, dependent on his creator for guidance; the second phase makes Buster more independent and able to get out of tough situations.

VIDEO

BP100: AN INTRODUCTION TO VIDEO
D.K. MATHEWSON $7.60
Presents in as non-technical a way as possible how a video recorder works and how to get the best out of it and its accessories. Among the items discussed are the pros and cons of the various systems, copying and editing, international tape exchange and understanding specifications.

Tab1519: ALL ABOUT HOME SATELLITE TELEVISION $22.95
Covers such aspects as where to buy, problems in setting up your TVRO station and how to solve them, antenna siting and equipment selection.

Tab1490: VIDEO CASSETTE RECORDERS: BUYING, USING AND MAINTAINING $14.95
A complete handbook for the video enthusiast. You'll learn about how the systems work and how to choose as well as take a technical look at the inside workings. There are also sections on making your own video recordings.

MISCELLANEOUS

PH255: COMPLETE GUIDE TO READING SCHEMATIC DIAGRAMS, 2nd Edition
J. DOUGLAS-YOUNG $11.95
Packed with scores of easy-to-understand diagram and invaluable troubleshooting tips as well as a circuit finder chart and a new section on logic circuits.

BP101: HOW TO IDENTIFY UNMARKED IC'S $2.75
K.H. RECORR
Originally published as a feature in 'Radio Electronics', this chart shows how to record the particular signature of an unmarked IC using a test meter, this information can then be used with manufacturer's data to establish the application.

BASIC TELEPHONE SWITCHING SYSTEMS
TALLEY
HB27 $17.95
The Revised Second Edition of this book, for trainee and engineer alike, includes updated statistical data on telephone stations, and new and improved signaling methods and switching techniques. It also includes E & M signaling interface for electronic central offices and automatic number identification methods used in step-by-step, panel and crossbar central offices.

PH252: DIGITAL ICs: HOW THEY WORK AND HOW TO USE THEM
A. BARBER $10.95
The dozens of illustrations included in this essential reference book will help explain time-saving test procedures, interpreting values, performing voltage measurements, and much more!

AUDIO AND VIDEO INTERFERENCE CURES
KAHANER
HB21 $8.95
A practical work about interference causes and cures that affect TV, radio, hi-fi, CB, and other devices. Provides all the information needed to stop interference. Schematic wiring diagrams of filters for all types of receivers and transmitters are included. Also, it supplies simple filter diagrams to eliminate radio and TV interference caused by noisy home appliances, neon lights, motors, etc.

BP121: How to Design and Make Your Own PCBs
R.A. Penfold $7.60
The emphasis is on practical rather than theoretical techniques. Starts by giving simple methods of copying from magazines, carries on with photographic methods of producing PCBs and continues with layout design.

 continued from page 25

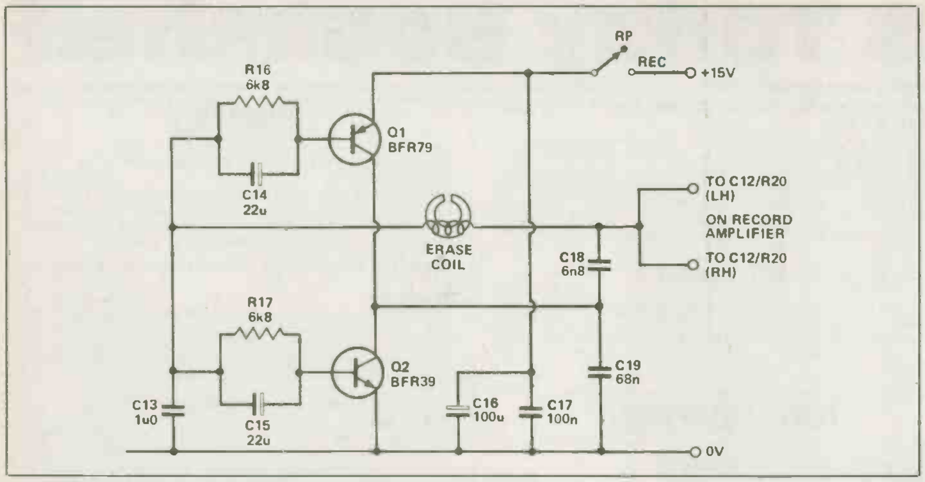


Fig. 15. A cassette recorder bias and erase oscillator.

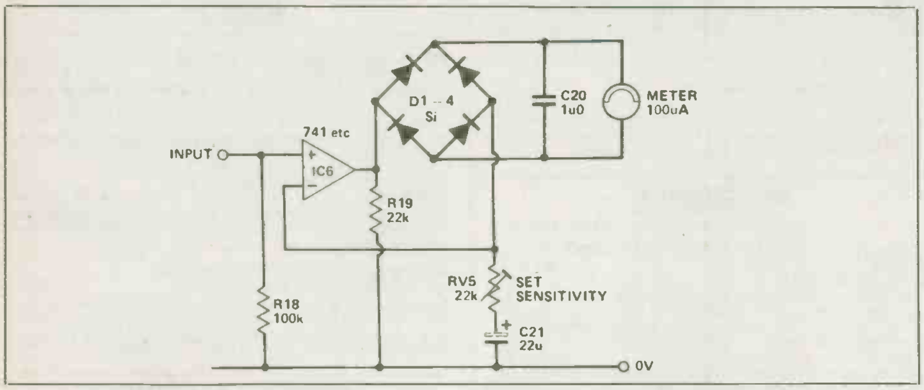


Fig. 16. A simple recording level meter circuit.

V supplies. It has to provide a means for adjusting the record signal level. It has to provide a modicum of bass lift, say +3 dB at 50 Hz and +6 dB at 30 Hz, to compensate for the specified roll-off in the replay curve. It has to provide the specified de-emphasis at 70*u*S or 120 *u*S as required, and finally, it has to generate a peak, of +15 dB or so, at 15 kHz, to offset the head losses.

A circuit which will meet these requirements, and give a high quality performance, is shown in Fig. 14. In this, IC3 is a simple unity gain buffer amplifier, which has a low output impedance but yet allows a high impedance input to the record level control. R9, R10, C6 and S2 generate the 70 and 120*u*S de-emphasis characteristics. Since we have calculated suitable values for these for the replay amp., we can use these again. R11 is a trimmer resistor which we can use to assist in getting an optimally flat overall frequency response, by lessening the extent of this de-emphasis. IC4 is a gain stage with a low-frequency gain of 5.7. However, the LCR network formed by L1, C8 and RV4 is tuned to resonate at 15 kHz; this makes the gain increase at this frequency to an extent which is governed by the Q of the circuit, which can be adjusted by RV4 (for the tuned circuit, f_0 = ½ LC).

R11, R12 and C9 generate the boost at 50 Hz (3180 *u*s, the time constant of C9R11) and the levelling off at 30 Hz (5300 *u*s, the time constant of C9 (R11+R12)). IC5 is another straight gain stage, with a gain of 5.7, and this drives the record head through C11 and R19.

Overall, the gain of this amplifier is 30 at 1 kHz, which allows a 5 V RMS output from IC5 for a 170 mV input. Bias is applied to the head directly from the bias oscillator circuit.

Bias and Erase Oscillator

In reel-to-reel recorders, and in the rather more up-market cassette decks, a separate transformer would be used, both as the coil in the LC erase oscillator, and as a transformer coupling from a secondary winding to drive the erase coils and HF bias circuitry. However, in cassette recorders, provided it is not proposed to use 'metal' tape (for which very high erase voltages across the erase head are needed to achieve the required 60 dB erasure of previously recorded signals), it is quite satisfactory to use the erase head itself as the coil in the oscillator circuit, and up to 25 V RMS can be generated by the oscillator circuit shown in Fig. 15. A small proportion of this is then bled off through an RC network to bias the record head.

The actual RMS bias voltage across the head for optimum recording characteristics must be determined by experience for the record head and tape being used, but it will probably lie somewhere between 5.5 and 10 V RMS, as measured by a wide-bandwith AC milli-voltmeter. Understandably, from Figs. 10 and 11, there is no such thing as a 'correct' bias voltage setting. All that one can do is to try to choose a voltage at which all of the conflicting tape characteristics are partially satisfied, in your own judgment. As simple a solution as any is to design the record and replay amps so that they give a reasonably good frequency response, and then trim the 'bias' voltage so that the overall frequency response is as level as possible. Obviously, if one has good instruments and a lot of time to experiment, a better compromise value could be found.

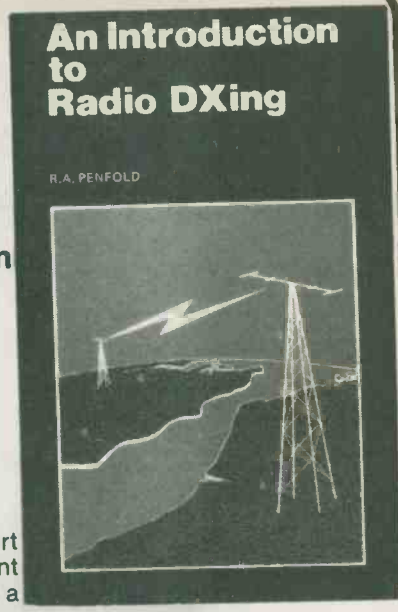
In Conclusion

These then are the basics of tape recording, and the circuits shown above, when used with a suitable cassette mechanism, an adquate power supply (derived for example from a pair of + and - output 12 or 15 V IC stabilizers and a decent quality pair of supply line bypass capacitors) and some form of recording level indicator which could well be a simple one-IC AC millivoltmeter of the form shown in Fig. 16, could be used to make a quite high performance DIY cassette recorder. However, being realistic, I do not really believe that anyone would want to build a cassette recorder — unless of course, they had most of the parts already at hand — when they could buy one, ready built, and with all the trimmings, for about two thirds of the wholesale price of the components.

