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electronics today

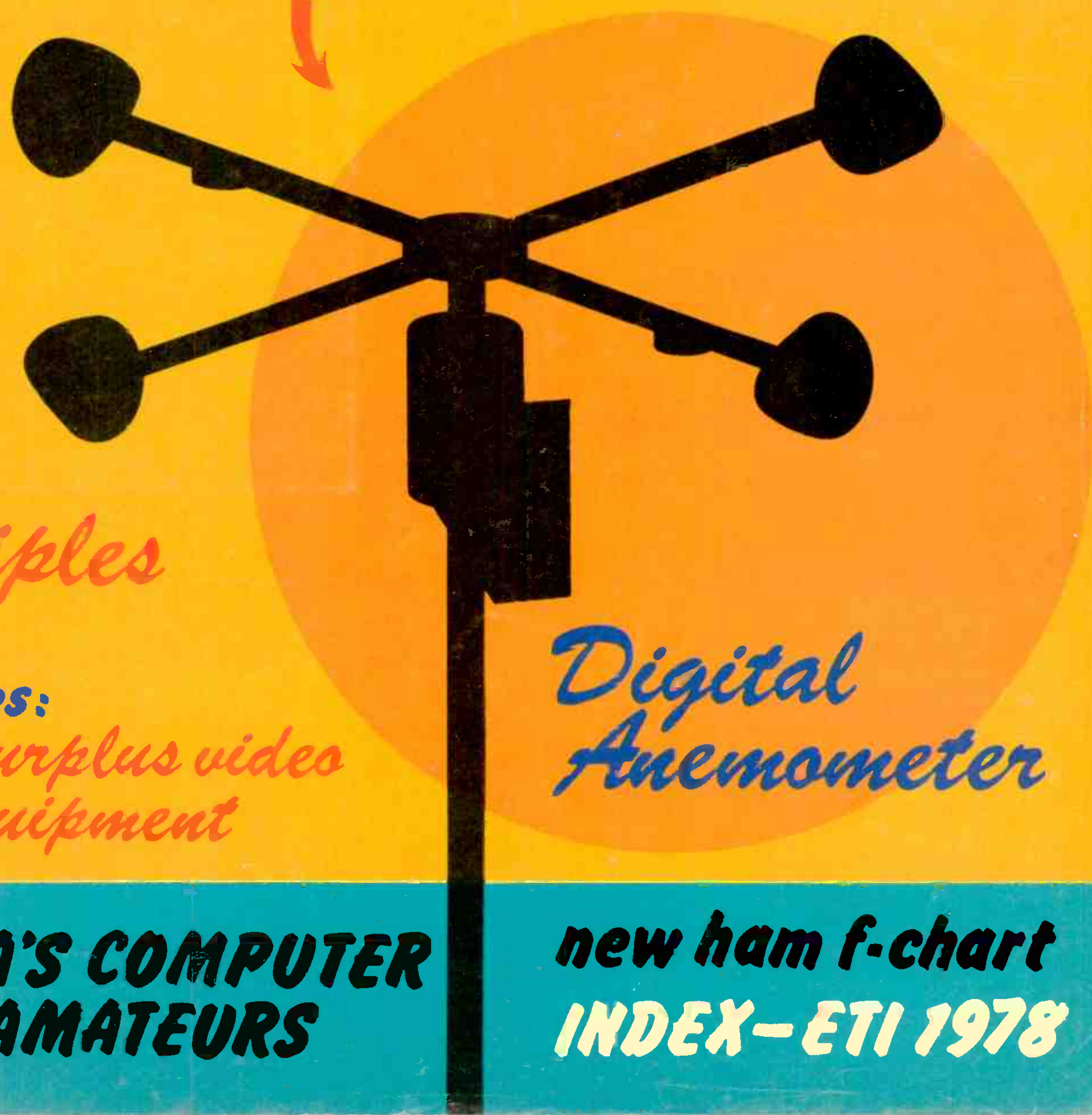
DECEMBER 1978

SPECIAL OFFER — STEREO TUNER BOARD — ONLY $16.95!
— see inside front cover —

Tape-noise Limiter

three great projects

EPROM Programmer



Video principles

new series:
Using surplus video equipment

Digital Anemometer

CANADA'S COMPUTER RADIO AMATEURS

new ham f-chart

INDEX — ETI 1978

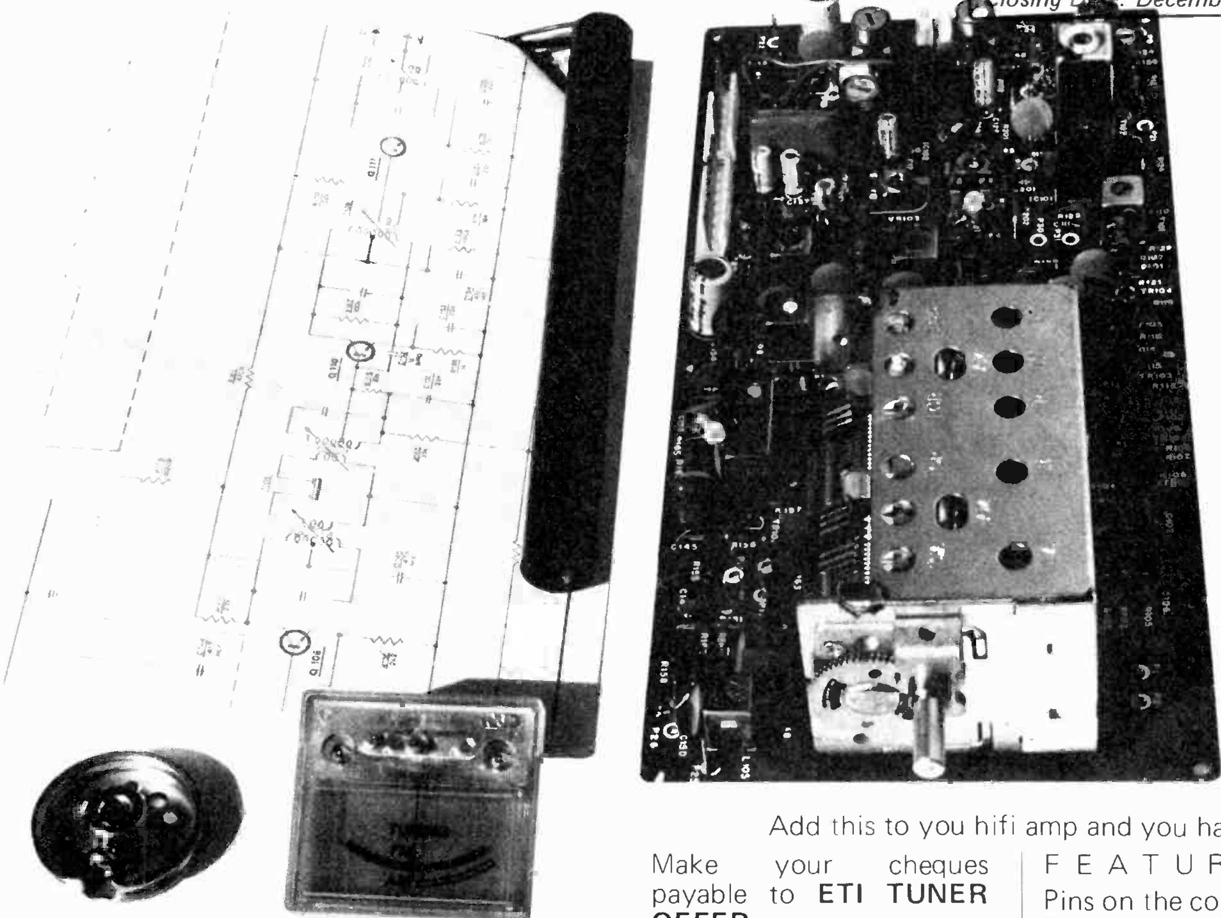
Come-on, everyone has a use for high quality radio.

ETI SPECIAL OFFER!

This offer is subject to the availablity of the product — only the first 500 orders can be guarranteed.

MAIL THIS CARD TODAY!
Send to ETI Tuner Offer, Unit Six, 25 Overlea Blvd, Toronto, Ontario, M4H 1B1.
All orders must use this card.
Closing Date: December 29 1978.

PRICE INCLUDES POSTAGE AND PACKING. ONTARIO RESIDENTS ADD PST



NOT A KIT — THE PCB IS FULLY ASSEMBLED.

Add this to you hifi amp and you have a receiver.

ETI has made arrangements with a Toronto company to supply these AM/FM stereo tuners at the amazing low price of $16.95. For this you get:

1. The 4½ x 9½ inch pcb, fully assembled with IC Multiplex Decoder and FM gain circuit, transistors to give four stages of FM IF amplification and two AM IF stages. Plus all the features listed elsewhere.
2. The 3-winding AM ferrite rod antenna, 6¾ inches long.
3. The pulley wheel for driving the the tuning capacitor.
4. A photocopy of the manufacturer's circuit diagram, showing all component values, test voltages, and part numbers corresponding to those printed on the pcb.

Make your cheques payable to **ETI TUNER OFFER.**

BONUS FOR THE FIRST 500 ORDERS:
The first five hundred orders will get a special bonus — a free tuning meter. This centre-zero meter connects directly to the tuner board and is already labelled for AM and FM tuning.

What is an ETI Special Offer?
A Special Offer is an arrangement made between ETI and a supplier which enables our readers to get cheap prices. Because we want you to get the best deal we keep costs down, by using unsold advertising space, by negotiating a cheap price with the supplier, etc.

If we come across suppliers with other interesting products at really cheap prices we'll probably have more offers in future issues.

F E A T U R E S

Pins on the connector—
1. Mono/Stereo
2. Stereo Beacon
3. +12V dc
4. Ground
5. Left audio (FM)
6. Right audio (FM)
7. Dummy
8. Mute Switch
9. Mute Switch
10. Ground
11. Meter
12. Audio (AM)
13. +12V (FM)
14. Ground
15. +12V (AM)

Other connections—
Internal AM antenna
External AM antenna
75 ohm FM antenna
25us/75us de-emphasis switch
FM tuning meter
Quadricast

Add a box and 12V power supply and you have a hifi tuner.

STOP PRESS, ADVERTISER'S CORRECTION: Marketron Ad, p. 68, PET P-1 Printer Price Should Read $895, complete. KIM-1 Price Should Read $245.

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INCORPORATING **ELECTRONIC WORKSHOP**

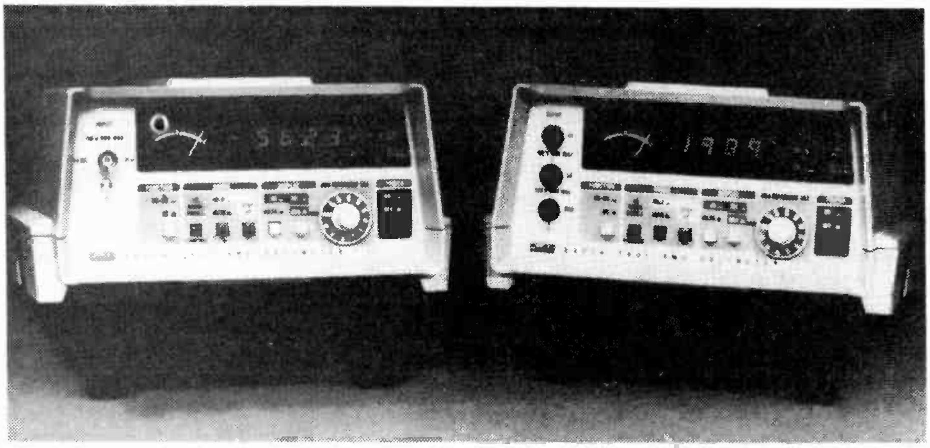
PROJECTS

FEATURES

NEWS & COLUMNS

INFO & MISCELLANEOUS

NEWS DIGEST



Telecom Voltmeters

Two new 3½ digit true RMS AC/dB voltmeters available in Canada from Allan Crawford Associates, are ideally suited for telecommunications level measurements including the measuring of voice, program, tone and carrier levels.

The Fluke model 8921A is designed for users requiring a floating input and is similar to the recently announced Fluke model 8920A. Both units incorporate identical features except that the model 8921A is not available with either linear or logarithmic outputs.

Bandwidth extends from 10 Hz to 20 MHz. Readings are direct in dBm for 93, 110, 124, 135, 150, 600, 900 ohms and five other reference impedances, eliminating bothersome conversion factor calculations to adjust the dBm reading to the desired impedance.

For other dB applications, the operator can use the 'Relative dB Reference' mode to store any input voltage as a 'O dB reference point.' All future inputs are displayed in dB relative to this voltage, eliminating the mental calculations normally required to set a desired voltage as 'O dB'.

Gain checks at various points in a system are easily made, since any point can become a 'O dB reference' at the press of a button. Basic accuracy for both the dBm and relative dB reference modes is +/- 0.1 dB with a resolution of 0.01 dB.

CMOS 555

A CMOS equivalent to the classic 555 timer has been introduced by Intersil. The new ICM7555 general-purpose timer features a typical power supply current rating of less than 1/20th of that required by its bipolar counterpart. Expanded high-speed operation to 500 kHz is guaranteed.

The ICM7555 (single) and the ICM7556 (dual) devices are pin-for-pin, function-for-function, direct replacements for popular 555 timers. They are capable of operating up to 3750 hours, driven by only two 300 mA-hr NiCd batteries. Widened supply voltage range of 2 to 18V opens up applications previously barred to the 4.5V bipolar 555s. KTrigger, threshold and reset currents are only 20 pA typical. Traditional supply voltage and control voltage decoupling capacitors are not required to eliminate supply voltage transients.

Commercial prices in 100-unit quantities are US $0.75 for minidips or US $0.95 for TO-99 cans (ICM7555), and US $1.45 for plastic DIP packages (ICM7556). Delivery is from stock.

Contact Lenbrook Industries, 1145 Bellamy Road, Scarborough, Ont. M1H 1H5. Phone (416) 438-4610.

When Is An IC Not An Integrated Circuit?

When it's a new form of energy-storage using super-conducting magnets. The IC units (InductorConvertor units) use large coils buried deep underground and kept near absolute zero. A $200 million IC unit could store 10GW/h, according to University of Wisconsin researchers.

Light Bubble Memories?

IBM researchers have produced mobile light bubbles which appear to have a future which will rival magnetic bubbles as mass data storage media. The mobility of the bubbles increases in discrete steps as excitation frequency increases from 10 to 50 kHz. The bubbles are produced in thin films of manganese-doped ZnS and electroluminescent material.

DMM Ap-Note

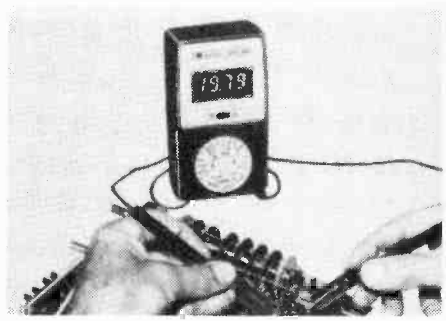
A new applications note available from Intersil provides construction data and operating notes which will enable the reader to build a 4½-digit auto-ranging DMM with the ICL7103A/8052A A/D converter chip pair.

Applications Bulletin A028 describes the operation and potential pitfalls of an auto-ranging scheme with 10 uV resolution. Two separate auto-ranging DMM/DPM circuits are included, along with design hints and circuit troubleshooting suggestions.

Intersil is now available in Canada through the newly-appointed Canadian Sales Representative, Lenbrook Industries Limited, 1145 Bellamy Road North, Scarborough, Ontario. M1H 1H5 (416) 438-4610.

Pocket DVOM

The model 3400 digital VOM, just introduced by Triplett Corporation, features auto-zeroing, auto-polarity, auto-low battery and auto-overrange indication.