Nevertheless, it is useful to know what kind of circuitry is employed in tape recorders, and what the problems and limitations are, so that one might rebuild or modify existing unsatisfactory equipment, or simply know where the strengths and weaknesses of the method lie. Also, because every tape or cassette recorder represents the end product of a very large number of design compromises, which affect distortion, modulation noise, overload characteristics, flatness of response and background noise level, as well as the straightforward HF bandwidth, cassette and reel to reel tape recorders differ in sound quality, one from another, very much more than, say, audio amplifiers or tuners do. Evaluation of the effect of these many compromises is truly an appropriate field for the 'subjective' listener. **ETI**

Book of the Month

An Introduction to Radio DXing



by R.A. Penfold

List Price: $7.60

Number BP91

Radio DXing, the art of tuning in to distant radio broadcasts, is a hobby enjoyed by many. This book contains two sections: one dealing with amateur band reception, and the other with broadcast bands. Advice on equipment and techniques, as well as a number of related projects are also included.

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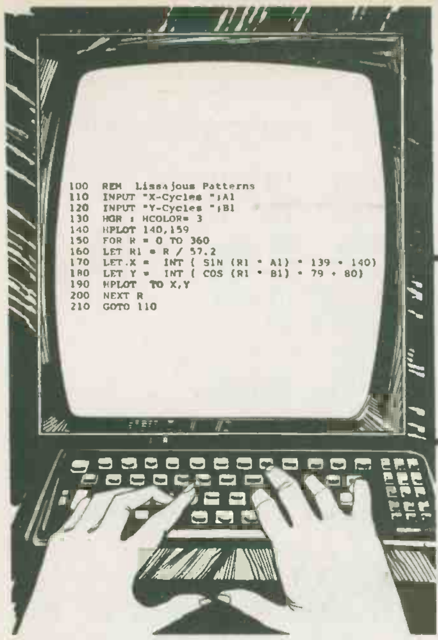


A look at Apple's new Disk Operating System.

Computing Today

Apple ProDOS

by Yin H. Pun

HAILED AS the successor of the aging DOS 3.3, ProDOS has beautiful structure, powerful in all respects; it has similarities to many main-frame operating systems. Here is a comparison of ProDOS to the usual Apple DOS 3.3.

ProDOS was released in January 1984, and it is highly structured and more complex than DOS 3.3, having borrowed from CP/M and Pascal. ProDOS even supports the use of a clock card (A Thunderclock or similar) since all files are dated when they are created or modified. ProDOS permits the use of a "binary" tree called a "pathway" that tells which way a program is loaded. The speed of the loading and saving is about 2 to 5 times faster than an unmodified DOS 3.3.

Hardware Requirements

ProDOS needs no special modification of the basic hardware, an Apple II and a disk drive with controller; no new disk controller PROMs are necessary. However, it does require 64K of RAM and Applesoft in ROM at least; Apple II and II pluses must have a 16K RAMcard. Apple IIes and IIc's already have 64K built-in. ProDOS, like the DOS 3.3, PASCAL and CP/M operating systems, is recorded on 16-sector disks (whereas DOS 3.2 is a 13-sector disk). A ProDOS disk may be read on the sector level with no difficulty. This means that a ProDOS may be copied with a normal 16-sector copy program, such as the popular COPYA on the DOS 3.3 system master. However, the way the information is organized on the disk is totally different.

The User's Disk

A disk of utilities is provided with ProDOS, along with a User's Disk Manual. It contains a FILER program, a disk utility analogous to DOS 3.3's FID and COPYA, used to copy files and whole disks. ProDOS, following the Pascal convention, calls disks "VOLUMES". A "VOLUME" may be a floppy or a hard disk, and is treated in the same way from the user's point of view. CONVERT is to ProDOS as MUFFIN is to DOS 3.3. It converts DOS 3.3 and ProDOS files back and forth. However, not all files may work under their foreign environments due to the differences in the two operating systems. The

```
]CATALOG

DISK VOLUME 254

*A 003 HELLO
*I 003 APPLESOFT
*B 006 LOADER.OBJ0
*B 042 FPBASIC
*B 042 INTBASIC
*A 003 MASTER
*B 009 MASTER CREATE
*I 009 COPY
*B 003 COPY.OBJ0
*A 009 COPYA
*B 003 CHAIN
*A 014 RENUMBER
*A 003 FILEM
*B 020 FID
*A 003 CONVERT13
*B 027 MUFFIN
*A 003 START13
*B 007 BOOT13
*A 004 SLOT#
```

Fig 1. A directory listing of a DOS 3.3 disk (The DOS 3.3 System Master) by the "CATALOG" command.

STARTUP program shows what you have in the slots of your computer and can set the time if you do not have a clock card. All of these utilities include a helpful tutor which can be requested at any time to describe the use of a command. The classic, ANIMALS, an animal guessing game that learns while you play it, is included too.

New Catalog

Most of the DOS 3.3 commands are retained in ProDOS. However, the CATALOG command is different in its usage. CATALOG results in a very informative 80-column listing, but is rather hard to read when you have only 40 columns since everything "wraps around". CAT results in a truncated 40-column listing. The DISK VOLUME number is replaced by a "prefix", the title of the disk. It can be up to 34 characters long. The directory also tells when files were created and updated if a clock card is installed. The "ENDFILE" column indicates the number of bytes that a file takes up. The "SUBTYPE" indicates the starting address of binary files and the number of records in random access text files. Instead of using the regular slot and drive parameters in the CATALOG command (i.e. CATALOG, S6, D1), you can specify the prefix instead (i.e. CATALOG/USERS.DISK/). ProDOS will go through each available disk drive and search for the disk. Otherwise it will say "PATH NOT FOUND". Don't be intimidated when you see the word "BLOCKS": ProDOS again follows the PASCAL convention of calling two disk sectors (512 bytes of memory) a "BLOCK". Therefore, files can only have an even number of sectors. A ProDOS disk stores the same total amount of memory as a DOS 3.3 disk: 280 BLOCKS or 560 sectors. The ProDOS directory presents a

```
/USERS.DISK

 NAME           TYPE  BLOCKS    MODIFIED         CREATED           ENDFILE SUBTYPE

*PRODOS         SYS    31    1-JAN-84  0:00   1-JAN-84   0:00  15360
*BASIC.SYSTEM   SYS    21   15-NOV-83  0:00  15-NOV-83   0:00  10240
*FILER          SYS    51    1-JAN-84  0:00   1-JAN-84   0:00  5600
*CONVERT        SYS    42    1-NOV-83  0:00   1-NOV-83   0:00  20481
*STARTUP        BAS    24   15-OCT-83  0:00  15-OCT-83   0:00  11465
*MOIRE          BAS         15-OCT-83  0:00  15-OCT-83   0:00  941
*HYPNOSIS       BAS     3   15-OCT-83  0:00  15-OCT-83   0:00  637
*ANIMALS        BAS    10   15-OCT-83  0:00  15-OCT-83   0:00  4578

BLOCKS FREE:    88     BLOCKS USED:   192      TOTAL BLOCKS:   280
```

Fig 2. An 80-column directory listing of a Pro DOS disk (The USER's DISK) by the "CATALOG" command. The "CAT" command lists only the left half in 40 columns.

significant improvement over the old DOS 3.3 directory.

Command Differences

A number of DOS commands are missing from ProDOS and will cause a syntax error if they are used. The INIT command to format a disk is no longer supported. A disk must be initialized using the FILER program on the USER'S DISK. MON, NOMON and MAXFILES are also not supported by ProDOS.

The VERIFY command does not check for the integrity of a file on the disk; it only checks if that file exists. Also it is no longer possible to DELETE a text file if it has been OPENed.

For example:

```
10 D$ = CHR$(4)
20 PRINT D$ "OPEN FILE"
30 PRINT D$ "DELETE FILE"
40 PRINT D$ "OPEN FILE"
50 PRINT D$ "WRITE FILE"
```

will work nicely under DOS 3.3, but not under ProDOS. Simply insert: 25 PRINT D$ "CLOSE FILE" to close the file before DELETEing it.

Control-D must precede all ProDOS commands in a PRINT statement, just like DOS 3.3. However, the concatenation of CHR$(13) and CHR$(4) to clear the DOS input buffer to ensure that a DOS command is issued (especially after a GET statement) does not work.

For example:

```
10 D$ = CHR$(13) + CHR$(4)
20 PRINT D$ "BLOAD
PROGRAM"
```

will work under DOS 3.3 but will not work under ProDOS. Use instead:

```
10 D$ = CHR$(4)
20 PRINT: PRINT D$ "BLOAD
PROGRAM"
```

Since ProDOS requires 64K of RAM, Integer BASIC cannot be loaded into the language card and cannot be supported at all.

All filenames must be only 15 characters long. Characters may be any combination of uppercase letters, digits and periods; spaces, punctuation marks and lowercase letters are not allowed.

Other than these major deletions, all of the DOS 3.3 commands are still present, including "BLOAD" and BSAVE", which have retained their original usage. The binary file start address and length cannot be found at locations $AA72 and $AA60 respectively anymore. The directory "ENDFILE" and "SUBTYPE" tell you this.

The .SYS File

The ".SYS" (system) file type is similar to CP/M's ".COM" files. They are machine language programs executed by typing a hyphen followed by the name. "Load" or "RUN" commands are not necessary. To execute the FILER, simply type "-FILER".

An Annoyance Killed

A major annoyance that I am glad to see cured is the execution of the "PR#" and "IN#" commands used to reroute output or input to printers, modems and 80-column cards via the slots. In DOS 3.3, if you type "PR#4" and there is no I/O peripheral card in slot number 4, you would probably lose control over the computer. If you are lucky, you may break into the monitor safely, but sometimes the program flow goes on a rampage, murdering your program and DOS itself. Normally, you have to restart the machine from the very beginning by turning the machine off and on again, certainly losing all its memory contents. ProDOS changes the output or input vector to the slot, it actually checks to see if a peripheral card with ROM memory is present. If it isn't, a "DEVICE NOT PRESENT" error results. This new error message also prints out if you try to access a non-existent disk drive in another slot.

Is DOS 3.3 Dead?

Does ProDOS obsolete DOS 3.3? Probably with time it will, just as DOS 3.3 replaced DOS 3.2 However, I still relish the simplicity of DOS 3.3 and it's adequate for my application programs. I hate to see Integer BASIC die away along with it. DOS 3.3 took a big step from DOS 3.2 in increasing the disk memory storage from 124K to 143K by increasing the sectors per track from 13 to 16. ProDOS took no step in increasing memory storage; the disk itself still uses only 35 tracks with 16 sectors per track (in keeping with older disk drives). It should be simple to fit ProDOS for use with 40 tracks in the same way as DOS 3.3. (from my article in TechTips, E.T.I. May 1984).

Nevertheless, I am generally impressed with Apple's new disk operating system, and hope to soon harness the full potential of it. **ETI**

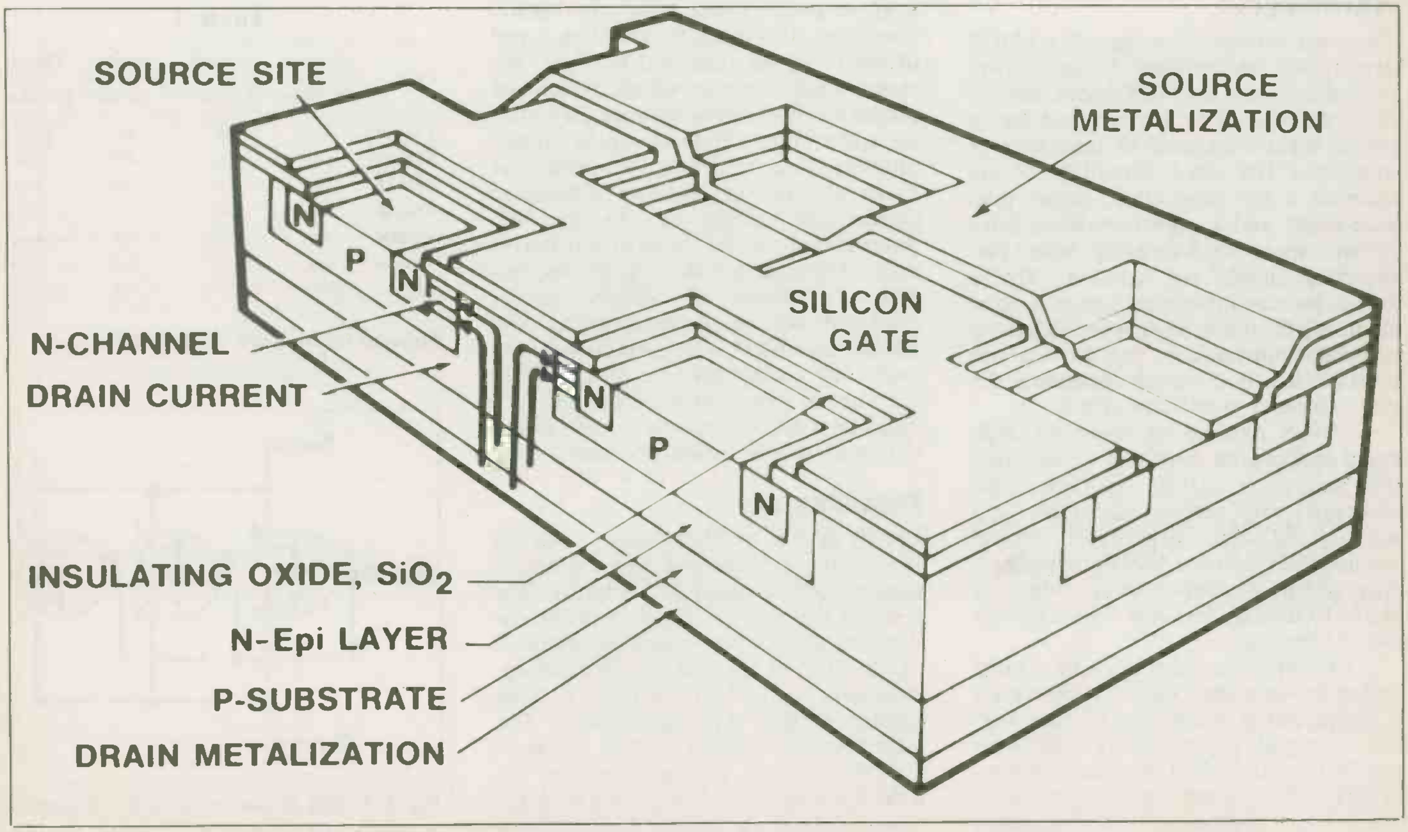
VMOS CIRCUITS

Explore the possibilities of VMOS transistors; they're close to being a voltage-controlled resistor.

by R.A. Penfold

THERE ARE three basic types of power FETs; the VMOS type, power MOSFETs, and V-JFETs. This article will primarily be concerned with VMOS power FETs because these are readily available at reasonably low prices. Low, medium and high power devices can be obtained, and although only N channel devices were originally produced, P channel devices are now produced commercially as well. Power MOSFETs are available to the amateur user, although they are relatively expensive. These are primarily designed for use in audio amplifiers (but are also suitable for a variety of other applications), and will be dealt with in the examples of audio circuits. Like power MOSFETs, V-JFETs are mainly intended for use in high quality high power audio amplifiers. However, they are depletion mode devices, whereas VMOS and power MOSFETs are enhancement mode devices. In other words, a V-JFET is switched full on when it has a gate to source voltage of zero, and is switched off by reverse biasing its gate (as in the case of an ordinary JFET). VMOS and power MOSFETs are switched off if the gate to source voltage is made zero, and are switched on by applying a forward bias to the gate. In this respect they are like ordinary bipolar transistors, or the MOSFETs fabricated in CMOS IC's. V-JFETs are more difficult to use than the other two types of power FET, and would not seem to be available to amateur users. Therefore, they will not be considered further here.

An ordinary field effect transistor has an "on" resistance that is usually in the range of 100 to 500 ohms, and so producing a useable power FET is not just a matter of producing a device that is capable of dissipating high power without being destroyed; it is also necessary to obtain a much lower "on" resistance. The struc-



The construction of a FET chip, courtesy of Motorola.

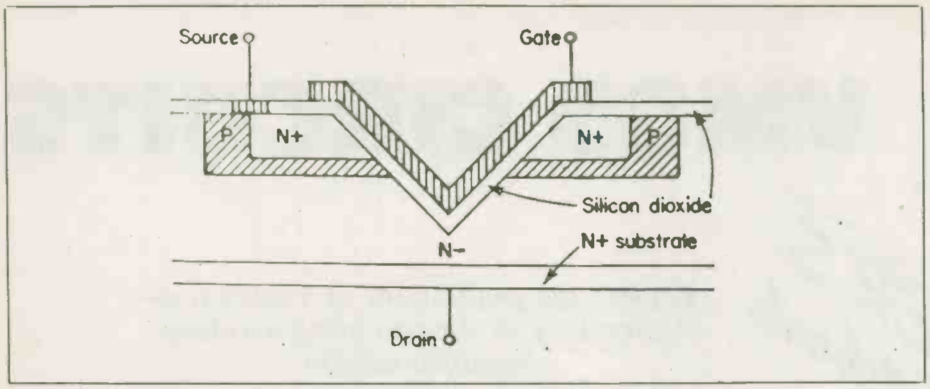


Fig. 1. A cross-section illustrating the construction of a VMOS device.

ture of a VMOS FET is therefore substantially different to that of an ordinary MOSFET, and Fig. 1 shows a cross-section that illustrates the internal structure of a VMOS device. With an ordinary MOSFET (or JFET) the current flows horizontally between the drain and source terminals, but the structure of a VMOS device is such that this current flow is vertical, and a low "on" resistance is obtained. Another necessary characteristic of VMOS devices is that they have a far higher gain than conventional FETs, so that a gate signal of a few volts peak to peak is sufficient to produce a change in drain current of perhaps an ampere or more.

Advantages

The most obvious advantage of a VMOS device over an ordinary bipolar power transistor, is that a VMOS device requires no significant input current and has a typical input impedance of thousands of megohms. The input current is of the order of a few nano-amps, rather than milli-amps, and a high impedance drive circuit is quite adequate except where fast switching speeds are required. VMOS devices have an input capacitance of up to about 50pF, and in high speed switching or similar applications, the drive circuit must be at a low enough impedance for this to have no significant effect.

VMOS devices are ideal for high speed applications since they do not have the minority carrier storage time associated with bipolar transistors, and are majority carrier devices. The typical rise and fall time for a VMOS transistor is only about 4 nano-seconds, which is about 10 to 100 times less than a bipolar power transistor.

An important advantage of VMOS devices in some applications, such as class B audio power amplifiers, is that they have a negative temperature coefficient and do not suffer from thermal runaway. Bipolar transistors have a positive temperature coefficient, and thus when they heat up in use they tend to conduct more heavily. This can produce increased current flow and dissipation in the device, which causes further heating and a further increase in current flow. This process can continue until the device becomes overheated and is destroyed. Since VMOS transistors have a negative temperature coefficient, internal heat makes them conduct less heavily, giving slightly reduced current flow and no possibility of thermal runaway. This is not to say that a VMOS device cannot be destroyed by overheating since the reduction in current flow, due to heating, is not very large and is not sufficient to make it impossible to over-power the device.

A further important advantage of VMOS devices is that they do not suffer from secondary breakdown. In bipolar transistors, this effect is caused by a sort of local thermal runaway, causing "hot spots" which cause the silicon to melt and produce a short circuit between the collector and emitter terminals. To avoid this problem, it is necessary to operate the device at safe combinations of collector current and voltage, and the manufacturers data shows the "area of safe operation." The structure and negative temperature coefficient of VMOS devices eliminate secondary breakdown, and VMOS transistors can operate with virtually any combination of drain voltage and current (provided the maximum permissible voltage, current, and power ratings are not exceeded of course).