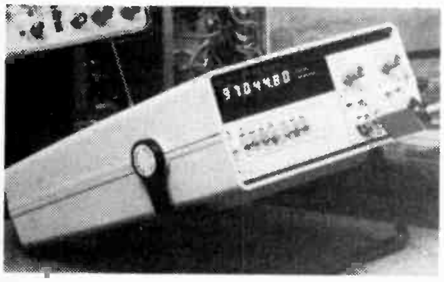


The 3-1/2 digit, 6 function, 24 range tester costs $196.00, which includes two test probes, batteryand instruction booklet, and 1 year limited warranty.

For further information on the 3400 DVOM, contact: Len Finkler Limited, 25 Toro Road, Downsview, Ontario, M3J 2A6.

HP Counter for $476

Model 5314A Universal Counter from Hewlett-Packard measures frequency to 100 MHz, period to 400 nanoseconds with 100 picosecond resolution, and time interval. Pulsewidth, time between events, and logic timing can be measured to a resolution of 100 nanoseconds. Measurements of ratio, ratio averaging and totalize (from 10 Hz to 10 MHz) are also included in its capabilities.



The Canadian price of the 5314A is $476, duty and taxes are extra where applicable. Delivery is 30 days.

Tuneable Dye Laser Memories?

IBM researchers are developing a new system of data storage based on the chemical change which can be programmed into a photoreactive material using a technique known as hole burning. To burn a hole you direct a blast of laser light onto the substance and then cool it to within a few degrees of absolute zero. The result is a hole in the optical absorption response of the material at the frequency used in the burning process.

By using a tuneable laser writing and reading information is possible over a range of frequencies. Using the system incredibly dense storage is possible.

Write For ETI And Your Dreams Come True

News about two of ETI's regular contributors —

Bill Johnson, VE3APZ, will be getting married on 29 December to Gail Manning. Bill and Gail co-authored ETI's 'Canadian Semiconductor Guide' in our August issue. All the best to them both from ETI.

And Wally Parsons is proud to announce he has another column. Starting in the December issue of Audio Market News, Wally will have a few things to say to the guys who sell hifi gear.

Future Catalogue

The 64-page 1977 catalogue from Future Electronics has just been replaced by a 352-page 1979 edition. Future claim their catalogue contains more specs and data than any competitative catalogue, and the widest variety of semiconductor devices. Plus passive components, books, and the complete TI calculator line.

ETI is a firm believer in friendly presentation — easy layflat binding (called 'saddle-stitching' in the trade) and no-glare paper. Future's old catalogue was friendly in this way. The new catalogue, however, suffers from expensive production — glossy paper,

TI Word Chip

Texas Instruments have a digital speech synthesis IC that can speak over 200 words from the data in two 128Kbit ROMs. The output is 200 mW of audio, the input parameters from the ROMs are pitch, energy, and coefficients for the digital filter which does a clever simulation of the human vocal organs. The chip derives pitch by dividing it's clock and contains a noise generator for unvoiced sounds.

The programmable filter comprises a pipleined 10 by 14-bit multiplier, a 14-bit adder, and shift registers. Recirculating data gives the effect of a 10-stage lattice filter.

TI use the chip in Speak & Spell, a 200-word spelling aid for children.

TV With A Brain

British TV manufacturers are experimenting with microcomputer devices in consumer sets. For some time sets have been available with computer memory, keyboard and character-generator — these are needed for utilisation of the Teletext signals which are broadcast with all British TV signals. By simply adding a microprocessor to the set a very interesting computer system results. With cooperation from the broadcasters computer programs could piggy-back the video output.

Computer Graphics Prediction

The market for computer graphics is predicted to be $1.5 billion in the US production industry by 1986.

square-back binding, etc, ... like the American computer magazines. Still, many people prefer it that way.

The pages are 4½ by 8½ inches — pocketsize. Well worth the $4 price (but if you are a customer you'll get one free if you ask next time you order).

Future also confirm the address of their store in Ottawa given on p73 of the October issue. Future's over-the-counter stores use the name Active Component Sales. The prices in the Future catalogue are the same as those used by Active for store or mail-order business.

Clever Glasses

Two items about glasses:

A New York optometrist has invented glasses (custom-made at around $2000 a pair) that enable blind people (with 10% vision) to see. Vision improves six times using the camera-lens, prism, and eyepiece combination.

And in Australia pairs of red plastic glasses only 45mm wide are working miracles. Hens wearing these glasses need less food than regular hens for the same egg output.

50 MHz Pulse Function Generator

A new 50 MHz combination pulse and function generator has been introduced by Wavetek and is available in Canada from Allan Crawford Associates Ltd.

The Wavetek model 166 signal source operates over the frequency range of 0.0001 Hz to 50 MHz and delivers a 30 volt peak-to-peak output with sine, square, triangle, ramp and pulse outputs.

As a pulse generator, the model 166 features independent repetition, width, and rise and fall transition time control. Fixed TTL outputs are available simultaneously with the variable output. The pulse baseline can be varied and the main output can be switched from normal to inverted.

As a function generator, the unit features linear and logarithmic sweep capability, trigger, gate and double trigger modes of operation, as well as external AM and FM modulation capability.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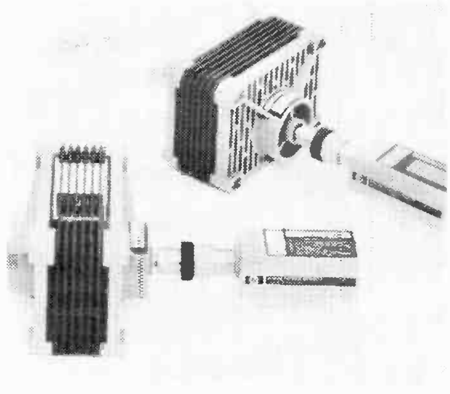
Measure 25W at 18GHz

The usual method for measuring power levels up to 25 watts has been to connect an attenuator in front of a 100 mW sensor. Such a combination created some undesired measuring ambiguities because each element has its own accuracy specification and the interacting mismatch effect adds to that.

Now HP has combined the attenuator and the power sensor into a single unit. Model 8481B covers the frequency range 10MHz to 18 GHz, and Model 8482B covers 100 kHz to 4.2 GHz. Both models include a 25 watt, 30 dB attenuator permanently attached to a 100 mW power sensor. The sensors work directly with the HP 435A and



436A Power Meters.

The Canadian price of the 8481B/8482B Power Sensors is $1,172 each (plus tax and duty), delivery is 12 weeks.

New Scope Catalogue

A new 8-page oscilloscope catalogue has been published in Canada by Allan Crawford Associates Ltd. The catalog lists the complete range of Gould/Advance oscilloscopes available from stock in Toronto, Montreal, Calgary or Vancouver. Copies are available at any ACA Electronic Centre of from Allan Crawford Associates Ltd., 6503 Northam Drive, Mississauga, Ontario L4V 1J2. Telephone 416-678-1500.

Other news from ACA is that their Electronic Centres now stock Sams books.

microfile

PASCAL for Alpha

PASCAL is now available on the Alpha Micro computer system and it is free to all new and existing Alpha Micro users. Contact the Computer Place, 186 Queen Street West, Toronto, M5V 1Z1 • Tel. (416) 598-0262.

PASCAL Processor

Western Digital Corporation has developed a 16-bit computer chip set that directly executes PASCAL object programs at least five times faster than is possible with conventional system software and eliminates the previously required host operating system and interpreter.

The company will sell its development both as a chip set and as a packaged software development computer to both OEM's and personal computing stores.

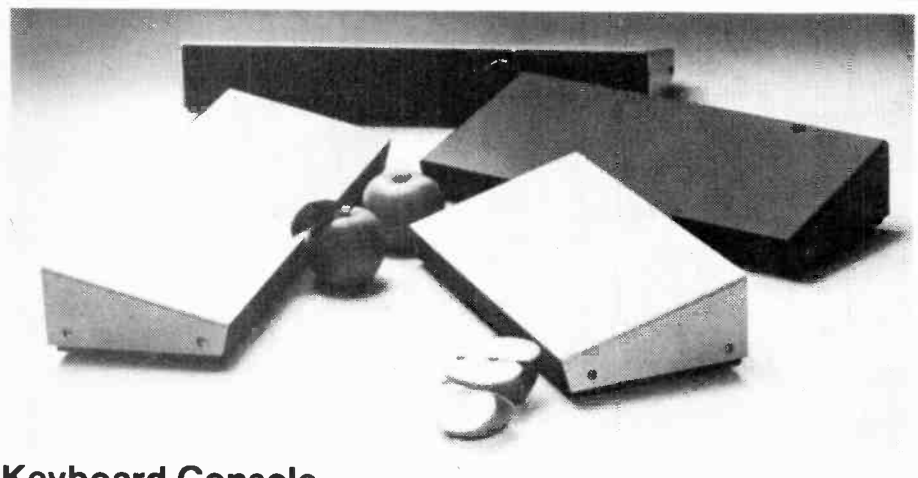
Designated the PASCAL microengine product line, the chip set standardizes the version of PASCAL offered by the University of California at San Diego. UCSD's version is generally regarded by the computer industry as an excellent implementation language for business, industrial and computer aided instruction applications. It was derived from (and is source compatible with) the original PASCAL developed in 1971 at the Swiss Institute of Technology.

The UCSD software system includes a complete PASCAL operating system: PASCAL compiler, BASIC compiler, file manager, screen-oriented editor, debug program and graphics package, all written in the PASCAL language.

The chip set is comprised of four LSI (MOS) components: • An arithmetic chip that contains micro-instruction decode, ALU, ;and the register file. • A micro-sequencer chip that contains macro-instruction decode, portions of the control circuitry, micro-instruction counters, and 1/0 control logic. • Two MICROM chips (each 22 bits x 512) that contain the micro-instruction ROMs and micro-diagnostics.

Additional features of the Microengine chip set include user-defined bus configuration, four levels of interrupts, single- and multi-byte instructions, hardware floating point, stack architecture, 3.0 MHz four-phase clock (75 nanoseconds per phase), and a TTL-compatible three-state interface.

The desktop computer features the 16-bit Microengine processor, 32K words (64K bytes) of RAM memory, full DMA control functions, fully-integrated floppy disk controller, two RS-232 asynchronous ports, and two 8-



Keyboard Console

This keyboard console is designed to match many existing OEM products in data entry, control or mixer applications. The simple, 2-piece construction consists of heavy gauge aluminum pieces separated by a neoprene gasket to eliminate vibration noise. The 15^0 sloped panel is available with either sand or charcoal coloured textured finishes. Both colours have a textured black base and rubber feet. Three sizes are stocked, 14", 17" and 20" wide, all with a 7" deep panel. Contact Hammond Manufacturing, 394 Edinburgh Rd., Guelph, Ontario, N1H 1E5. Phone (519) 822-2960.

bit parallel ports — all on a single 8 x 16 board, and three power supplies (+12V, +5V and -5V) packaged in a low-profile (5 1/4 inches high x 16 1/4 x 13 1/2) stylized enclosure.

The chip set (CP 9008B-01) is priced at US $195 for a single set and is discounted to $97.50 each at 10,000 quantity. The development system carries a single unit suggested retail price of US $2995 and an OEM single quantity price of $2495. Volume discounts are available. Both products will be available for shipment in the first quarter of 1979.

(The company also announced a special introductory offer of US $1995 for the Pascal computer available to the first 500 customers.)

Western Digital Corp., 3128 Red Hill Avenue, P.O. Box 2180, Newport Beach, CA 92663. Phone (714) 557-3550.

IMSAI's VDP-4X

IMSAI have announced their series VDP-4X Video Dta Processor. Three versions, the VDP-40, VDP-42 and VDP-44, provide a disk storage capacity of 180K, 400K and 780K bytes, respectively.

A fuilly integrated system, the VDP-4X features an 8085 microprocessor, 32K/64K RAM, dual 5¼-inch floppy disks, 9-inch CRT, keyboard and serial I/O in a desk-top cabinet.

IMSAI's multi-disk operating system (IMDOS) is provided with the VDP-4X and has a large number of utilities — including an 8080/85 assembler, video/context editor, dynamic software debugging program and floppy disk system diagnostic program.

780K bytes on mini-floppies is achieved by combining the IMDOS disk formats with double density, 77-track mini-disk drives.

The VDP-4X can communicate with other VDP-4Xs and other computers, or act as a terminal in a data communication network. Virtually unlimited applicatins are possible. For example, use the VDP-40 for distributed data processing applications. Or computerize the accounting and inventory functions of a small business with the double density VDP-42. Select the double density, double track VDP-44 where grater disk storage capacity is required.

Serial I/O is used to drive optional peripheral devices, including line printers, moderns and auxiliary terminals.

Sorcerer Computer

The Sorcerer computer is a self-contained unit that needs to be plugged into a video display unit and a cassette tape recorder to be fully functional.

The unique ROM PAC tape cartridge holds up to 16K — for high level languages, operating systems and special priority software.

User-defined graphics allow you to icreate up to 128 symbols.

The standard features include: a Z80 Processor, a 63-key typewriter-style keyboard and 16-key numerical pad, interfacing for standard I/O equipment 8K RAM (expandable to 32K), 4K ROM operating system, 8K ROM Microsoft Basic in ROM PAC, and SIZ x 240 resolution graphics.

The Sorcerer begins at $1,279.00 (inc. FST). More details from the Computer Place 186 Queen Street West, Toronto, Canada, M5V 1Z1 • Tel. (416) 598-0262.

Audio Today

Developments in audio reviewed by Wally Parsons

READERS WHO HAVE been following these pages over the past few months should, I hope, have a good idea of the nature of electrical power, and the relationships which exist between current, voltage, impedance, and different methods of specifying power. It's really quite a straight forward business once you clean out the mythology and the fairy tales which surround the subject. Another area in which mythology abounds deals with the subject of how much power is actually needed to achieve a given sound level. At this point I can see both the superhigh power enthusiasts and the lower power advocates, the ones who like to talk about 'civilized' sound levels lining up ready to place bets as to which side the professor is going to land on. Hang on to your money, guys; the professor is a Libran, and if you're into astrology, you know what that means. (I know, so is Trudeau, but we all have our bummers; after all, Hitler was a Taurus).

Intensity of sound is a function of pressure, density of the medium of transmission, and the velocity of propagation in the medium and is usually measured in decibels above a reference level of 10^{-16} acoustical watts per square centimeter. Table 1 shows the intensity levels of a variety of non-musical sounds. The first two columns should be rather self-evident in meaning, the second one referring to acoustical watts. The third column refers to pressure as measured by a non-compliant surface, such as the wall of a room, and the fourth column refers to the actual rate of molecular movement in the medium, in this case, air.

AMBIENT SOUND

For the moment, let's pay particular attention to column 1. Most of us are aware that it is impossible to hear normal speech in a subway station while a train is entering or leaving. The reason is obvious: the train makes too much noise, it drowns out speech, that is, it *masks* speech, with a sound level over 30 dB above that of speech. The significance of this masking effect cannot be over-emphasized; it has a direct bearing on the sound levels required for satisfactory reproduction even if we could arrange for a listening room to have no sound in it except that which is to be reproduced. Even in the average residential room there is some ambient sound, about 40 dB worth, which often goes unnoticed, but which requires us to adjust the levels of reproduced sound, and even conversational speech so as to override it. Late night types generally are accustomed to turning the music down or watching television at low volume levels at late hours. To some extent we do this so as to avoid annoying neighbours, but in fact you will observe that the minimum level which was acceptable at 2.00 am might be inaudible in the middle of the afternoon. Likewise in thin-walled apartments one might very readily hear a neighbour's conversation or television set at such hours, and yet at other times of the day higher levels would be quite inaudible simply because they would be masked by higher ambient noise levels within and outside the building. The noise of traffic several blocks away, machinery such as air conditioners, furnaces, refrigerators, all of these so far away as to be individually inaudible, nevertheless all

Table 1: How the numbers relate to the sound.

Type of Sound	Intensity Level (dB above 10^{-16} W/cm^2)	Intensity (uW/cm^2)	RMS Sound Pressure (dynes/cm^2)	RMS Particle Velocity (cm/s)	Particle displacement for 1kHz sinusoidal tone (cm p—p)
Threshold of painful sound	130	1000	645	15.5	6.98×10^{-3}
Airplane, 1600 rpm, 18ft	121	126	228	5.5	2.47×10^{-3}
Subway, local station, express passing.	102	1.58	25.5	0.98	4.40×10^{-4}
Noisiest spot at Niagara Falls	92	0.158	8.08	0.31	1.38×10^{-4}
Average automobile, at 15 ft	70	10^{-3}	0.645	15.5×10^{-3}	6.98×10^{-6}
Average conversational speech at 3.25 ft	70	10^{-3}	0.645	15.5×10^{-3}	6.98×10^{-6}
Average office	55	3.16×10^{-5}	0.114	2.75×10^{-3}	1.24×10^{-6}
Average residence	40	10^{-6}	20.4×10^{-3}	4.9×10^{-4}	2.21×10^{-7}
Quiet whisper at 5 ft	18	6.3×10^{-9}	1.62×10^{-3}	3.9×10^{-5}	1.75×10^{-8}
Reference level	0	10^{-10}	2.04×10^{-4}	4.9×10^{-6}	2.21×10^{-9}

add their little bit to the overall acoustic energy which finally reaches our ears.

Music generally covers an intensity level of about that of a soft singing voice or a solo instrument playing pianissimo, while at the upper end we encounter large pipe organs, loud orchestral tuttis and rock music. Bear in mind that these levels are not necessarily what the audience experiences, because of distances, especially in outdoor performances and very large, heavily damped halls.

SIGNAL TO AMBIENCE LEVELS

Obviously, if the music we're listening to drops below the ambient level it will be lost, masked by the noise. Generally, the desired sounds can be heard satisfactorily as long as they are at least 10 dB above the ambient level. This is a pretty lucky state of affairs, too, because if it were not so we might have a rather tough time listening to reproduced music.

Let's suppose you're listening to a folk singer, and you want to listen at live levels. Or even a jazz singer like Mel Torme, whose voice is really quite soft even at its highest levels. If the ambient sound level in the room is up around 55 dB, there isn't much chance of hearing this voice satisfactorily at live levels. Or such 'folk' instruments as the auto-harp, which are often barely audible. Anyone who has ever tried to record a singer who is also playing this instrument knows how difficult it is to get a good balance between the two.

So far we've been considering minimum levels, but how much power is actually required to reproduce a full dynamic range up to maximum anticipated live sound levels? Fig. 1 shows the power levels required for speech and music assuming speaker efficiency of 100%. Suppose we wish to reproduce concert music at concert hall level in a room of 4000 cu. ft., a volume somewhat larger than the average living room, but about the size of a combined living room and dining room of modest dimensions. Under these conditions the chart shows a power requirement of 0.5 Watts, with a speaker of 100% efficiency. If efficiency is only (?) 10% this becomes 5.0 Watts. If the speaker is an air suspension type of moderate size, the most we can hope for is about 1%, so our power requirements become 50 Watts.

SPEAKER EFFICIENCY AND TRADE-OFFS

About this point I can understand the owner of a set of small bookshelf speakers starting to worry. After all, 50 Watts is about the rating of most of the better receivers which are currently available at a reasonable price, and we are looking at this rating as being a mimimum requirement for a fairly efficient speaker. If the little bookshelf jobs are only 0.1% efficient, a not unusual figure, he would need 500 Watts. Assuming money is no object, how many small bookshelf speakers on the market can handle a 500 Watt input even on peaks without breaking down?

Maybe we should go at this from a different direction. Suppose our speaker has its efficiency specified as delivering 90 dB at a distance of 1 meter with an input of 1 Watt. This looks a little more promising; 90 dB is still a lot of sound. It corresponds to the noisest spot at Niagara Falls, and in fact is as loud as noisy traffic. However, it is still 30 dB lower than the highest level we wish to reproduce, and would. therefore, require a power level of 1000 Watts. That is a whole kilowatt, baby, and in anybody's language it's a lot of power.

WHO NEEDS IT?

But hold on a second. Why are we attempting to reproduce this level?

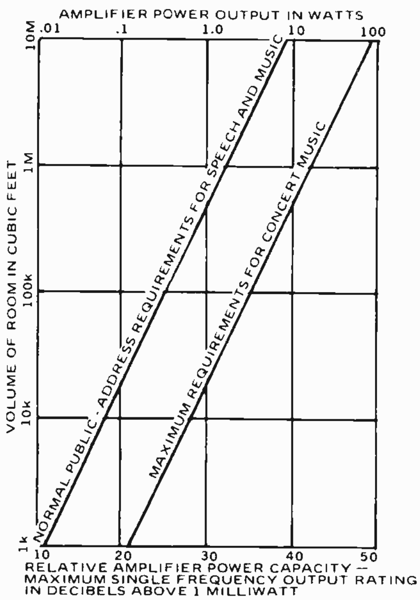


Fig. 1. Graph relating room size to required amplifier power.

Do we really want to? We said earlier that a large symphony orchestra or an organ *can* reach such levels, but, in fact, at these levels we're approaching the level at which sound is actually *felt* rather than heard; you can actually feel the ear-drums move. Disregarding any question of damage to hearing, when was the last time you sat in a concert hall and felt your ear-drums moving? In actual practice, it is extremely rare for sound levels to exceed 110 dB, which, in our example, would require amplifier power of 100 Watts. We're still presupposing a fairly efficient speaker, but we're also talking about a lot of sound.

In a closed room it makes little difference whether we listen at 3 feet or 10 feet, the sound level is about the same, because the reverberant field reduces the loss of energy; we simply exchange direct sound for reverberant sound. But in a concert hall the distances involved are sufficient to produce considerable attenuation by the time it reaches the listener, which might be 10 dB or more. Now our requirements have been reduced to 100 dB and 10 Watts. After all, what we wish to reproduce is the sound field actually perceived in a live performance, not necessarily that which exists on the stage.

TURN IT DOWN

Most people do not listen to con

Most people do not listen to concert music at live performance levels, so perhaps this can ease the power requirements. Or can it? Let's suppose you like your music loud, but not quite THAT loud. So let's drop our levels by 10 dB, for a maximum level of 90dB and 1 Watt. Fig. 2 is the set of equal loudness curves published many years ago by Fletcher and Munson. Each curve shows the actual level required at different frequencies to produce the same loudness sensation as perceived at 1000 Hz. Notice that as the level drops at the reference frequency, it drops by considerably less amount at low and high frequencies.

Moreover, although the *shape* of the curve is about the same at high frequencies, they tend to bunch up at the low end. What is the significance of this? It means that if we reduce the level by 10 dB at 1000 Hz and at 10 kHz, we will perceive this as a 10dB drop, but at lower frequencies it will be perceived as *more* than 10dB.

Let's put it another way: suppose we reduce level by 10dB from 70 dB to 60dB at 1000 Hz. To produce

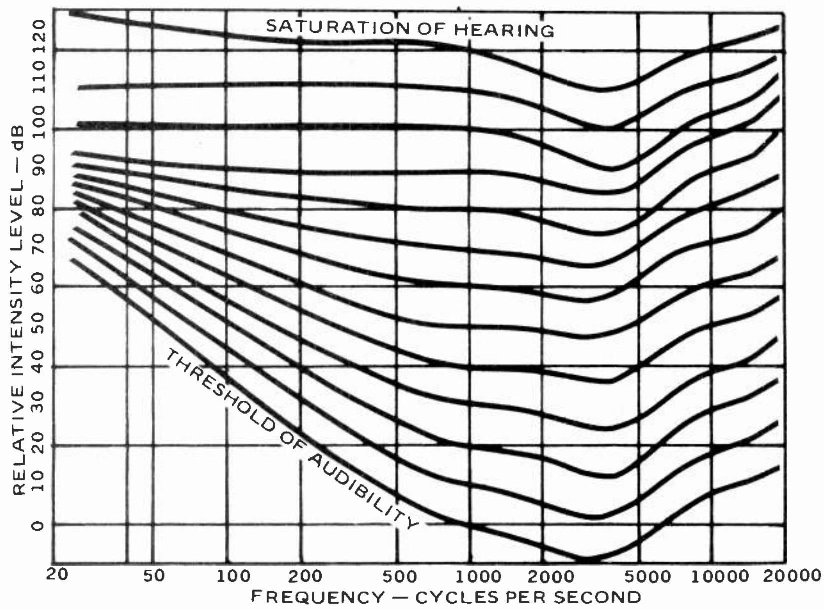


Fig. 2. Graph shows how well the ear hears across the sound spectrum. Note that on this plot the better the ear hears, the lower the line.

the same effect at 30 Hz requires a reduction of about 2.5 dB, that is, from 87.5 dB to 85 dB to perceive the same change. It also means that at 30 Hz a sound level of 85 dB sounds the same as a sound level of 60 dB at 1000 Hz. Now, in live music this is no concern of the listener; the musician controls his balances so that they sound right, but if we reproduce the performance at a level different from the original balances required are different. This is what a loudness control is supposed to do. The fact that I have yet to see a commercial amplifier with a loudness control which works properly attests to the almost universal failure to understand loudness perception. In our last example of level reduction it also means that we haven't reduced our power requirement as much as we thought unless we are prepared to lose bass response, or more accurately, frequency balance. Our 90 dB level is actually 93 dB at 25 Hz which is 2 Watts, with an efficient speaker and no headroom. Bear in mind that a 2 to 1 perceived difference in sound level requires a change of 10 dB we now find ourselves requiring at least 20 Watts, and if we want to be able occasionally to turn the level up a bit more we need another 10 dB or 200 Watts.

If your preferences in music is of the kind that is usually compressed, and this includes most rock and pseudo-rock, things are a little simpler, but not much, because this kind of music is intended to be performed loud. Symphonic music, on the other hand, generally has a wider dynamic range, 60 dB or more. Much of this music is compressed, however and any attempt to achieve live level on peaks results in an unnaturally high level on the triple-piano passages, unless you have an accurately tracking expander. As a compromise, generally the soft passages are brought up a little and peaks lowered. However, with improving recording technology the dynamic range encountered is gradually increasing, with the result that if levels are set high enough for the softest passages to be natural, then the peaks will make heavy demands on power requirements. Reducing levels to accommodate the peaks can result in loss of detail in quiet passages especially at low frequencies, and thus the benefit of wide dynamic range is not appreciated.

A SOLUTION

One compromise which appears attractive is the use of non-linear compression at reduced listening levels. Such a compressor would operate only at lower levels, leaving the impact of peak levels unimpaired. If levels are reduced to near background music levels such a compressor would operate more linearly over the whole dynamic range. It would not be highest fidelity, but would be a lot more satisfactory than most alternatives, including the ubiquitous so-called 'Loudness Control'. No one, to my knowledge, has such a device on the commercial market, but the need is there and really is not too difficult to achieve.

ANSWERS

Any reader who is looking for a chart or table, or perhaps a magic formula which will tell him or her how powerful an amplifier is needed in his own system will be disappointed. I don't know how much power *you* need; I only know my own requirements.

But then, nobody ever said that it was a simple problem.

Audio Today Products

Audio developments reviewed by ETI's Contributing Audio Editor Wally Parsons

ZENITH COMPONENT LINE

For the past few decades High Fidelity Audio as we know it has been pretty much a specialist field, as far as manufacturing is concerned. In other words a field populated mostly by medium to small companies specializing in quality components. Until recently, that is, when the Japanese appliance manufacturers decided to get in on the act. 'Appliance' manufacturers is a term which has been used derisively over the years to describe a company which is involved in a broad range of consumer products, usually electrical and/or electronic, and covering a range which includes washing machines, stoves, irons, television receivers, and console radio-phonograph combinations. Generally the derision has been deserved, because such sound equipment has generally been poorly designed and of shoddy manufacture, with a high price tag in comparison with performance, generally justified by what some might consider to be handsome cabinetry.

But such was not always the case. That which is referred to as 'Appliance audio' is, in many cases, what remains of what was once a very respectable industry. Back in the early days much of the basic research work on sound reproduction was undertaken by such companies as RCA and Marconi (now defunct), and much of modern speaker design stems directly from the work of Harry Olson for RCA. General Electric was the first company of its kind to popularize and manufacture magnetic pickups for broadcast and domestic use, and many other such manufacturers included such components in their deluxe consoles.

The Zenith Radio Corp. is perhaps best known to audio historians as the company which manufactured the first pick-up which did not have to drive a crystal, or a magnet armature, or any similar device, and so could track at a low (for its day) 14 grams, at a time when 50 grams was considered pretty good. In this pick-up, the Q of a fixed coil in an oscillator circuit was varied, thus amplitude-modulating the RF signal. Known as the 'Cobra' because it was shaped like the head of the cobra snake, it appeared for many years in their best home consoles and was the standard pick-up used in Wurlitzer juke boxes.

TODAY

Zenith has re-entered the component audio field with a line of components aimed at lower to mid-price field, and I had an opportunity to examine the line in detail during a recent open house.

Right at the beginning let's establish something quite clearly: although not state of the art by any means, this line is definitely *not* a repackaging of cheap components with bells, whistles and chrome plating.

For example, although the MC 6010 appears unimpressive with 5 Watts output at 2% distortion, it's no worse than some of the cheapies from Japan and sounds a great deal better.

On the other hand, the MC7050 boasts an output of 40 Watts with 0.2% harmonic distortion. This rises somewhat at low power levels, suggesting some cross-over distortion, but this is still on a par with the competition, and what is particularly interesting is the fact that the advertising literature even includes this low power specification. FM specs are equally good, and include a capture ratio of 1.0 dB, an important figure for minimizing multi-path distortion.

ZENITH SPEAKERS

Four speaker models were on display but special mention must be made of the MC3000, a two-way bass reflex representing next to the top of the line, and, to my ears, a better speaker. into the demonstration room and promptly began re-arranging things. The main reason for this was that I couldn't believe they should sound so boomy and wanted to hear how much of this was due to room placement. It should be remembered that this is very much a new field to many of the sales people, and the subtleties of such things have not always been mastered. However, with careful placement of two top models proved capable of delivering a clean, well detailed sound, without top-end harshness or bass boom. The MC3000 proved especially smooth and clean at the bottom end and could be expected to deliver even better performance when placed on stands. Highly recommended, and a lot better sounding than much of the Japanese product, and most house brands.

TURNTABLES & RECEIVERS

Three automatic turntables are part of the line and each comes equipped with a Shure pick-up of the M75 series. These are modern designs which work well and carry respectable specifications.

The receivers, unfortunately, don't come up the the same standards with regards to finish, in my opinion, as the performance would justify. With the exception of the fly-wheel tuning which has a lovely effortless feel to it, the switches and controls have a certain 'clunky' feel to them which is not normally associated with a quality product, but which is not really an indicator of quality. It's much like the 'thunk' of a car door. This is no indication of the quality of the car, but buyers are often misled by such things. The appearance looks as if it's trying to look 'quality' if you understand my meaning, but again the performance belies this effect. These are matters of aesthetics, of course, and are very much subject to personal taste. If anything, one could say that the equipment performs much better than such cosmetic details would suggest, and if you can find a dealer who knows how to demonstrate them, they should be worth looking into.