Disadvantages

VMOS devices are not perfect, and do have a couple of disadvantages, although these are of a relatively minor nature. One is simply that they are slightly more expensive than bipolar power deivces, although this is offset by the fact that in many applications, it would take two or even three bipolar devices (plus possibiliy a few passive components as well) to replace a VMOS transistor, and this is perhaps not a valid criticism. The second disadvantage is that most of the current devices have a comparativley high "on" resistance. This means that the voltage developed across a VMOS device when switched full on and passing a high current, is likely to be somewhat more than would be the case for a bipolar device operating under similar conditions. This can result in reduced efficiency in some applications. However, devices having "on" resistance of only about 0.2 or 0.3 ohms are now produced, and two or more devices can be connected in parallel, as shown in Fig. 2, to give reduced "on" resistance. Although this simple parallel method of connection does not work well with bipolar transistors, where the positive temperature coefficient can result in one device passing a steadily increasing percentage of the total current flow, until it eventually overheats and is destroyed, this does not occur with VMOS transistors due to their negative temperature coefficient. In fact, the circuit tends to be self stabilizing with the two devices taking a virtually identical share of the current flow. Of course, the transistors used should all be of the same type, or should have similar characteristics, or a greatly unequal current could flow through them and the stabilizing action might be inadequate to properly compensate for this. The "on" resistance is equal to the "on" resistance of a single device divided by the number of devices used.

Table 1

Device	Maximum Power Dissipated	Maximum Drain Current	Maximum Drain-Source Voltage	Typical "on" Resistance
VN46AF	15W	2A	40V	2 ohms
VN66AF	15W	2A	60V	2 ohms
VN67AF	15W	2A	60V	2 ohms
VN88AF	15W	2A	80V	3 ohms
VN10KM	1W	0.5A	60V	4 ohms
VN64GA	80W	12.5A	60V	0.3 ohms
VMP4	25W	2A	60V	2 ohms

Some of the available N-channel devices.

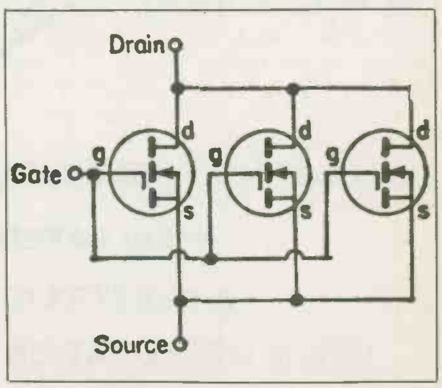


Fig. 2. VMOS devices can be added in parallel to reduce "on" resistance.

Output Characteristic

Although it is normal to refer to the "on resistance" of a VMOS transistor, it should perhaps be pointed out that it is not a true resistance that is provided between the drain and source terminals of the device. Up to a point there is virtually a linear relationship between applied voltage and the current flowing through the device, and the device does provide what for all practical purposes can be regarded as true resistance. However, above a certain threshold level, increased drain to source voltage has little effect on the current passed by the device. The greater the gate bias supplied to the transistor, the greater the threshold current. This effect is shown in Figure 3, which shows the output characteristic of a typical VMOS device. This is similar to the output characteristic of normal FETs, but the currrents involved are, of course, very much higher.

When designing circuits using VMOS transistors, it should be born in mind that the gate voltage versus drain current, characteristic of a VMOS device, is very different to the base voltage versus collector current, characteristic of a bipolar transistor. Simply changing a bipolar transistor (or Darlington Pair) for a VMOS device may not necessarily give good reuslts, and could, in certain circumstances, fail to work at all. A bipolar transistor does not start to conduct significantly until the base to emitter voltage equals about 0.5 volts or so (for a normal silicon device anyway), and an increase of only about 200 mV or so is needed in order to bias bipolars into saturation.

10 Watt Amplifier

Figure 4 shows the schematic of a good quality 10 watt RMS amplifier using a quasi-complementary, class B VMOS output. The source follower TR3 drives the output on positive-going cycles, and bootstrapping via D1 and C6 improves the output swing. IC1 has 100% negative feedback over TR4, and produces the complement of TR3. R9 is adjusted to set the quiescent current drain of the amplifier to 30 mA. An input of 450 mV produces full power at the output with a distortion of about 0.1%.

Class A Amplifier

Figure 5's circuit produces 7 watts RMS into 8 ohms. TR3/TR5 form a constant current source which sets a current of about 1.3 amps through output transistor TR4. This high quiescent current eliminates crossover distortion. TR4 and TR5 should have generous heatsinks, since the transistors dissipate full power at all times.

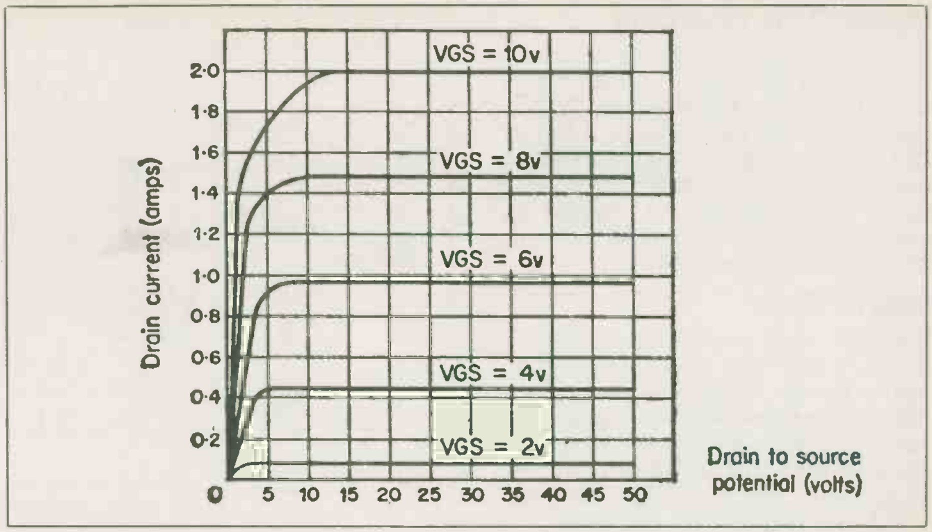


Fig. 3. Typical output characteristic of a VMOS transistor.

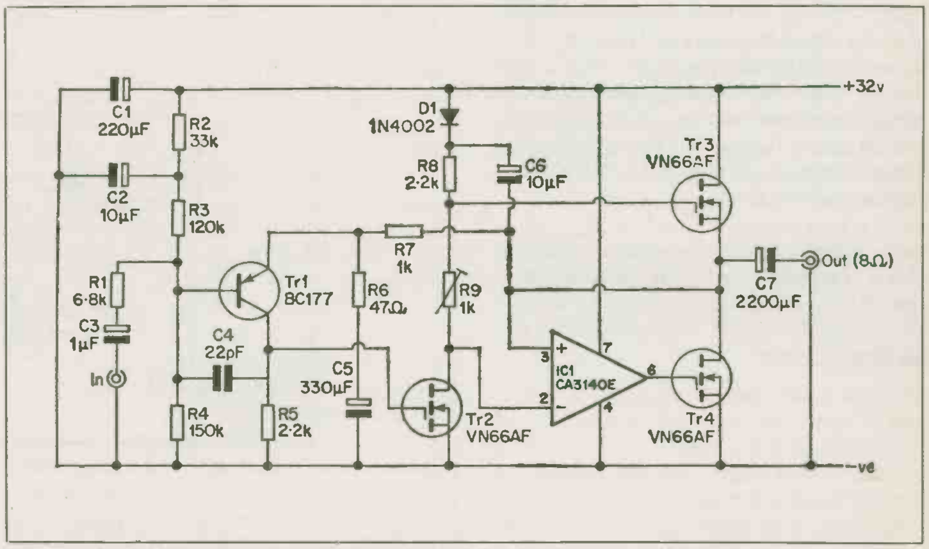


Fig. 4. A quasi-complementary VMOS amplifier giving 7 watts RMS.

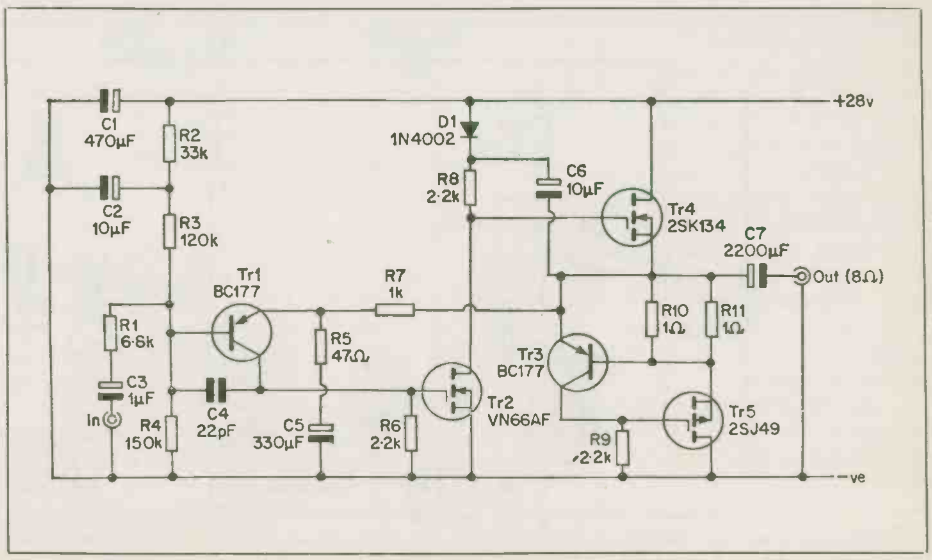


Fig. 5. The circuit diagram of a 7 watt RMS class A amplifier.

Pulsed Tone Generator

In Figure 6, gates 1 and 2 form an astable multivibrator with an output frequency of about 1 Hz. This signal gates the 800 Hz multivibrator formed by gates 3 and 4. TR1 then drives a high-impedance speaker; it is cut off when the generator is muted. The circuit can be disabled by pulling pin 2 or gate 1 to ground, or by interrupting the power supply.

Simple Timer

The high input impedance of VMOS devices, makes them ideal for timers. In Figure 7, the delay is approximately .3RtCt, with Ct in microfarads and Rt in megohms, although this will vary due to device parameters, relay current, etc. S1 discharges the capacitor to allow resetting; R1 prevents arcing during discharge.