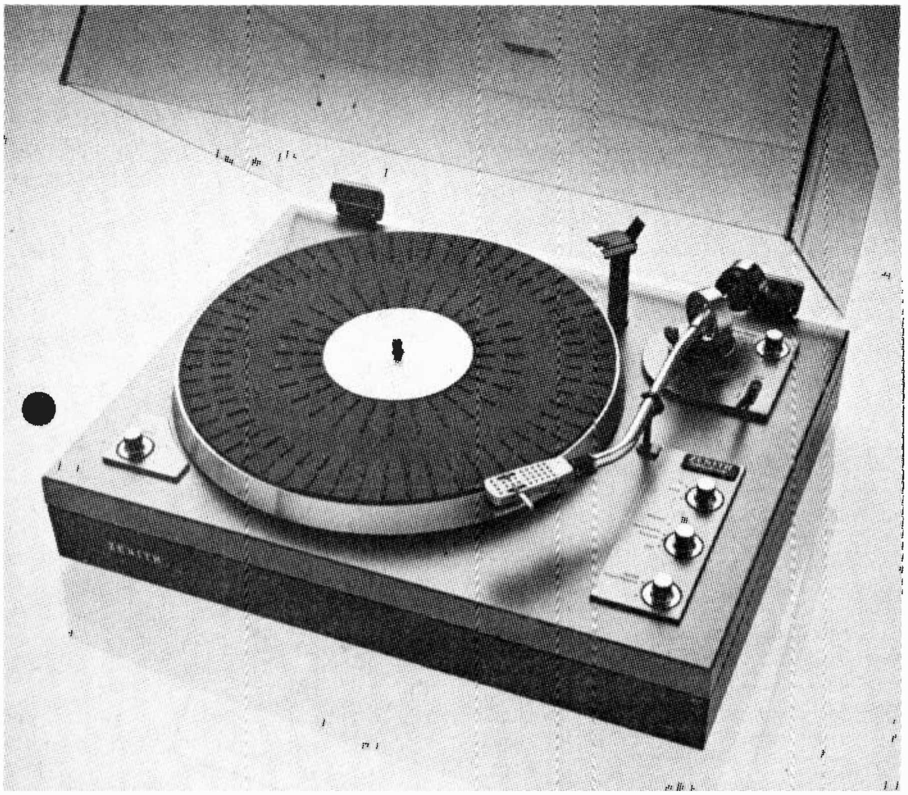
I can't comment on reliability, but I know that Zenith has a good reputation in this regard as far as its television sets are concerned, and the current line delivers one of the best pictures I've seen since my old Philips K7-2 chassis.

I'm not sure that this audio line will appeal to the sophisticated audiophile. If not, the audiophile would still find it a good suggestion for the friend who comes to him for advice, especially if the friend is reluctant to get involved in matching up different components.

RC BEAT CHESS CHALLENGER WP CLAIMS FOUL PLAY

Incidentally, I had a chance to play a game against their chess-playing computer. I must have given it a hard time, because it had to cheat. As you know by now, ETI's Service editor actually beat it.

Anyway, write to Zenith Radio Corp., of Canada, 1020 Islington Avenue, Toronto for spec sheets, or see your dealer, as they say.



Zenith's entry into the flashy looking turntable market.

Audio Today Letters

If you want to express your views or report on news write to Audio Today, ETI Magazine, Unit Six, 25 Overlea Blvd, Toronto. Ont. M4H 1B1.

SPEAKERS, SPEAKERS

'Audio Today' is a welcome feature to ETI and enjoyable, informative reading.

In a future issue an in-depth discussion of passive and electronic crossovers would probably be of interest to your readers and myself; this would clear up some of the questions I have concerning this subject.

For example, I have five different books (some by Sam's) giving five different formulae and/or graphs to be used when rolling your own coils. Not one of the books is the same as the others when it comes to the inductance or capacitance values for the filters.

I should imagine that L and C of low pass section would be the same as in the high pass section. Some books don't agree.

(My present speaker boxes) sound great with a lower 3dB down point of about 50 Hz. However, I'd like to add a centre channel woofer with a 150 to 200 watt amplifier and electronic crossover of about 80 to 120 Hz and with a 3 dB down point of 40 Hz. I had thought of a folded horn or a large reflex but your transmission line speakers sound interesting. Are they easier to build than a horn? Also, are you aware of any feedback (via transducer) system which could be used in a small infinite baffle cabinet?

JCS, Downsview Ont.

Quite frankly, before we do anything on crossover networks, I'd rather devote space to the design of speaker enclosures. I think this would be a more useful approach. Your five different books and formulae illustrate the problem. I can probably give you a sixth approach. The reason for the difference lies in the different end results required. For example, one may design for constant power transfer and linear phase, or one may wish to correct for phase differences in drivers, or provide equalization in the crossover or compensate for voice coil inductance. That's why I would rather do enclosures first. In other words, probably every writer is right, but for a different reason.

I don't see much point in building a sub woofer with a 3dB down point of 40Hz for use with awoofer which goes down to 50 Hz. In any case your woofer (an RSC model LF 15) has a free air resonance of 20 Hz and was intended to go down to 16 Hz in an 11 cu. ft. reflex enclosure using a B4 alignment. In your smaller enclosure of 7 cu. ft. you should be able to get down to 20 Hz with a C4 alignment with reasonable flatness to cutoff. In other words, I suspect your speakers are incorrectly tuned and I would work on that before going in for a transmission line. For such a driver you would end up with an enclosure of about 15 cu. ft., and they tend to be tall. Generally, transmission line sub-woofers work best either as pairs, or singly with restricted range "satellite" speakers. But they are easier to build than horns.

The small driver you want might be a Philips AD8067MFB which has a built in accellerometer.

MAGNAVOX PHONES

I have a problem and I don't know who else to turn to for a possible answer. I recently purchased a set of electrostatic headphones; but without a power supply. Now I have the task of hunting down an address.

The address I need is for Magnavox. I would like to know if you could send me a Canadian address or even a U.S. address for Magnavox. I would like to purchase the power supply or at least get plans for it. Any help would be much appreciated.

O.A.K., Macklin,Sask .

P.S. If it's not too much trouble, how about an autographed picture of each of the ETI staff. I like the Magazine and would like to know what you people look like.

The last I heard Magnavox had been taken over by Philips Electronics Industries. You might write them at 601 Milner Ave., Scarborough, Ont. M1B 1M8. I have a hunch that this might turn out to be a product which was sold only in the U.S. In that case, your best bet might be the nearest U.S. Consulate which I would presume to be in Regina. Address inquiries to the Commercial department.

As for pictures everyone around here is much too modest to agree to your request. However, my picture is at the top of the column and was drawn by the lovely and talented Gail Armbrust from a colour slide taken by my wife. If you want to see Gail look for the ETI T-Shirts advertisements in recent issues. Never mind the guy with her, that's just somebody else who sometimes works at ETI. If you have the July '77 issue you can see Sharon on the cover. This picture does not do her justice; actually it's at the second to last position on my list of favourite covers. Sharon is quite a beauty in her own right, and if Graham or I had taken it this would have been obvious.

We like you too.

* digital tachometer
* FM broadcaster
* Log-Exp Converter
* * ROBOTS * *
COMING UP IN JANUARY'S ETI!

Designing Oscillators

One of the problems in electronics is stopping amplifiers from oscillating, another is getting oscillators to oscillate . . . Tim Orr explains.

AN OSCILLATOR IS BASICALLY an amplifier with positive feedback applied around it. The feedback must be AC coupled otherwise a DC latch up condition would occur. Having got some sort of oscillation, one of two things can happen. The oscillation can build up in amplitude until clipping occurs due to the power supply voltage levels. At this point a stable, but truncated waveform will be generated. Alternatively if the gain of the amplifier is too low the oscillation will die away. To produce a pure sinusoidal oscillation the level of the signal in the system must be accurately controlled. There must be some amplitude limiting or automatic gain control such that when the peak signal level tries to exceed a reference voltage, the amplifier's gain is reduced. This is in fact what limiting does. To maintain stable oscilation, the overall gain of the system must be exactly unity. Any less and the oscillations will never start. If the gain is more than unity, the oscillations will occur, but amplitude limiting will cause gross distortion.

A very common method for stabilising the oscillations, which is often used in Wein bridge oscillators, is to employ a very sensitive thermistor as an AGC. However, the thermal time constant of this component often produces an annoying amplitude bounce which occurs when changing to a new frequency.

Other methods are diode limiters (which tend to cause large amounts of distortion) and FET AGC circuits. The latter method can be used to generate super low distortion sinusoids by allowing the system gain to stabilise over tens of seconds.

The oscillation frequency is mainly determined by the feedback around the amplifier. By making the feedback a reactive network, the phase of the feedback will vary as a function of frequency. Oscillations can only occur when the feedback is positive and thus the phase response of the feedback will determine the frequency of oscillation, assuming that the overall gain at this frequency is at least unity. By varying the phase response of the feedback, the oscillation frequency may be altered.

An oscillator should be thought of as being a circuit which continuously generates a waveform, no matter what the shape of the waveform. There are very many circuit techniques for generating these signals which range from relaxation oscillators to piecewise approximations using square waves. Some of these methods will now be illustrated.

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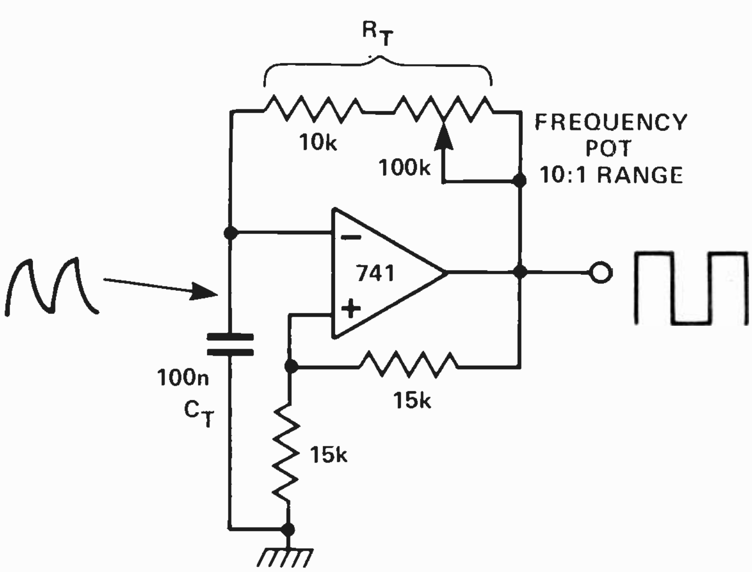
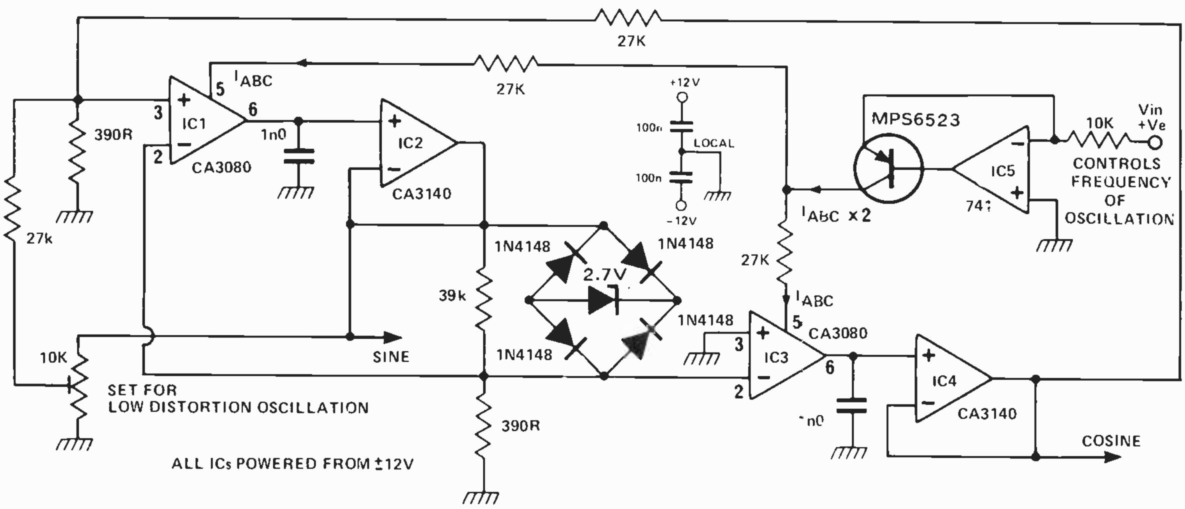


Manually Controlled Oscillator

In this circuit there are two feedback paths around an op-amp. One is positive DC feedback which forms a Schmitt trigger, the other is a CR timing network. Imagine that the output voltage is +10V. The voltage at the non-inverting terminal is +15V. The voltage at the inverting terminal is a rising voltage with a time constant of C_T R_T. When this voltage exceeds +5V, the op amp's output will go low and the Schmitt trigger action will make it snap into its negative state. Now the output is —10V and the voltage at the inverting terminal falls with the same time constant as before. By changing this time constant with a variable resistor a variable frequency oscillation may be produced.



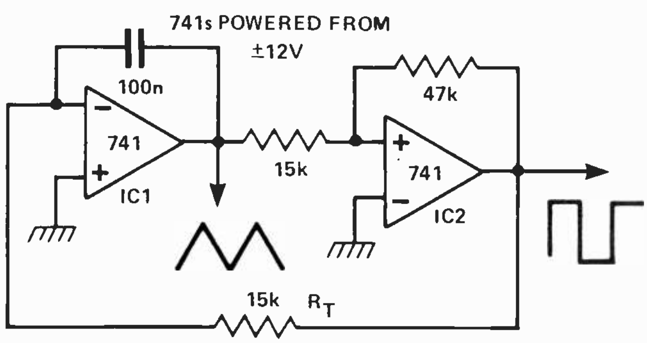
Dual Integrator Quadrature VCO

This is a sinusoidal oscillator which uses frequency dependent feedback and zener diode amplitude limiting. IC1,2,3&4 form a dual integrator circuit which is an analogue model of a second order differential equation! There is some positive feedback around IC1,2 which is analogous to having a zero damping factor in the equation. This means that the oscillations will build up. The positive feedback is controlled by the 10k preset. IC1,3 are integrators and IC2 and IC4 are voltage followers with high input impedance. The phase shift produced by an integrator is 90° so there is no overall feedback around the loop (IC1 is non-inverting, IC2 inverts). Thus we have all the conditions for oscillation, and in fact oscillations will occur when the preset is adjusted to give the correct phase shift around the IC1,2 stage. Amplitude limiting is produced by the 2.7V zener inside the diode bridge. By placing it inside the bridge the same diode is used for both positive and negative signals and the limiting is symmetrical. The integrators are two quadrant multipliers (CA3080s), so the gain of the loop can be controlled by the current I_{ABC}. In the solution of this second order differential equation, the gain of the loop is proportional to the resonant frequency. Thus, by varying I_{ABC} or rather by varying V_{IN}, the frequency of oscillation may be altered.

As the integrators produce a 90° phase shift, the two sinusoid outputs are in phase quadrature, i.e. one is a sinewave, the other a cosine wave. The cosine output is lower in distortion than the sinewave, because the amplitude limiting (and hence the distortion) is produced at the IC1,2 stage.

The second stage (IC3,4), acts as a filter and hence produces a purer sinusoid. Using this circuit a 1000 to 1 continuous frequency sweep can be obtained. However, the inaccuracies in the CA3080's will cause some amplitude variations and it may be necessary to set the positive feedback a bit high (and hence attract more distortion), to maintain stable amplitude limiting over the sweep range. This circuit is an oscillating filter and if you turn down the positive feedback and inject a small signal through a 100k resistor into IC1 pin 3, a bandpass and low pass response is obtained from the sine and cosine outputs respectively.

Simple Triangle Square Wave Oscillator

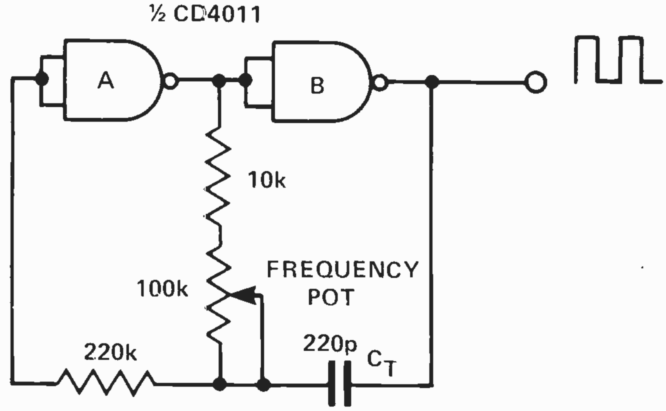


This circuit generates simultaneously a triangle and a square waveform. The triangle could be 'bent' by a diode function generator to produce a sinewave. The circuit is always self starting and has no latch up problems. IC1 is an integrator with a slew rate determined by C_T and R_T and IC2 is a Schmitt trigger. The output of IC1 ramps up and down between the hysteresis levels of the Schmitt, the output of which drives the integrator. By making R_T variable it is possible to alter the operating frequency over a 100 to 1 range. Three resistors, one capacitor and a dual op amp is all that is needed to make a versatile triangle squarewave oscillator with a possible frequency range of 0.1Hz to 100kHz.