Noise Gate

Figure 8 shows a circuit which attenuates an audio signal by 20 dB until the level exceeds an adjustable amount set by R3; the VMOS voltage-controlled attenuator is then switched out and the circuit operates at unity gain. It is useful for suppressing noise ("squelching") in audio with a poor signal-to-noise ratio.

Note: These circuits are excerpted from VMOS Projects, R.A. Penfold, Babani book BP83. It's available from our Book Service for $7.70; see the Order Form in this issue.

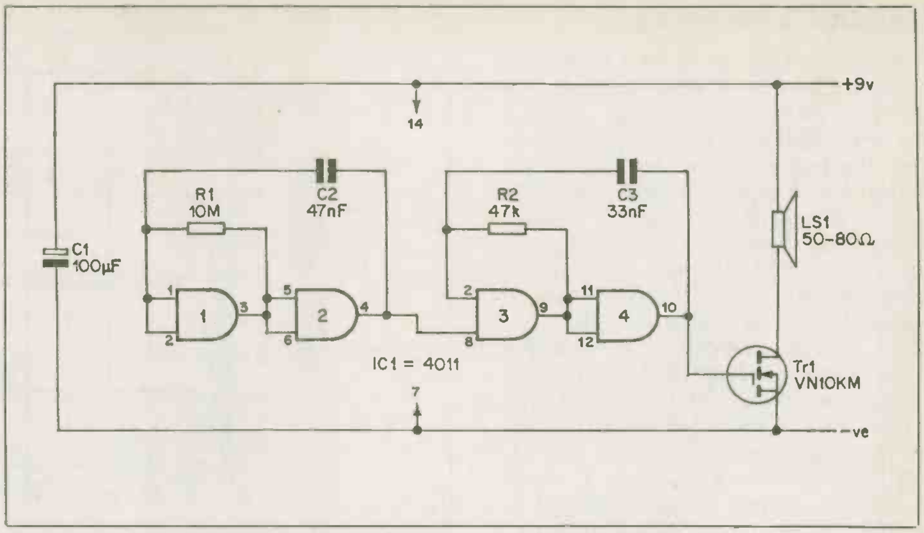


Fig 6. The circuit diagram of a pulsed tone generator.

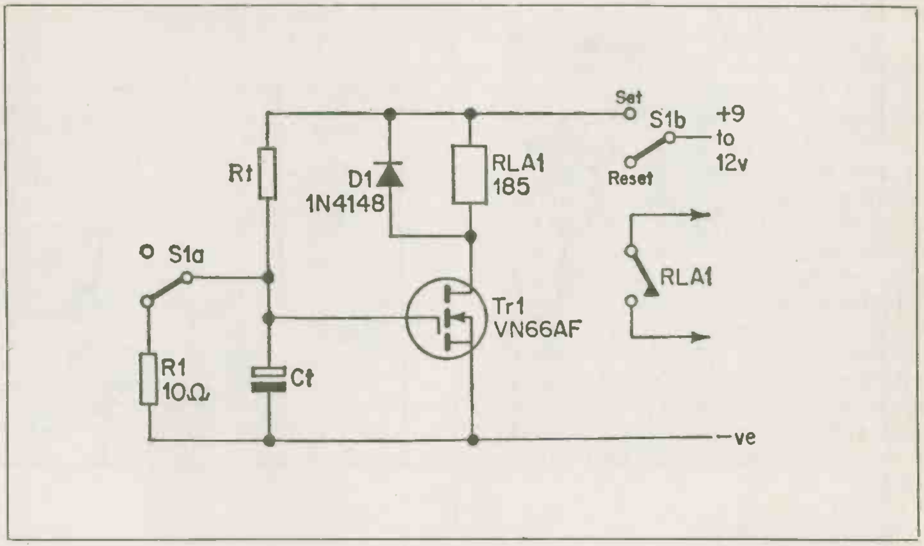


Fig. 7. An ultra-simple VMOS timer circuit.

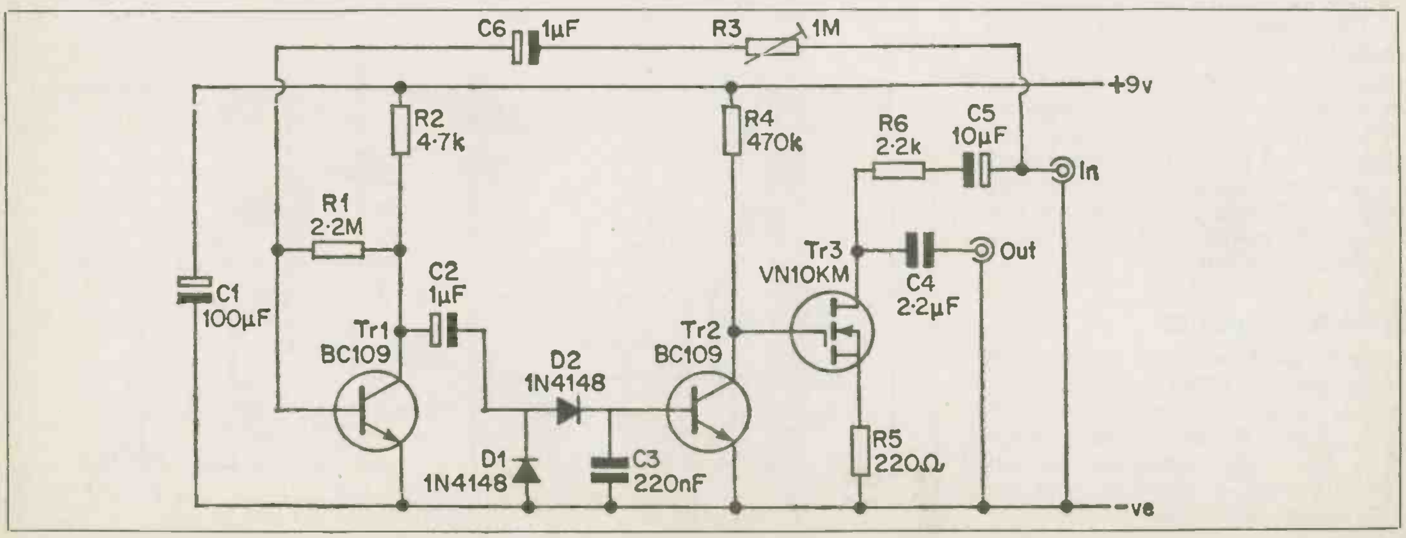


Fig. 8. The circuit diagram of the noise gate.

ETI

This Month in Computing Now!

Canada's Personal Computing Magazine

Computer Survey

Another one? Will it never end? Not as long as manufacturers keep turning out the latest, greatest, death-defying plastic box with buttons on the front. Go from total bewilderment to organized confusion with our 160-plus computer survey.

Down to the Ships in C

We stayed up nights working on that pun, and while it isn't Nobel quality, you must admit it isn't bad. A look into the C language, one of the more versatile compiler languages around. C for yourself (sorry!).

Godzilla Meets All the BBS Numbers in the World

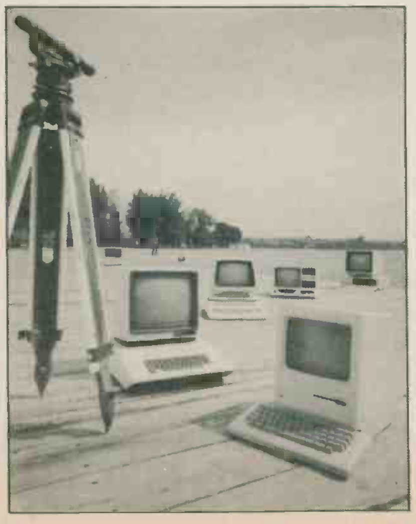
Bulletin Board System numbers aren't all that easy to find; you won't get much help from Ma Bell, whose information service looks askance at these things. Get a modem and the latest CN! and stay up all night doodling the lines.

Computer Museum

They want to build a computer museum in Toronto? They can't be serious. They are? Maybe it makes sense. Computers become ancient history as soon as the latest model is released. Take a look at an ambitious project: a shrine to hi-tech.

Graphics Toolkit Review

We did okay fitting the PC board and running the software, but we couldn't figure out what to do with the socket wrenches and the radial arm saw. Mind you, after we got the Apple to display all sorts of graphics with 640 by 384 pixel resolution, we were impressed.



On Newstand Across Canada Now

Machine Code Programming Part 4

Every month we plunge deeper into the mysteries of machine code — taking our readers with us, we hope. This month, Bob Bennett goes beyond the index registers.

LAST MONTH I gave examples of instruction of the form **Ld (pq),A** etc., and showed how two bytes are pushed back onto the stack. I also left you with the question of what happens if you push HL and pop DE. The answer is that both HL and DE now hold the data that was in HL originally.

One last thing, for the moment, regarding the stack: when you have finished with your machine code program and wish to return to BASIC, for example, then you must make sure that everything that you pushed onto the stack has been popped off. This is because when you GOSUB, and call to USR (machine code) program is a GOSUB, then the return address is pushed onto the stack. When the time to return comes along, then the address is popped off the stack, but if you have left some pushes un-popped, so to speak, then some very funny things can happen.

Whether you use pq to represent an address, or mn a number, doesn't matter as long as you the programmer know what is happening. However, what is significant is the presence or absence of brackets in the instruction, as I mentioned last month. Fig. 11 shows part of a program with a Z80 instruction to load HL with

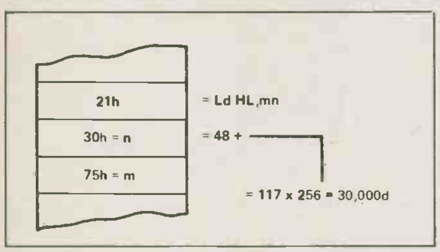


Fig. 11. Z80 instruction to load HL with 30 000 decimal.

30,000d or 7530h. Note how the low byte, the one in L, goes straight after the instruction. Some of you will be familiar with the BASIC instruction, PRINT PEEK (address) + 256 x PEEK (address + 1); now you can match up the request with Fig. 11. The difference between the two instructions 2A — **Ld HL, (pq)** and 21 — **Ld HL,mn** should now be apparent. The first instruction loads the contents of the address pq into L, and the contents of pq + 1 into H; the second instruction loads the byte n into L and the byte m into H. If the two bytes mn represent an address, then HL is said to be pointing to that address.