CMOS Oscillator

Two CMOS gates can be used to produce a simple oscillator. Imagine that output B is high. Then the input to A is also high due to it being coupled via the capacitor C_T to output B. Thus output A is low, input B is low and output B is high, which is as we would expect. However, capacitor C_T is being discharged via the 100k pot and 10k resistor to a logic 0. When this voltage reaches the crossover point for A, output A goes high, and thus output B goes low. Now the capacitor is charged up to a logic 1. Thus the process repeats itself. Varying the 100k pot changes the discharge rate of C_T and hence the frequency. A square wave output is generated. The maximum frequency using CMOS is limited to 2MHz.

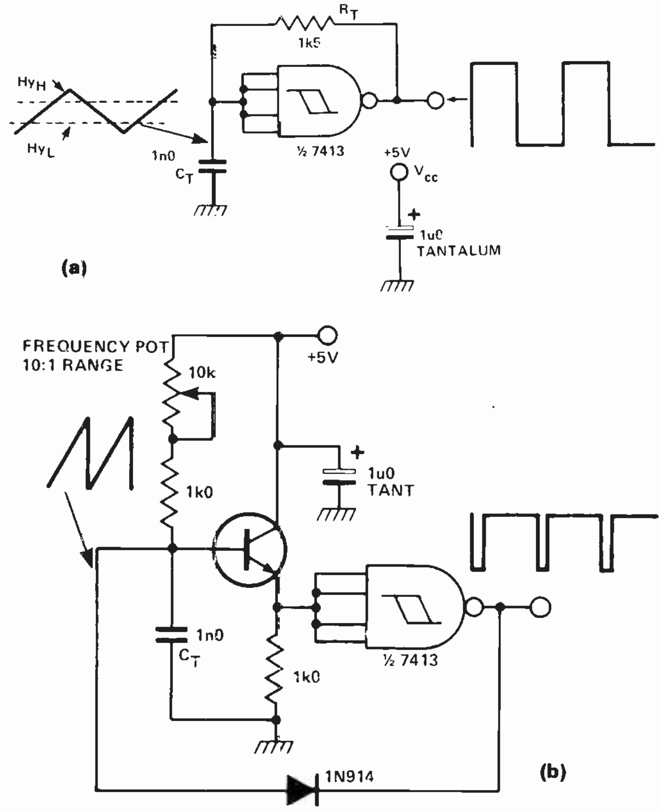
½ CD4011

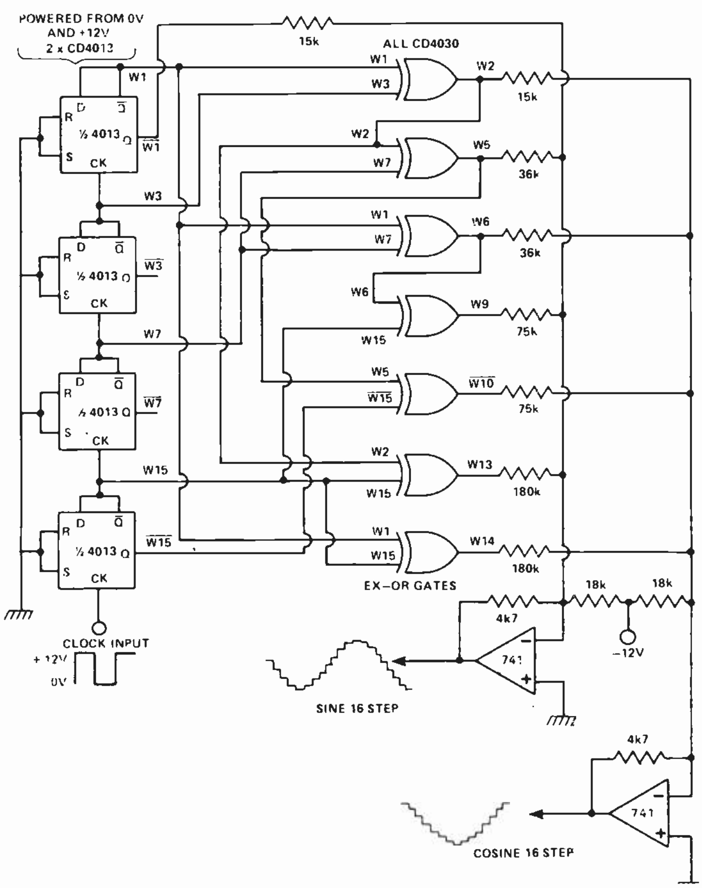


TTL Oscillator

A simple relaxation oscillator can be made using a TTL Schmitt trigger. The circuit 'a' is the most simple version that can be produced. Imagine that the output is high. Capacitor C_T is charged up via R_T. When the upper hysteresis level (Hyh) is reached, the output goes low. CT is now discharged until the low hysteresis level (Hyl) is reached whereupon the output goes high. Thus the oscillator generates a square wave, with an uneven mark to space ratio, due to the input current requirements of the 7413. The frequency can be set at any value up to several megahertz by varying C_T and R_T. C_T can be an electrolytic but R_T must not be more than about 1k5 or it will not be able to pull down the Schmitt trigger inputs. (If you use a CMOS Schmitt this does not apply). The output is a nice fast squarewave capable of directly driving several TTL loads. One problem to be encountered is frequency jitter. When the input is very near to a hysteresis level, noise in the system may cause the oscillator to prematurely trigger, thus making that period slightly shorter and producing a noise induced frequency jitter. Also using two Schmitt triggers from the same IC is sure to cause interaction and thus jitter. To reduce power supply noise effects the IC should be decoupled with a 1uF tantulum capacitor actually at the V_{CC} and GND pins of the package.

Diagram 'b' shows the same oscillator, but with a 10 to 1 manual control of frequency. The timing capacitor is charged up by the 10k pot and the 1k resistor. This voltage is then buffered by the emitter follower and fed to the Schmitt trigger. When the upper hysteresis level is reached the output of the Schmitt goes low and the capacitor is rapidly discharged via the diode until the lower level is reached. The process then repeats itself. As the discharge period is so fast, it can be thought of as being determined by the charging time, which is controlled by the 10k pot.





Walsh Function Generator

The mathematician, Fourier, said that any repeating waveform could be made up out of harmonic components. These components are sinusoids which are integrally related to the fundamental period of the waveform in question. This is a convenient conceptual approach, but as a way of practically synthesising waveforms it is not on. You would have to generate a whole series of harmonically related sinewaves which might prove a little difficult. However, a man called Walsh said that you could do the same thing as Fourier, but with square waves. So, instead of using sinusoidal Fourier sets, we can use square wave Walsh functions to synthesise waveforms. There are various techniques for calculating the Walsh function co-efficients for generating particular waveforms but these are beyond the scope of an article such as this. The diagram shows the circuit for generating a sine and cosine waveforms using 16 steps. Walsh functions are orthogonal functions, just as sine and cosine are orthogonal, and so the generation of these two waveforms is relatively simple using this technique. The 4013 dividers and the exclusive OR gates generate the Walsh functions, which in turn are converted into analogue waveforms by use of the correctly weighted resistor networks. Note that you only need 4 resistors to generate a 16 step sinewave approximation.

The resultant outputs can be easily filtered by fixed or tracking filters to produce pure sinusoids. The output frequency is 1/16th of the input clock frequency. The clock can be stopped and the outputs will remain fixed, try that with analogue techniques!

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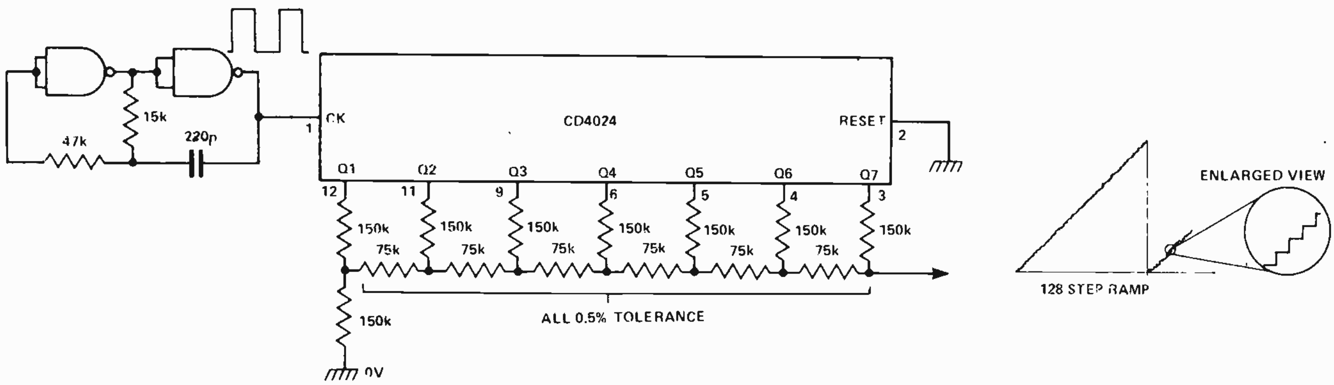
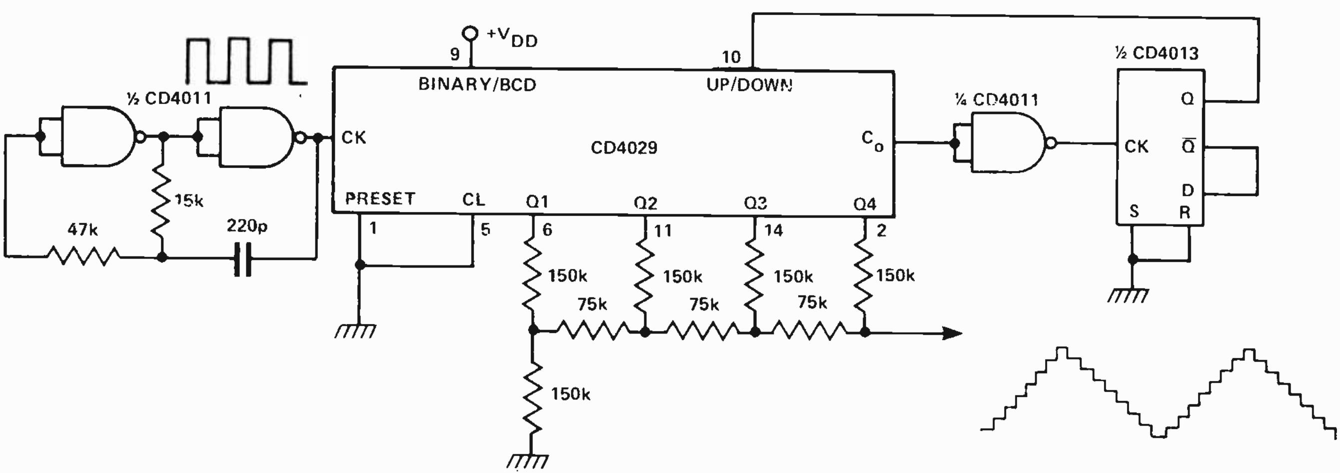


R-2R Staircase Generator

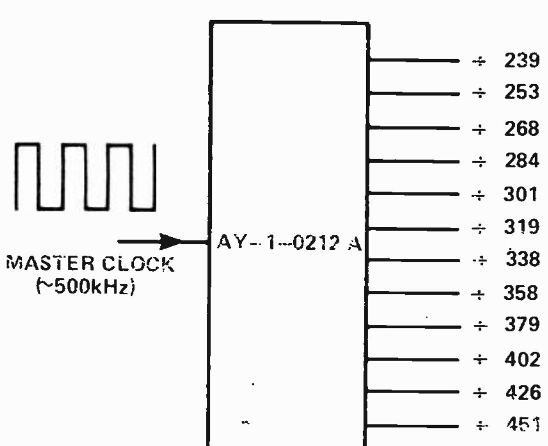
Waveforms can be constructed by building them up out of separate elements. In this case a linear ramp waveform is generated out of 128 steps. The CD4024 is a seven stage binary counter. It is being driven from a CMOS clock oscillator similar to that already described.

The Q1 to 7 outputs divide this clock frequency by 2,4,8,16,32,64 and 128 respectively and the divided outputs are then fed into an R,2R ladder network. This is in fact a Digital to Analogue Converter (DAC) and as the counter is merely counting up, then the converter will generate a linearly rising waveform made out of 128 steps. When the counter overflows, the ramp waveform resets and the process repeats itself.



R-2R Triangle Generator

This circuit is similar to the previous except an up down counter is included. A clock signal is applied to the 4029 counter. When it has counted 16 clocks a Carry signal is generated. This clocks a D type flip-flop (4013), which changes state and reverses the up down mode of the 4029. Thus the circuit counts up, down, up, etc. The counting is converted via an R,2R ladder into an analogue output, a triangle waveform made up out of several steps.



Master Tone Generator

If you have ever made an electric organ, piano or string machine you would have had to produce the top twelve notes for the top octave by some means or other. More expensive organs might use 12 master oscillators which would be tuned to the top twelve semitones on the keyboard. This gives a nice free phase quality to the sound. The notes in the octaves below are made by using binary dividers and filtering. Very expensive organs would use an oscillator per note. This allows every note to be individually tuned and produces a very good sound quality. However, there is an easy way of producing the semitones and this is with a master tone generator chip. This is a pre-programmed divider having one input and twelve or thirteen outputs. A high frequency master clock is put into the chip which is divided by numbers ranging from 239 to 451. These divisions produce the semitone outputs. Thus, by using one master oscillator and one master tone generator a lot of the work of making an organ is removed. It is possible to produce more accurate intervals using 12 oscillators, but the speed and efficiency of the chip usually wins in the lower price end of the market.

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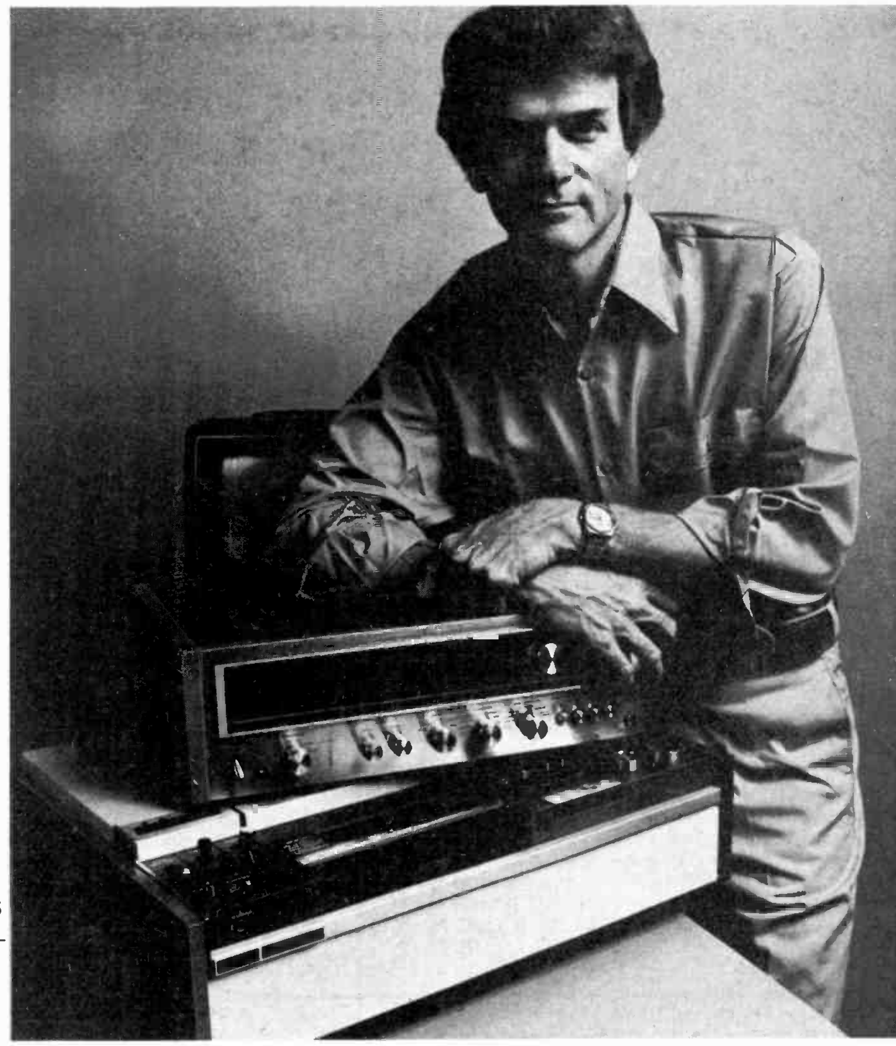

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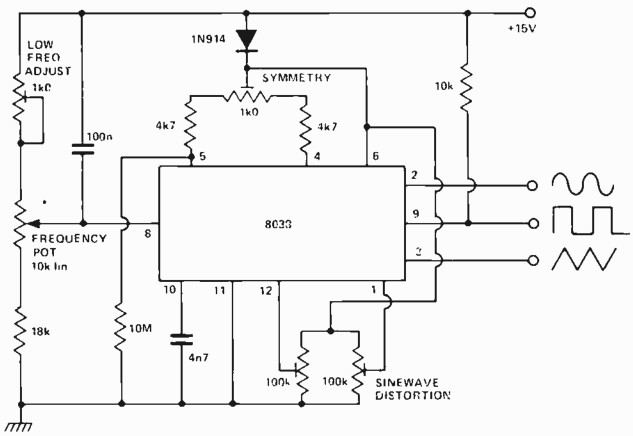
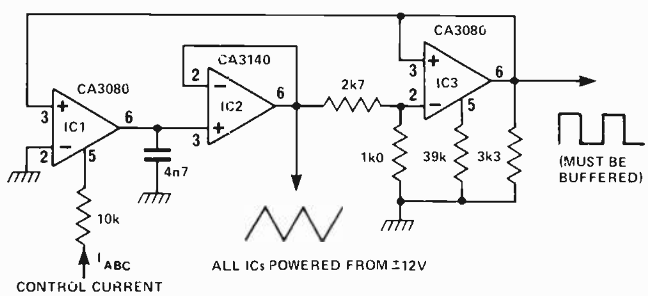


8038 Function Generator

There are several ICs available which perform some sort of oscillator function. One such is the Intersil 8038 which is a VCO with sine, triangle and squarewave outputs. The basic oscillator is a triangle squarewave device with a function generator to produce the sinewave. The frequency is voltage controllable but is not a linear function. The triangle symmetry and hence sinewave distortion are adjustable with a preset but change when the frequency is altered. Operation up to 1MHz is possible.

Triangle Squarewave ICO Using CA3080's

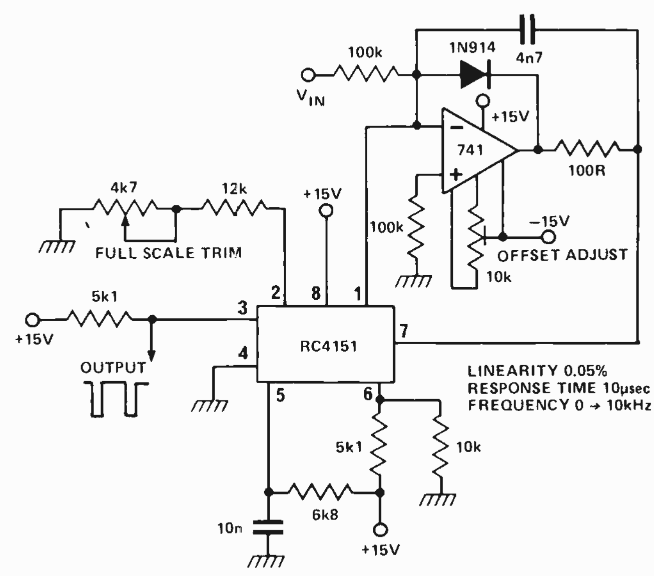


This circuit is very similar to that of the simple triangle/square oscillator, except that the operating frequency is controlled by a current IABC. (ICO stands for current controlled oscillator, as opposed to VCO, voltage controlled oscillator). Using this circuit, a sweep range of 10,000 to 1 is possible (for IABC 500µA to 50nA). The CA3080 is a two quadrant multiplier and the CA3140 is a MOS FET op-amp. IC1 is used as an integrator. IC2 is a high input impedance voltage follower and IC3 is a Schmitt trigger. The CA3080 has a current output which in the case of IC1 is used to charge up a capacitor. The voltage on this capacitor is buffered by the CA3140 and fed into the Schmitt IC3. The CA3080 (IC3) forms a very fast Schmitt trigger but as it has a current output, it cannot be loaded in any way without effecting the operating frequency. The output of the Schmitt is used to make the integrator inverting or non-inverting. Thus the operation is as follows. The integrator ramps upward until the positive hysteresis level is reached. The Schmitt flips over, the integrator then ramps downwards until the negative hysteresis level is reached. The Schmitt flips back and the process is repeated. The ramp rate is determined by the size of the current IABC is linearly proportional to the oscillation frequency. At very low currents the triangle waveform may become very asymmetrical. This is due to current mirror mismatches inside IC1 and this device may have to be specially selected for continuous symmetry.

Precision Voltage Controlled Oscillator

The RC 4151 is a precision voltage to frequency converter. It generates a pulse train output which is linearly proportional to the input voltage. The linearity for the circuit shown is 0.05%. The IC compares the input voltage with an internally generated one. It dumps controlled pulses of charge into a Parallel RC network and compares this generated voltage with the input. If the input is greater it puts more pulses of charge into the RC network until the two are balanced. To get a larger sustained voltage in the RC network the frequency of the pulses must be increased. Thus the frequency of the pulses generated is made to be proportional to the input voltage.

The output is a pulse waveform and is intended to drive some sort of counting system, the chip being used as simple analogue to digital converter. It can also be used as a frequency to voltage converter. A maximum frequency of 10kHz has to be observed.



Digital Anemometer

Impress your neighbours with the very latest in CB antennae.

Contributed by L. H. Mc Cracken

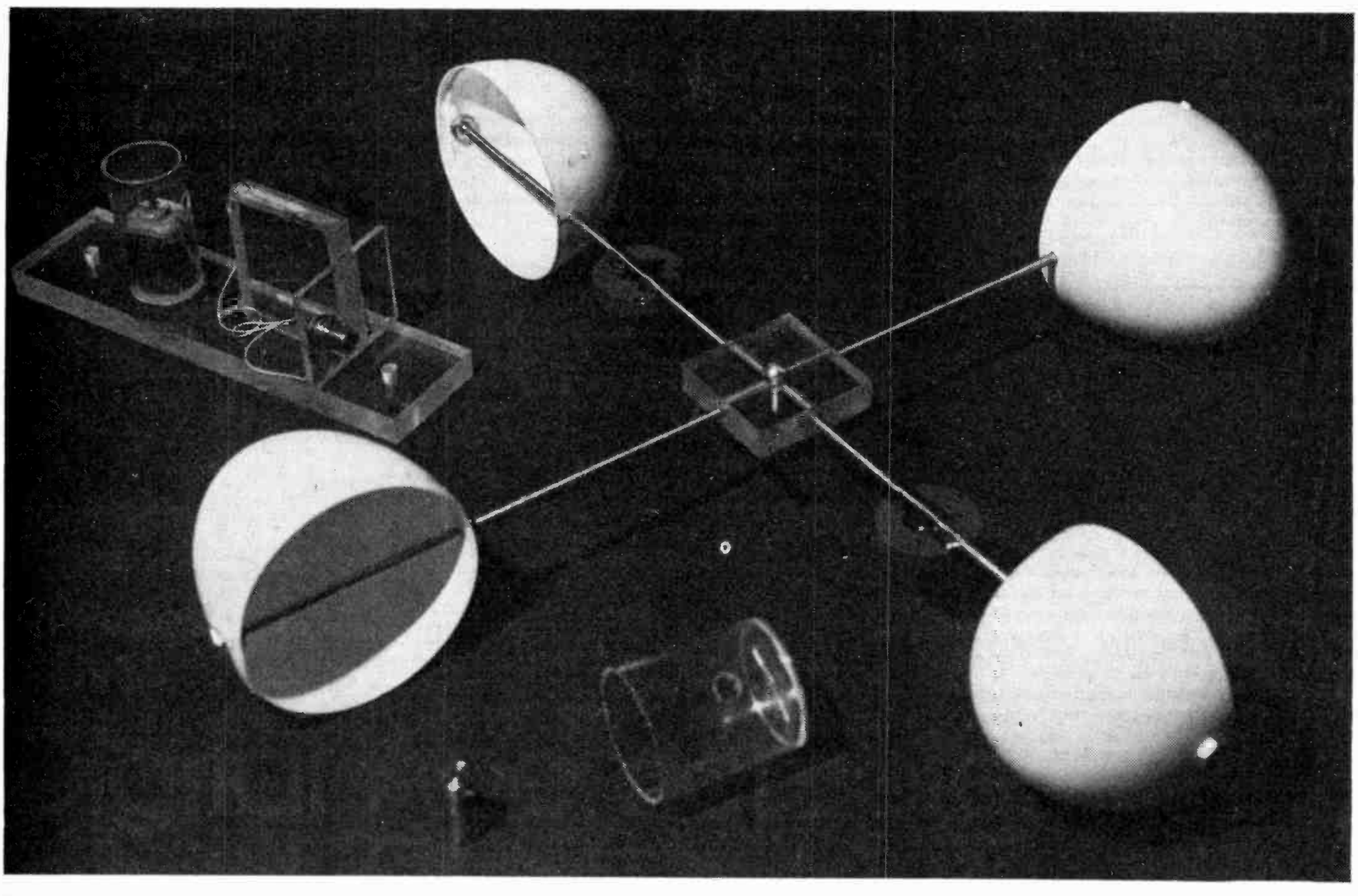
THE OCEANS AND SEAS make up about 75 to 80% of the earth's surface. Yet, there is another ocean that completely evelopes the planet. This is our atmosphere, and like the seas, it is seldom at rest. When certain physical conditions occur, it can be just as destructive as a violent ocean. Of course, this phenomenon is called wind. When both elements are in a highly agitated state, the results can be disastrous to those who dwell on land near the coast, fly in the air, or sail the seas.

Just as hydrographic and/or oceanographic agencies have sophisticated instruments to record and measure the diurnal vagaries of tides and currents, meteorological people have devices to observe properties peculiar to our atmosphere. One of these instruments is the anemometer, a device to measure wind velocities.

WIND SPEED

If you have never seen an anemometer, a visit to your local airport will satisfy your curiosity, look for a device with four cups turning in the breeze. You'll find them on the roof of the meteorological building or nearby. The control tower will certainly have one or two, while others will be strategically located near the ends of the runways, and may or may not have a vane as part of its mechanism to indicate wind direction. Weather ships, and other marine craft have them mounted on the bridge or mast. Depending where in the world you live, the wind speed is reported in knots, or in miles, or kilometers per hour.

Wind velocities are of paramount importance to aircraft pilots during landing and taking off. This is particularly so if the plane is small and a heavy cross-wind is present. Those who sail the wide open seas also have a



keen interest, as well as those who live in areas peculiarly prone to hurricanes and tornadoes. Other interested people, are the fast growing clan of amateur weather observers and kite flying buffs. Hang glider enthusiasts, just before stepping off a sheer mountain cliff, might find a final glance at a portable anemometer most reassuring to life and limb.

TWO TYPES

In general, 2 types of anemometers are commonly available, and although both use wind cups, their circuitry is quite different. The simplest of these, use a tiny D.C. generator whose voltage output is calibrated in terms of wind speed. A more sophisticated device, generates pulses and these are integrated by a capacitor and associated circuitry to produce a voltage proportional to the force of the wind. Both use a meter to indicate wind speeds. While an anemometer can be expensive, and one digital kit on the market can cost an arm and a leg, the project described here can be just as accurate, and with shrewd shopping, can be assembled under $50.00. The device generates pulses, but unlike the sophisticated manufactured type, instead of integrating them with complicated circuitry, it displays them digitally on an easy to read display board.

ABOUT THE PROJECT

The circuit is a simple 2 digit frequency counter. The display board contains all the logic to count from 0 to 99, recycle, and start over again. The larger board contains circuitry to condition the input, generate other logic, and a variable time base. The project can be applied to other counting requirements, see end of text for other suggested applications.

CONSTRUCTION

The wind sensor can be fabricated from a host of materials either found in the average household, or cheaply purchased. The 3/8 inch thick plexiglass used in this project amounted to fifty-cents, including cutting to size, plus 2 plastic vials from a local plastics outlet. The streamlined cups can be small plastic funnels (seal the small open end) or from certain round top spray cans ('Ban'). The prototype, used 'Leggs', the egg shaped containers in which ladies' hosiery is packaged. The rods that support the cups were fabricated from brass welding rod having a diameter of slightly less than 1/8 inch. The rotating shaft and bearing utilized Radio Shack's hobby motor with wiring and brushes removed.

With these ideas in mind, we are sure that constructors will have no difficulty using their ingenuity and materials at hand to make up an appropriate rotor. It should also be noted that a closest distance of 1/8 inch between magnet and reed switch appeared to be very effective.