Taking The Indirect Route

The Z80 instruction 77 — **Ld(HL),A** is an example of indirect addressing, which if you work it out, means load the contents of the A register into the address which is pointed to by the HL pair. This is the machine code equivalent of the BASIC instruction POKE (address), with whatever.

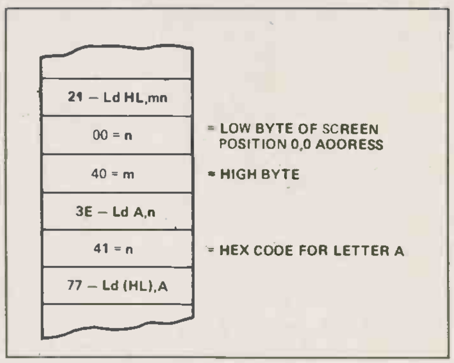


Fig. 12. One way of printing a screen position 0,0.

Earlier I explained that the display file is a series of addresses, with each address holding a byte of information relating to the screen display. I also gave the address 16384d - 400Ch as being the address of screen position 0,0 for no particular computer. Fig. 12 shows how to poke the code for the letter A onto the screen at position 0,0 using one method, and Fig. 13 shows a different method. However, an explanation is required for the method used in Fig. 13.

Suppose that you didn't know the address of the position 0,0 on the screen, but the system variable called D File held the address. If the address of D File was 19634d - 400Ch, this would mean that 400Ch would hold the low byte of the address of position 0,0 and 400Dh would hold the high byte.

One last example in this section is the Z80 instruction 7E — **Ld A,(HL),** which is the machine code equivalent of the BASIC instruction PEEK (address). Of course, registers other than A and HL can be used, but you should by now be able to identify the other instructions. Just in case you are wondering about the term indirect addressing, the instruction 77 — **LD (HL),A** pokes the contents of register A into the address via the HL pair. What I haven't mentioned yet is the use of such instructions in a program, so here is a short exaplanation using the two instructions given above.

Suppose instead of poking the letter A onto the screen, we had poked the code for 1 (this could be the start of a score, or the first try at something or other). Later on in the program we will want to test for the limit, say 9, and if we have reached it, then finish, otherwise increase (increment) the score and carry on. The instruction 7E — **LD A,(HL),** where HL points at the screen position of the number, will load A with the number on the screen. Comparing register A with the limit, 9, we can either finish if A equals 9, or increment A, poke it back onto the screen, and carry on with the program. I'll be covering the compare instructions later on, but it does involve the use of the flags. Things should be starting to fall into place now, but it does require a little thought.

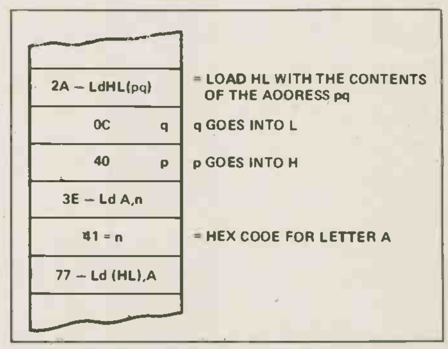


Fig. 13. Another way of printing a screen position 0,0.

Fingering The Index

Because the index registers, X and Y, allow great flexibility in machine code programming, this section will cover a lot of ground. As you get to know how the index registers work, the easiest way to visualize them is as pointers to a table — the X registers moving horizontally, and the Y registers moving vertically. This doesn't happen literally of course, but the table concept can easily be programmed.

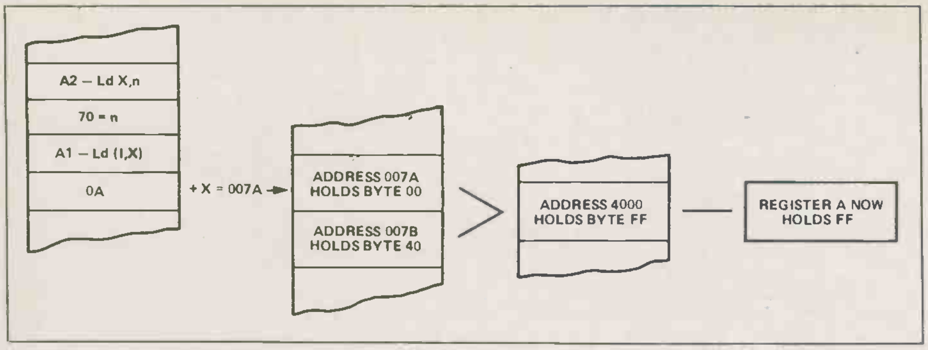


Fig. 14. Pre-indexing addressing from the 6502 set.

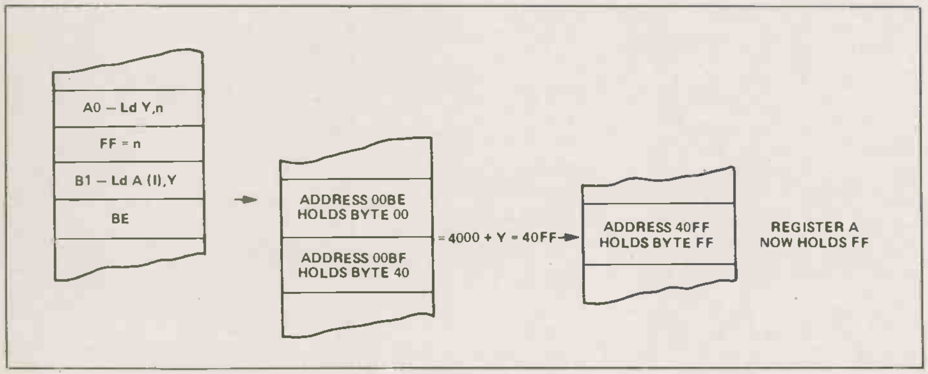


Fig. 15. Post-indexing indirect addressing from the 6502 set.

Because I wrote about indirect addressing in the last section, I'll give a couple of examples from the 6502 set using indirect and indexed addressing together. Pre-indexed indirect addressing is the grand title of the first example, and Fig. 14 will make what's happening clearer.

The instruction A1 — **Ld A,(I,X)**, requires a second byte after the op-code (A1). This second byte is added to the contents of the X register to get the address of the first of two sequential bytes in zero page of the memory. These two bytes form the address of the byte to be loaded into the accumulator (or A register). In the example, I've assumed that the X register holds 70h and that the second byte of the instruction is 0Ah. These two are then added together to get 7Ah (any carry bits will be lot), which is used as a pointer to locations 007Ah and 007Bh in the memory. The contents of these two locations are treated as a 16-bit address (low byte in the lower address) and in our example, this is 4000h. This is the address which holds the byte to be loaded into the accumulator, in this case FFh, to finish the instruction. Note that the X register still contains 70h at the end of the instruction. A most useful mnemonic would be A — (byte 2 + (X)), which illustrates quite clearly what is happening. Although I mentioned zero page addressing above, you could have reasoned out what was going on without it, because the X register will only hold one byte.

The second example from the 6502 set is B1 — **Ld A(I),Y** which is a post-indexed indirect instruction, with the mnemonic A — A ((Y) + (byte 2)). Before you look at Fig. 15, and before you read my explanation, see if you can work out what it does; think of the use of brackets.

The second byte, in this case BE, is address 00BE, and 00BE and 00BF hold the two bytes of an address, in this case 4000h. The byte in the Y register, which is FFh, is now added to 4000h to make 40FFh, and in address 40FFh is the data that is loaded into the A register. What could be simpler?

Please note that only certain index registers can do particular jobs in the 6502 set. I leave it as an exercise for you to work out how the two prefixes pre- and post- are justified.

The Z80 CPU has a host of instructions involving index register IX and IY. The instructions for the IX and IY pairs are the same as those for the HL pair with the prefix DD for IX and FD for IY instructions. As an exmaple, I'll take the Z80 op-code 77 — **LD(HL),A**, which I used in the previous section. The instruction DD77 — **LD (IX + d),A** is the indexed equivalent. This is quite straightforward; it means: poke the contents of A into the address formed by adding d to IX. That letter "d" means that there are three bytes in the instruction and "d", for displacement, is the third byte. This byte is treated as an 8-bit signed 2's complement number and thus has a value between -128d and +127d. (80h = -128d; 00h = 0d; and 7Fh = +127d). If IX held 4000h and we wanted to load the A register into address 4079h, and the full instruction would be: DD 77 79.

By now you should be able to recognize just about every addressing mode that you may come across. Before I carry on though, I would like to just clear up something I touched upon at the beginning of this month's article, when I was discussing pushing and popping.

Apart from the fact that we can't use line numbers in machine code, we do have the equivalent to GOSUB instructions where we GOSUB to an address (location). The 6502 instruction set has only the one instruction to GOSUB and that is 20 — **JSR**, where JSR means jump to subroutine. Now don't confuse this jump with the relative jumps and the like, that I wrote about earlier. Just as in BASIC, this jump to a subroutine expects a RETURN, which with the 6502 is 60 — **RTS** or return to subroutine.

The Z80 set has quite a few GOSUB instructions, although they are labelled CALL, with the simplest being CDpq — **CALL pq**. All of the flag conditions can be used for CALLs in the Z80 set; for example, CCpq — **CALL Zpq,** which means, when the result of the last instruction is zero, GOSUB pq. Again flag conditions can be used for a return, such as **DB P RET C,** when carry flag is set. The straightforward return in the Z80 set is C9. A word of warning, though, keep track of your calls to subroutines, and make sure that the returns match up. If in doubt, re-read this month's opening section.

A Logical Conclusion

A seemingly innocuous one-byte instruction is increment, or add one to. This can apply to single registers, pairs, index registers and even inc,(HL). The 6502 has single byte instructions for incrementing its X and Y registers only. Increment is one of three add instructions which involve the use of absolute binary arithmetic. All this means is that we will be using binary, but with no fractions and no negative or positive numbers. This will become clearer as we go along anyway.