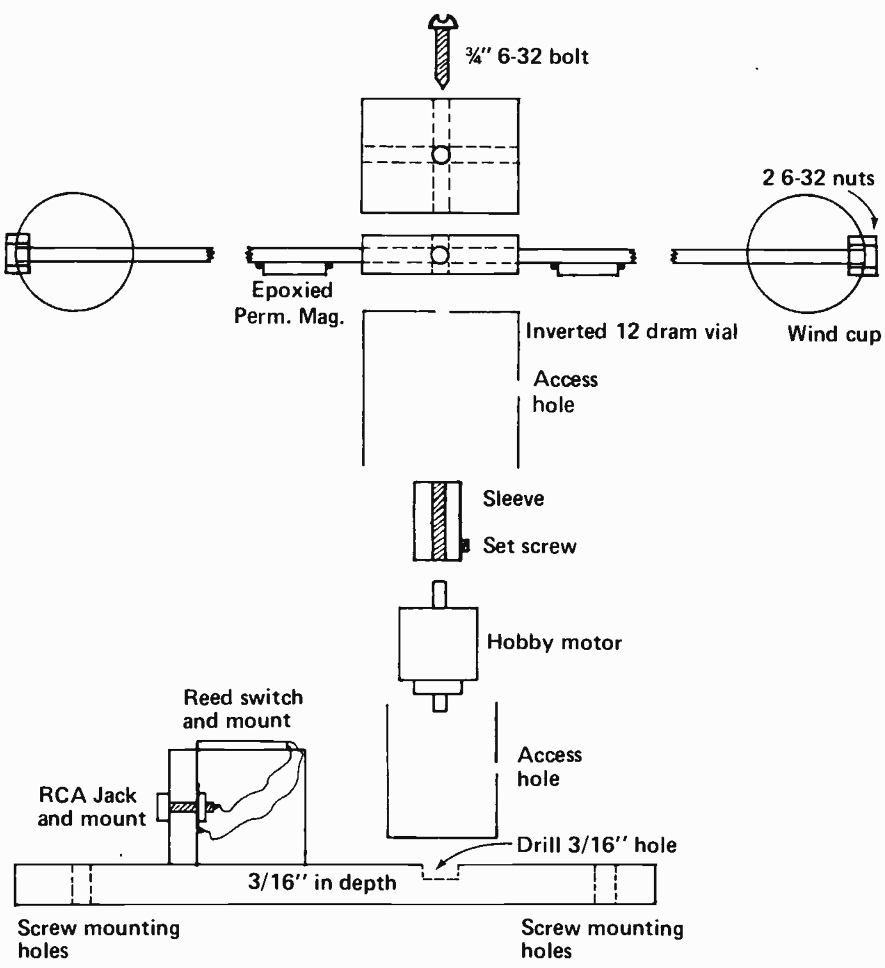
CIRCUIT ASSEMBLY

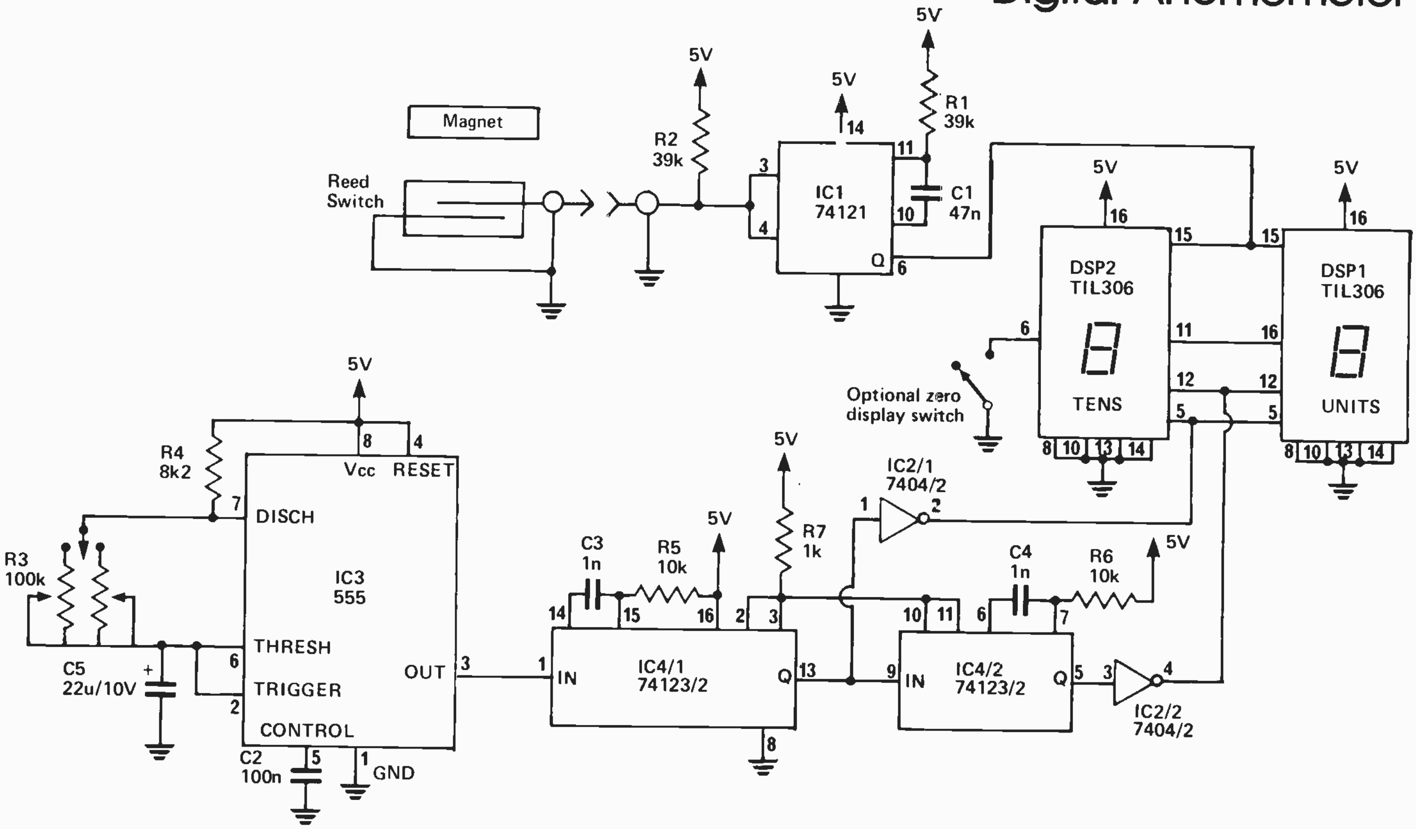
The circuit can be mounted on perf board using point to point wire wrapping techniques. The position of the components is not critical, and most any convenient layout will do. A good ground return is a consideration to be taken into account. All grounded components should be independantly wired to a central point. A narrow strip of copper can be used as a ground return bus, or a piece of heavy copper wire.

The use of the given printed circuit and drilling guides will make assembly an easy and straight forward one, and if you are careful, the project will get up and go the first time power is applied. Placement of parts have been etched on the foil sides of all boards. All resistors and electrolytic capacitors are end mounted, and be sure to correctly orientate all polarized components. Squeeze-throughs (traces between IC pads) have been used extensively, particularly on the display board. The use of a fine tipped low wattage soldering iron should be used to avoid solder bridges in these areas. IC sockets are recommended.

Calibration potentiometer R3 is mounted off board, the rear of the cabinet enclosure is a good place for it. Here, you can elaborate on the circuit. As discussed earlier, this pot is used to calibrate the device in terms of whatever wind speed units please you. By incorporating 2 or more R3s, and suitable switching, you can at will, switch between any of the commonly used methods of reporting wind speeds. The circuit diagram shows 2 calibration R3s with switching. The choice is yours.

Another option is the suppression or display of leading zeros. No connection to the BL pad on the display board results in leading zeros being displayed, and on a calm day, the display indicates 00. With a jumper to ground, leading zeros will be suppressed. Inserting a SPST switch





between the BL pad and ground, the display or suppression of leading zeros can be controlled at will. Again the choice is yours.

A regulated 5 volt supply is required. Two printed circuits are given, one for the house supply, and the other driven by a 7 to 24 volt D.C. source should you decide to have the benefit of an anemometer on board your marine vessel, or require a portable anemometer powered by batteries. The prototype has its sensor on the roof, and power is supplied by a wall type plug in transformer with a D.C. output of 9 volts at 600 milliamps. Using the D.C. driven regulated supply, the entire project was housed in a very small enclosure. In this case, Radio Shack's 270-260.

After installation of the components and you have carefully scanned all solder joints, interconnect both boards matching up the numerals 1,2, and 3 along with ground and 5V supplies. A short piece of 5 conductor ribbon wire makes a neat connection. Mount them in a housing of your choice along with whatever power supply you are using. An off-on switch and an in line fuse should be incorporated.

For an initial test, power up the unit. Temporary jumper the sensor to P1 and ground, and give the cups a spin with your hand. The display should now read out some count,

HOW IT WORKS

The wind force turns a shaft having streamlined cups fastened on four arms. Two diametrically opposed members have permanent magnets securely attached. A small reed switch mounted on a stationary base positioned so that the magnets pass over in close proximity. One complete revolution closes the reed switch twice. The pulses generated by the reed, trigger IC1, a 74121 mono-stable one shot. IC'1s output, free of contact bounce and other spurious pulses, is connected to the clock inputs of both TIL306 displays.

A variable time base is generated by IC3, a 555 timer connected in the astable mode. The associated circuitry and potentiometer R3 control the frequency output, and are used to calibrate the device against any convenient numerical standard. The time base triggers the first of 2 cascaded one-shots of IC4, a dual 74123 one-shot, generating a latch strobe or update pulse. To accommodate the logic of the TIL306(s), the pulse is inverted by 1/6 of IC2, a 7404 hex-inverter, and applied to the TIL306 latch inputs. Any counts stored in the latches are displayed by the read-outs.

Just after this sequence, the second half of IC4 is triggered, again, after being inverted by another 1/6th of IC2, resets or clears the TIL306 counters to 00, releasing the counter to gather new data (pulses). The net result is a steady flickerless display. Note, 00 is never displayed unless it is a calm day. The strobe and reset sequence takes only a few millionths of a second, hence the interval between the time base pulse, is spent counting the reed switch closures.

The displays may be Texas Instruments TIL306's or TIL307's, the only difference being a left or right hand decimal, and these are not used in this project. If left unconnected (high) the decimal is displayed, if grounded (low), they are blanked. Each TIL306 or 307 contains the four units necessary to display a counter frequency, that is, a BCD counter, a four bit latch, and decoder LED driver all contained in a 16 pin dip package.

Each display contains a feature called ripple blanking. If the number zero is detected in the latches, and the ripple blanking has been enabled (low) the display will be blanked. This function was incorporated to give leading zero suppresion in the counter. Starting from left to right (MSD to LSD), if zero is detected, that display will be blanked and the blanked data will be passed on to the right. Hence, a count of 5 will be displayed as 5, and not 05. The printed circuit board for the displays incorporates this feature and can be controlled at will. See text under options. The utilization of these TIL chips eliminates separate counters, latches, decoder/drivers, 2 LED displays, and 14 resistors, plus a maze of wiring or complicated printed circuit boards.

The use of a hand held calculator will be an aid in converting to other units of measurement. You may find it convenient to make up a table of M.P.H. versus knots or kilometers per hour, or any other combination beforehand.

MPH	X	0.8684	= Knots
MPH	X	1.6093	= km/h
km/h	X	0.6214	= MPH
km/h	X	0.5396	= Knots
Knots	X	1.1516	= MPH
Knots	X	1.8553	= km/h

gradually diminishing as the cups slow down. The rate of numerical change (up-date) will be a function of the setting of the R3 pot (s).

CALIBRATIONS

Securely mount the sensor on the roof of your car, and using temporary jumpers that are long enough to reach inside the car, connect to P1 and ground. If your unit is using the D.C. driven regulated supply, connect to a 12 volt lantern battery. Observe proper polarities. If you are using the house powered regulated supply, connect the positive side of the 12 volt lantern battery to pin 1 of the LM309K, and any convenient ground.

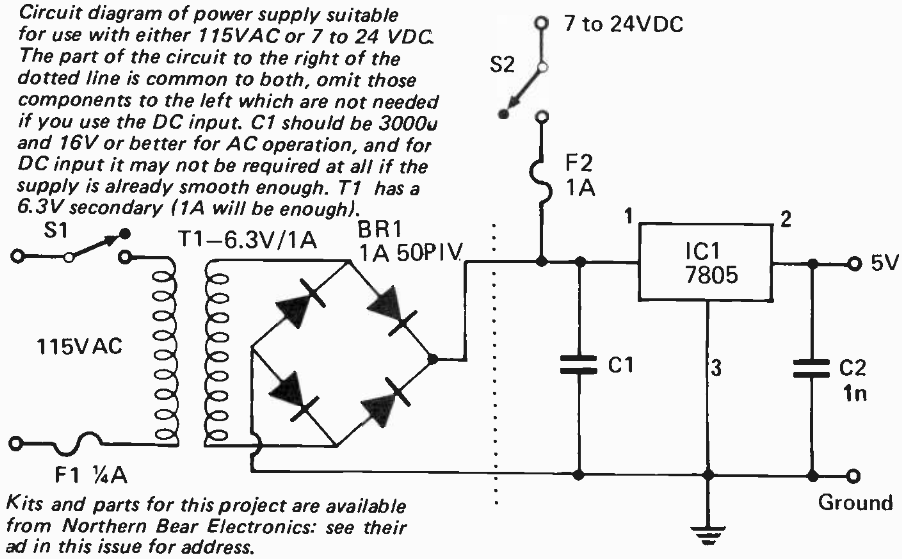
Have a friendly neighbor drive your car on a quiet street at a steady even rate when there is little or no wind. Adjust R3 until the display agrees with the speedometer, or if you are calibrating in knots or kilometers per hour, the readouts display the speedometer reading times the appropriate conversion factor. If more than one R3 pot has been incorporated into the circuit, switch it in, and carry on with your calibrations. When you are finished, apply a drop of epoxy to the rotor (s).

INSTALLATION

If you plan to use the device in your home, mount the sensor on the roof or in any other convenient location that will be free of obstructions. For marine use, mount the sensor on the bridge or mast. Terminate both ends of a suitable length of shielded audio cable with phono plugs and connect between the sensor and the enclosure. Be sure to weatherproof the plug and jack that is exposed to the elements.

OTHER USES

The circuit can be used in a great many other counting applications. If a digital anemometer is not for you, perhaps a digital speedometer for your car, motor bike, or that new ten speed bicycle might be of interest. No circuit changes are required, simply mount the perm mags on the rim of the wheel, and position the reed switch nearby. If the rim is ferrous, it will distort the magnetic field, hence an insulating block of wood or plastic should be inserted between the magnet and tire rim. Use a good strong adhesive. Calibrations are the same as previously outlined, only this time, wind is not a factor. You might find it convenient to calibrate in terms of kilometers per hour, since all speed limits will ultimately be posted using this portion of the metric system. Fifty miles per hour for all intents and purposes is equivalent to 80 kilometers per hour. When your bicycle reaches 100km/h., about 62.2 mph, the display will either blank or read 00, depending on the leading zero option. Simply add 100 to any reading thereafter.



Circuit diagram of power supply suitable for use with either 115VAC or 7 to 24 VDC. The part of the circuit to the right of the dotted line is common to both, omit those components to the left which are not needed if you use the DC input. C1 should be 3000u and 16V or better for AC operation, and for DC input it may not be required at all if the supply is already smooth enough. T1 has a 6.3V secondary (1A will be enough).

Kits and parts for this project are available from Northern Bear Electronics: see their ad in this issue for address.