Taking a single register first, as you would expect, increment will just add 1 to the contents of that register. This is all very well until the contents of that register reach FF, which is the maximum number that one register can hold. So now what happens? Figure 16 should be of some help, and if you don't understand binary addition, then this explanation will put you right. Remember that a binary digit, or bit, can only be either 1 or 0, if we add two 1s together, the answer must be 0 and carry one over to the left. Starting at bit 0, the one on the right in Fig. 16, work your way to the leftmost bit which is bit 7.

Contents of register = FF = 11111111 binary
1 INC or add 1
Contents of register = 00 = 00000000

Fig. 16. Incrementing the contents of a full register.

You should finish up with all the bits at 0, which means that the register now holds zero. So you see, incrementing a full register, or register pair, simply means that we start at zero again, and the zero flag should be set. I say *should* be set, because it's always advisable to check on the flags situation in the instructions set.

By the way, what happened to the last carry to the left, the one after we added 1 to bit 7? The answer in the case of incrementing is that it was discarded, but with the next two add operations, it is important as it affects the carry flag. The 6502 also has 2- and 3-byte instructions for incrementing (and decrementing) memory locations directly and indirectly.

In the Z80 set, you can add register to register, such as **ADD A,B**, or add pairs such as **ADD HL,DE**. Again, index registers can be involved, and even an instruction such as **ADD A,(HL)**. Usually the only register that you can add a constant to is register A, in instructions such as **ADD A,n**. Figure 17 shows the simple addition of two registers, which is quite straightforward. Again, when the two numbers added together come to more than one register can hold, then the register that is being added to will pass through zero. This time something different happens, so let's take a look at an example.

Contents of register A = 50 decimal = 00110010 binary
Contents of register B = 100 decimal = 01100100 binary
Contents of register C = 150 decimal = 10010110 binary

Fig. 17. Adding two full registers together.

Suppose register A held D1 or 209, and register B held B0 or 176, and the instruction was **ADD A,B**. Fig. 18 shows what happens, but I'll put it into words as well. Adding 209 and 176 gives an answer of 385; subtracting 256 leaves 129, which is what finishes up in register A.

Just to prove what a glutton for punishment I am, I will now go through the binary addition in Fig. 18. Bit 0, the rightmost bit, is where we start, and 0 + 1 equals 1, so a 1 goes on the bottom line. Bits 1,2, and 3 are 0 in both registers, so 0 goes on the bottom line in each case. Bit 4 in both registers is 1, so down goes 0 and carry to the left. Two 1's make a carry from bits 5 and 6; this 1 goes into bit 7 position on the bottom line. These two 1's above the bottom line in bit 7 position, give a carry to the left, and this last carry sets the carry flag 7.

Contents of register A = 209 decimal = 11010001 binary
Contents of register C = 176 decimal = 10110000
A carry to the left sets the carry flag

Fig. 18. What happens when two registers add ed together come to more than 255 decimal.

The third add instruction is **ADC**, which stands for add with carry, and is really straightforward. What happens is that all the above rules apply, plus the fact that the current value of the carry flag is added on to the total, and the carry flag altered according to what happens during the current instruction. In other words, if there is a carry over from bit 7, then the carry flag will be set, otherwise reset. The 6502 has no register to register arithmetic, but uses memory locations — especially zero page locations — instead, but always with ADC.

The subtraction instructions follow exactly the same pattern as the addition instructions with regard to the registers, etc. The first SUBtraction is DECrement, or decrease by 1, then SUB and finally SBC or subtract with carry. As you might expect, if you decrement a register, or register pair, which holds zero, then the number will zoom round to FF or FFF. Rather than giving you an example of subtracting in binary, why not have a go yourself? Write down two decimal numbers, take the smaller from the greater, convert the two numbers to binary, underneath write down the answer from the decimal subtraction converted to binary. Now work out how you can arrive at the answer.

AND The Rest

Usually there are three logical instructions that you can use which are: AND, OR and XOR. Taking AND as the first example, it usually comes in the form AND,r where r is another register such as AND,C. There should be an instruction such as AND,n where n is any number up to FF, and you may get AND(HL) and even AND(IX + d). Your CPU instruction set should show what AND instructions you can use. Whatever the instruction, everything is ANDed with register A, the accumulator.

Register A holds FF = 11111111
Register B holds 0F = 00001111 AND
Register A holds 0F = 00001111

Fig. 19. The result of the instruction AND B.

Assuming that register A holds FF and register B holds 0F, Fig. 19 shows what happens when the instruction AND,B is met. The explanation couldn't be easier: if the bits in A *and* B are both 1, then that bit remains the same in register A.

Check with your CPU instruction set, but an AND instruction will usually alter all of the flags, with the carry flag always being set. If, during the writing of your program, you are not sure of the status of the carry flag, then AND A or AND FF will always reset it for you. Another use for ANDing is to mask off certain bits, and this is worth an explanation.

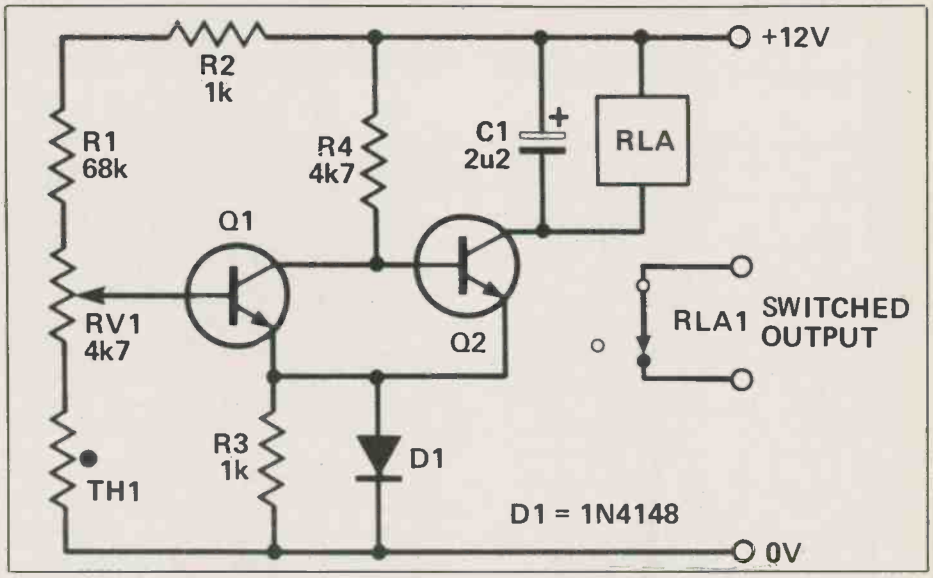
In the first part of this series, I made a passing mention to a refresh register, which is used to ensure that data isn't lost from FAM by the simple expedient of each address from time to time. What happens is that this register, R, starts off at zero and is incremented until it reaches 7F, it is then discharged and starts at zero again. So at any time, register R will hold a number between 00 and 7F. The Z80 set has an instruction ED 5F — **LD A,R**, which, is used from time to time in a program, gives the effect of putting a random number in A. If you want to make sure that this 'random' number doesn't go above a certain number, all you have to do is AND,x where x is your limit; note, however, that if you chose an x that is not equal to 2^n - 1, this operation will not return a truly random number (why?).

The refresh register is actually 8 bits, but only the 7 lower bits are incremented automatically. The 8th bit can be set or reset by using the **Ld R,A** — ED 4F, which transfers the contents of the A register to the refresh register. The refresh register will then be incremented from the value, but the MSB will stay in its current state. **ETI**

CIRCUIT IDEAS

Temperature Controlled Switch

This thermistor-based temperature switch can be set for one of two temperature ranges.



THIS simple temperature controlled switch allows the switching on and off of any electrical device when a preset temperature is reached in the range of -10 to 100 degrees C.

Thermistors are special forms of resistors manufactured from heavy metal oxides and designed to have strongly varying resistance versus temperature characteristics.

It is possible to obtain thermistors whose resistance either increases (positive temperature coefficent), or decreases (negative temperature coefficent) with rising temperature. For a typical negative temperature coefficient resistor, the charge in resistance with temperature is between three and six per cent per degree Kelvin rise.

The thermistor should be a negative coefficient type with a resistance of 5K to 10K at the temperature of interest. The transistors are any small-signal type, such as 2N3904.

The preset, RV1 allows the operating temperature to be set, and is adjusted so that below the desired trip point, the voltage on the base of Q2 is sufficient to keep it switched on. As the thermistor heats up, the voltage on the base of Q1, which is derived from the potential divider chain of R1, R2, RV1 and TH1, will drop, eventually allowing Q1 to switch off. As soon as Q1 switches off, the voltage on the base of Q2 rises and the relay is switched on. The diode, D1, provides temperature compensation for the two transistors, and C1 acts as a back EMF absorber for the relay.

As shown, the range of the circuit will be for temperatures between 35 to 100 degrees centigrade. If R1 is replaced by a 10k resistor, then a range centred on zero degrees will result.

When the relay is inoperative, the consumption of the circuit is very small, in the order of 2 to 3mA; it may thus be powered from either batteries, or a small DC power unit. **ETI**

continued from page 7

for your information

Liability
While every effort has been made to ensure that all constructional projects referred to in this magazine will operate as indicated efficiently and properly and that all necessary components are available, no responsibility whatsoever is accepted in respect of the failure for any reason at all of the project to operate efficiently or at all whether due to any fault in the design or otherwise and no responsibility is accepted for the failure to obtain component parts in respect of any such project. Further no responsibility is accepted in respect of any injury or damage caused by any fault in design of any such project as aforesaid.

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We can supply photocopies of any article published in ETI Canada; the charge is $2.00 per article, regardless of length. Please specify both issue and article.

Component Notation and Units
We normally specify components using an international standard. Many readers will be unfamiliar with this but it's simple, less likely to lead to error and will be widely used everywhere sooner or later. ETI has opted for sooner!
Firstly decimal points are dropped and substituted with the multiplier: thus 4.7uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1 uF is 100nF, 5600pF is 5n6. Other examples are 5.6pF = 5p6 and 0.5pF = 0p5.
Resistors are treated similarly: 1.8Mohms is 1M8, 56kohms is the same, 4.7kohms is 4k7, 100ohms is 100R and 5.6ohms is 5R6.

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Please note we do not keep track of what is available from who so please don't contact us for information on PCBs and kits. Similarly do not ask PCB suppliers for help with projects.

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Digital LCR Meter

The Avo B183 combines the measuring modes of inductance, capacitance and resistance, in one 9V battery operated hand-held instrument. Primarily suited to field service applications and the testing of discrete components, this small light-weight meter is ideal for the field service technician and quality assurance engineer, who wishes to quickly measure component values. There are six inductance ranges from 2mH to 200H; seven capacitance ranges from 200pF to 200uF; and seven resistance ranges from 20 ohms to 20M ohms. All readings, together with the decimal point, are clearly shown on a 3½ digit LCD. Measurements are made at a frequency of 1 kHz or 100 Hz depending on the range selected on the simple, positive action, eight-position slide switch. A similar four-position switch is used to select the function. For further details about the Avo B183 LCR meter, contact: Metermaster, division of R.H. Nichols Co. Ltd., 214 Dolomite Drive, Downsview, Ontario M3J 2P8.

Circle No. 42 on Reader Service Card.

A computer unlike any other in the world, possibly the forerunner of a whole new generation of supercomputers, is in existence in a lab on the University of Waterloo campus. It is the brainchild of Dr. Neil Ostlund, a professor in the computer science department, and his fellow researchers. They have put together the new machine with equipment valued at close to a quarter of a million dollars, which Ostlund has received from the Intel Corporation. The Ostlund supercomputer is a "prototype" model, used basically as a research instrument. The computer, which is called Waterloop V2/64, is a "high performance multiple processor." Its outstanding characteristic is that it consists of many (64) small, central processing units rather than one large one; traditional architecture for high speed mainframe computers involves only one large CPU. The new computer is said to be the equivalent of 10 VAX 11 computers. Ostlund's 64 CPU's are linked closely together in what he calls a "systolic loop" system; that is, data pulses from microprocessor to microprocessor within the system much as the contraction of the heart causes blood to pulse through the body in the human circulatory system.

Viewing Interval Programming (VIP), which allows the consumer to program the television to turn on and off automatically, or block out channels for up to a full week, is being introduced on two new Trinitron® TV's from Sony of Canada's TV and Consumer Video Division. This may be an especially attractive benefit for parents who want to prevent their children from viewing certain programs. The new VIP is featured in one of Sony's new 28-inch colour console models (KV-2675R) and the deluxe 20-inch model, (KV-1975R).

Arrow/Cesco Electronics Ltd. announces the availability of the Motorola MC68020 to the Canadian marketplace. The MC68020, an advanced high performance 32-bit microprocessor device, uses a 2 micron HCMOS process utilizing 200,000 transistors integrated onto a 375 x 350 mil die, and is placed in a 114 lead pin grid array package. The MC68020 contains full 32-bit address an data busses with additional addressing modes to further support high-level lanugage development.

Electronic Time Switch

An economical single-channel time switch, featuring an easy-to-read LCD digital display has been introduced by Davis Controls Ltd., P.O. Box 160, Islington, Ont. M9A 4X2 (416)233-3211. The compact and light-weight unit can be panel, wall or DIN rail mounted, and is ideally suited for controlling on/off times in industrial commercial and HVAC applications. Programming is fast and simple using clearly marked pushbuttons. Up to 10 individual programs can be stored in the unit's memory, with each program consisting of a switch-on time, switch-off time, and the day or days of the week when the switching is to take place. All information is displayed during programming.

The LCD display provides continuous monitoring of clock time, day of the week and switching status. A built-in rechargeable battery maintains off functions during loss of power.

Circle No. 36 on Reader Service Card.

Acoustical Covers

Trigild Limited of Mississauga, Ontario has announced the introduction of a new line of sound control enclosures designed to keep noisy computer printers quiet. The new "Special Edition Series" of Acousticovers are injection molded of Structural Foam. Use of this material has enabled Trigild to increase product efficiency, in some instances reducing printer noise by up to 90%. At the same time, Trigild has created a design that is compatible with today's microcomputer products. Special Edition Acousticovers are available to fit most popular dot matrix and letter quality printers. For more information, contact Ole Pedersen, Trigild Limited, 5195 Tomken Road, Mississauga, Ontario, Canada L4W 1P1. Telephone (416)624-5037, Telex: 06-960193.

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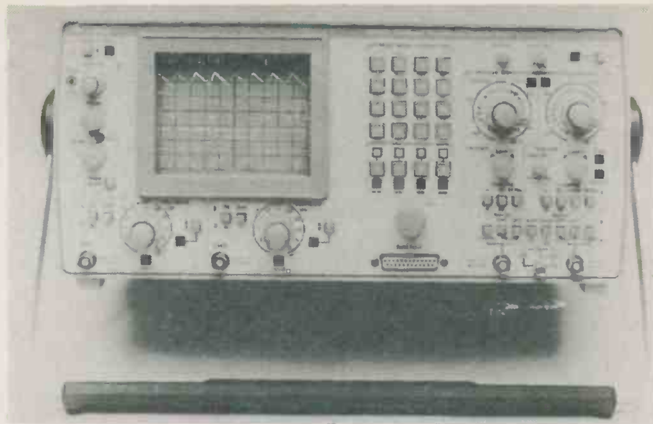

100 MHz Digital Scope

An intelligent and powerful 100 MHz digital storage oscilloscope, featuring internal waveform processing and the ability to operate in either non-storage or storage mode, is now available in Canada from the Electronic Instruments & Systems Division of Allan Crawford Associates Ltd., 6503 Northam Dr., Mississauga, Ont. (416)678-1500. The dual-trace Gould model 5110 can acquire and display two waveforms simultaneously for precise and repeatable time comparison measurements or accurate waveform characterization. Comprehensive automatic calculation capabilities, such as rise time, period and peak-to-peak values, provide rapid and accurate answers at the push of a button or under program control. The 5110 has an 8-bit digitizer for better than 0.4% vertical resolution and two 1024 byte memories. Comprehensive front panel keypad allows for direct selection of panel setups, calculation modes, and memory modes.

Circle No. 40 on Reader Service Card.

An enhanced release of Digital Reseach's CP/M™ operating system that takes full advantage of the keyboard and memory of the QX-10 Business Computer, has been introduced by Epson Canada. Version B 2.20 of the CP/M-80 operating system ("B-release") permits QX-10 users to access an expanded library of powerful CP/M-based software programs titled the "Executive Tool Kit." In addition, Version B-release provides software developers with broad opportunities to produce powerful new software packages for the QX-10. Among the new software packages for the QX-10 that take advantage of B-release's features, are Micropro's WordStar 3.3™, SpellStar™, MailMerge™, Change Labs MicroPlan™, GraphPlan™, and Aston-Tate's d-Base II™. The new oeprating system consists of the standard CP/M file manager and console command modules augmented by a customized BIOS (Basic Input/output System) module that uses all of the QX-10's 256K bytes of memory and the unique human-engineered (HASIC) keyboard. B-release allows the CP/M software packages to make use of the QX-10's special basic English command keys, which include STOP, UNDO, INSERT, PRIOR/NEXT PAGE and BOLD/ITALIC print styles. This new operating system also permits users to take advantage of all the features offered by the Epson line of dot matrix printers.

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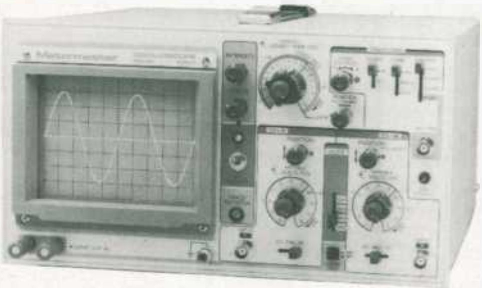

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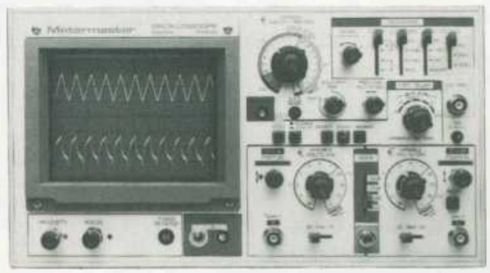

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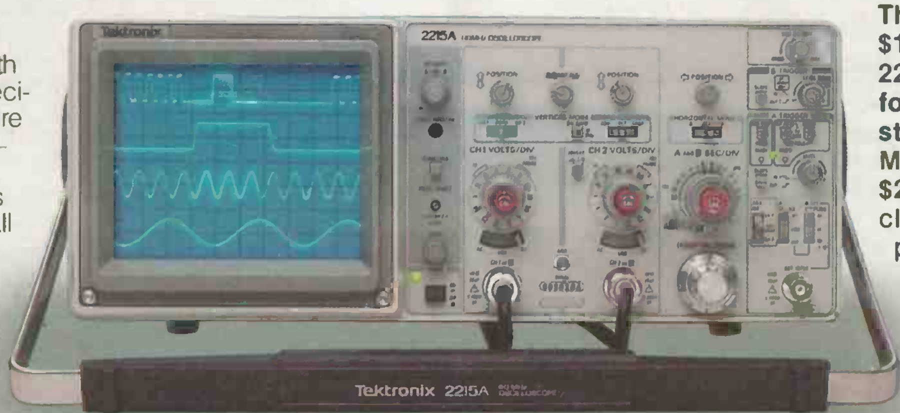

Specification enhancement	2213/2215 "A" Series	2213/2215
CRT brightness	14 kv accel. potential	10 kv accel. potential
Vertical accuracy	3%, 0° to 50°C	3%, +20° to 30°C
Chop rate	500 kHz	250 kHz
Input capacitance	20 pF	30 pF
CMRR	10 to 1 at 25 MHz	10 to 1 at 10 MHz
Channel isolation	100:1 at 25 MHz	Not specified
A Trigger sensitivity (int)	0.3 div at 5 MHz	0.4 div at 2 MHz
TV triggering	1.0 div compos. sync	2.0 div compos. sync
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