PARTS LIST

PARTS LIST FOR ANEMOMETER

RESISTORS

R1,2	39k
R3	100k pot or fixed resistor of your choice
R4	8k2
R5,6	10k
R7	1k

CAPACITORS

C1	47n
C2	100n
C3,4	1n
C5	22u/10V

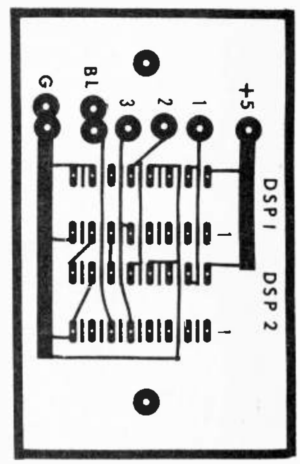
SEMICONDUCTORS

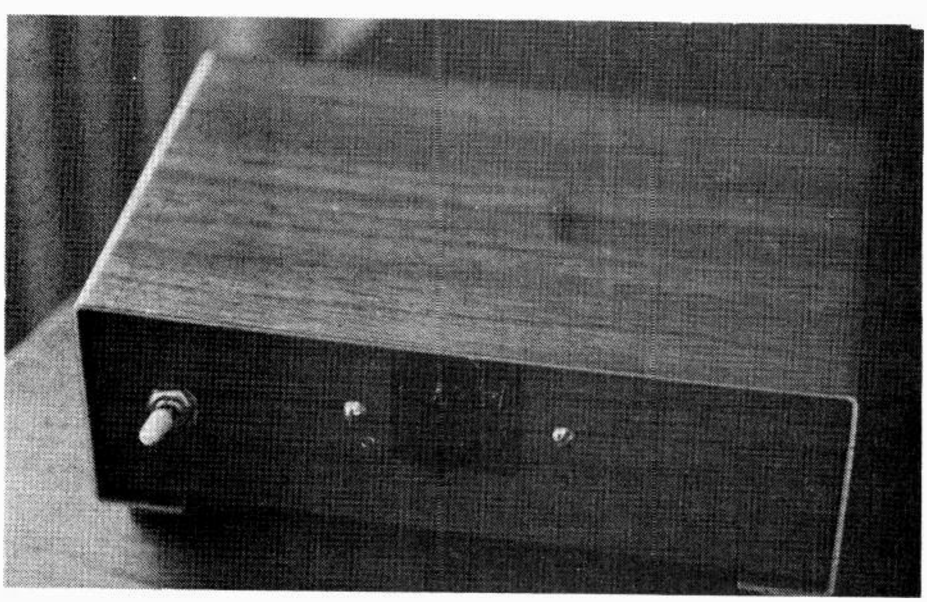
DSP1,2	TIL306 Texas Instruments
IC1	74121
IC2	7404
IC3	555
IC4	74123

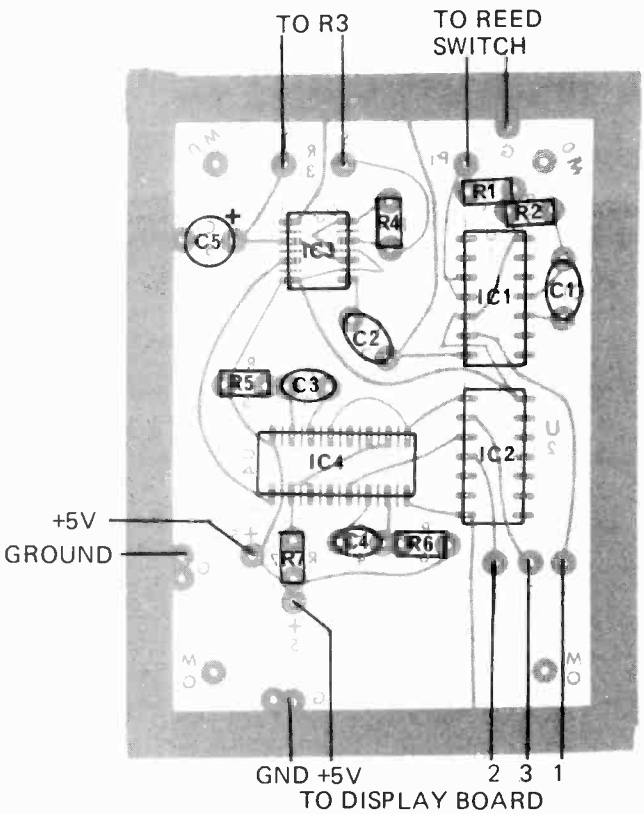
SWITCHES as required
MISCELLANEOUS hardware

Electrical Components of Anemometer Wind Rotor

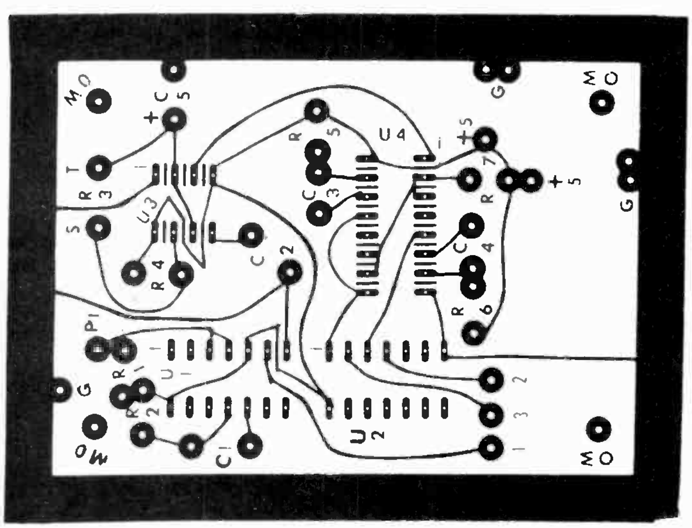
1 Reed Switch (Radio Shack 275-035)
1 'Hobby Motor' (Radio Shack 273-217
2 Magnets (Radio Shack 64-1885, or use those out of motor)

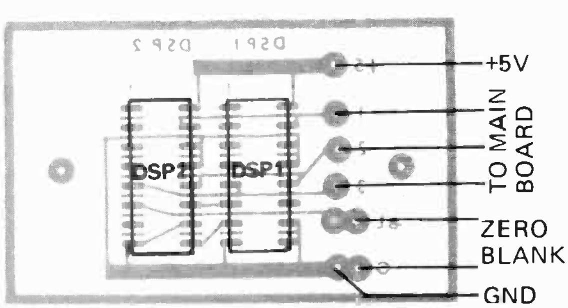






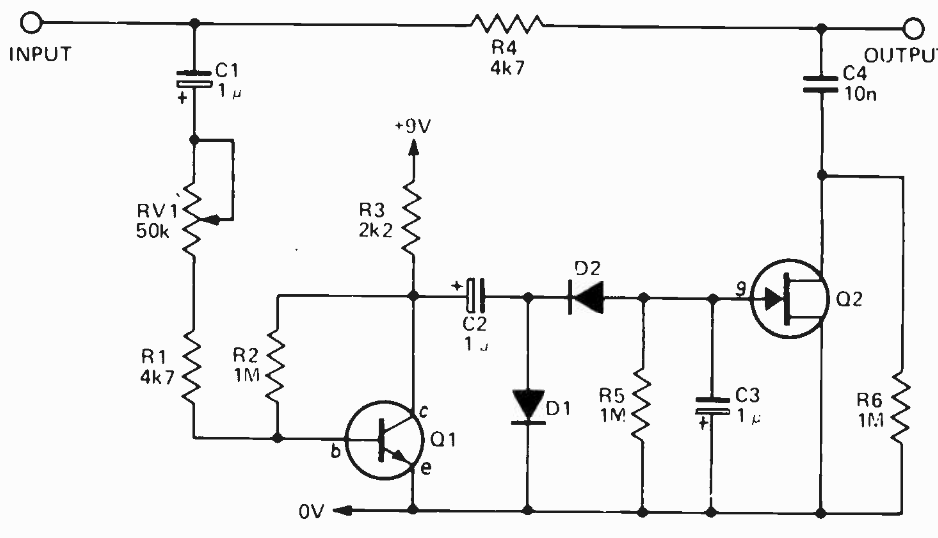
Component placement diagram for main and display boards.





Tape Noise Limiter

Cut down tape hiss by adding this unit to your cassette recorder.



DESPITE the small size, the performance obtainable from a cassette tape in a good recording deck is quite remarkable. In fact the latest top quality decks are so good that it is difficult to tell the difference between the recording and the original sound.('is it live or . . .')

Unfortunately this is not true of the cheaper units — in which 'tape hiss' can be very prominent. Tape hiss is caused by random irregularities in a tape's surface coating. The effect is common to all tapes but some are marginally worse than others.

The annoying characteristic of tape hiss delayed the acceptance of cassette tape recorders in hi-fi systems for some years -- until the advent of the Dolby system which was primarily developed as a cure for the phenomenon.

The Dolby system is often misunderstood -- *it only works if the cassette tape itself has been recorded using the Dolby process* — and few commercially produced tapes are. Unless the tape cassette says specifically that it is Dolby processed then it's not! You can of course record your own tapes using Dolby if you own a Dolby machine.

To overcome this limitation a number of cassette recorders are fitted with noise reduction circuitry which reduces the level of hiss on non-Dolby recordings. Most of these noise reducing circuits work by progressively reducing all high frequency signals when the output level falls below a preset minimum. Above that minimum level all sounds are allowed through because tape hiss cannot be heard once the sound level is substantially louder than the hiss. This effect is called 'acoustic masking'.

The circuit described in this project is a simple but very effective unit which may be used with any cassette recorder which is connected to a hi-fi system.

The unit should preferably be connected between the cassette recorder and the amplifier input — using short lengths of screened cable and suitable connecting plugs. If you really know what you're doing it may be actually built into the tape recorder or amplifier. Alternatively it may be connected between the pre-amplifier and power amplifier on those units which are so separated (note that many apparently integral amplifiers still have 'pre-amp out' and 'power-amp in' connectors on the rear panel. These connectors are normally bridged by 'U' shaped links—which should be removed to enable this unit to be plugged in).

CONSTRUCTION

As with most projects in this series you can use either Veroboard or the special printed circuit board shown here.

This project may be built using any neat construction method. We have provided both a printed circuit board pattern, and a Veroboard layout showing foil breaks (drilled) and connections.

Take the usual precautions about inserting components the right way round — taking particular care with the field effect transistor Q2. Note that the cathode lead of the diodes (shown as a horizontal bar on the circuit diagram) will be identified on the component by a black band or similar marking.

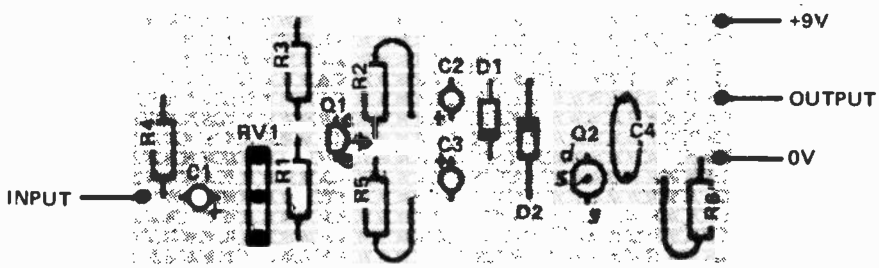
Unless the leads between this unit and the tape deck and amplifier are very short it is advisable to connect it via screened cable. Note that the 0V line shown on the diagram is also the ground side of the input/output connections.

To set up the unit simply choose a recording with a longish quiet passage and then adjust RV1 for the best compromise between tape hiss reduction and minimum loss of high frequency programme content.

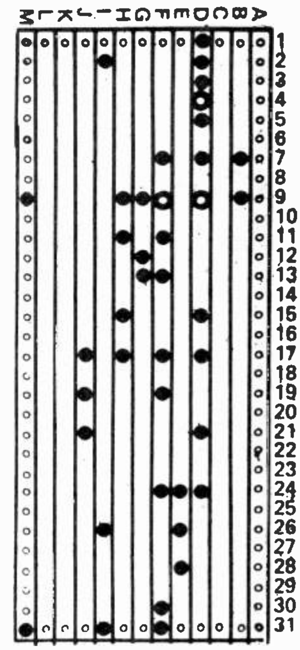
NOTE: If you listen only to hard rock — where there aren't any quiet passages — then this unit will be of little value to you. Its main effect is to reduce annoying tape hiss during otherwise quiet programme material.

SPECIFICATIONS

Input level –	**up to 2 Vrms**
Min level for flat response –	**about 10 mV**
Input impedance	**depends on Q1 gain but >4.7 k**
Output impedance	**impedance driving the input + 4.7 k**
Output impedance of drive device	**– preferably 600 ohms.**



Component layout of Veroboard version.



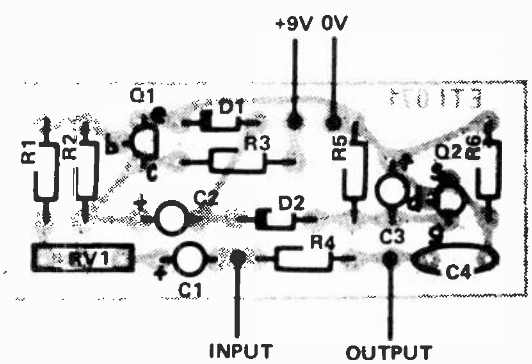
PARTS LIST

R1	RESISTOR	4k7	0.5 W	5%
R2	"	1M	"	"
R3	"	2k2	"	"
R4	"	4k7	"	"
R5,R6	"	1M	"	"
RV1	POTENTIOMETER	50 k trimpot		
C1-C3	CAPACITOR	1 uF	25 V	
C4	"	10 n polyester		
Q1	TRANSISTOR	MPS6515		
Q2	"	2N5459		
D1-D2	DIODE	1N914		

Nine volt battery and clip
Veroboard or pc board ETI 071.

Veroboard, and perhaps the name of a local supplier may be obtained from: Electronic Packaging Systems, P.O.Box 481, KINGSTON Ontario, K7L 4W5

Kits and parts for this project are available from Northern Bear Electronics: see their ad in this issue for address.



Component layout of printed circuit board version.

Note difference in order of source(s) and drain (d) of Q2 in the Veroboard version and pc board version of this project. This is in fact correct as the source and drain of this transistor are interchangeable in this circuit.

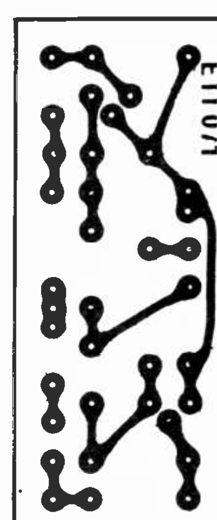
HOW IT WORKS

The circuit passes all frequencies (without attenuation) if the incoming signal is above a set minimum level. Signals below the preset minimum are progressively attenuated from 1 kHz upwards. The maximum attenuation of about 10 dB is applied at approx 10 kHz.

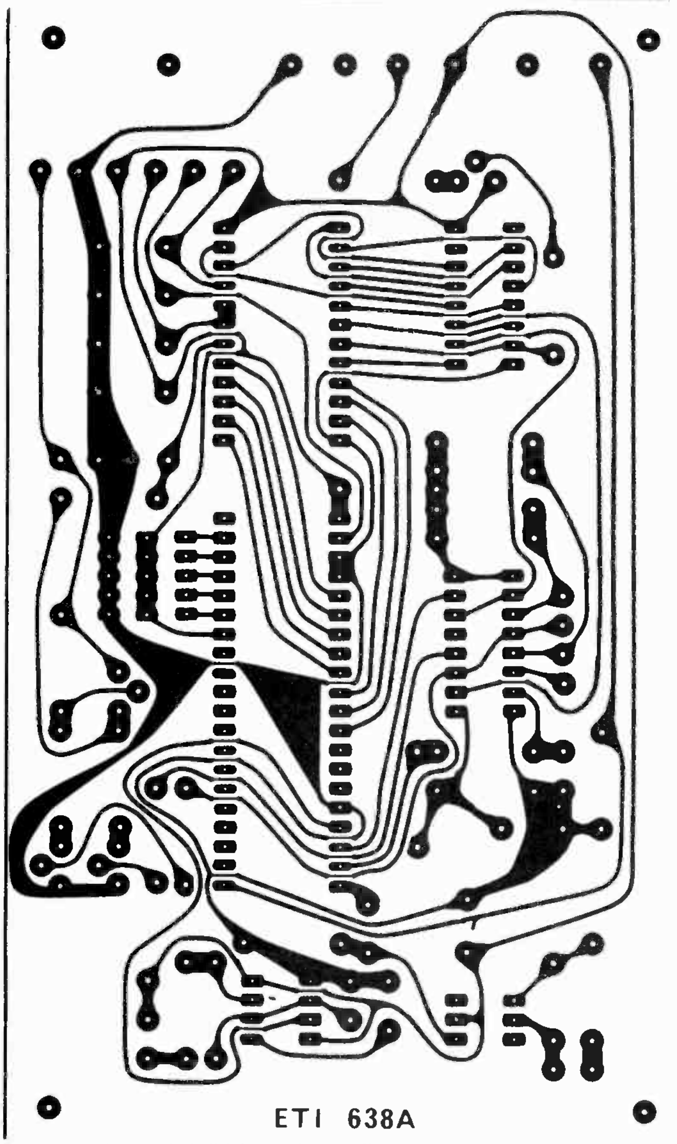
Resistor R4 and capacitor C4 form a filter in which Q2 is used as a variable resistor with the degree of resistance dependant on gate voltage. Thus, if the input voltage is at or near 0V then Q2 appears as a low resistance and C4 is in circuit. If on the other hand the input signal is higher than (say) four volts negative, Q2 has a very high resistance and C4 is effectively out of circuit.

The voltage applied to the gate of Q2 is that derived from Q1 – after rectification by D1 and D2. Transistor Q1 amplifies the input signal and with RV1 in minimum position, input signals above 10 mV or so will cause Q2 to be off.

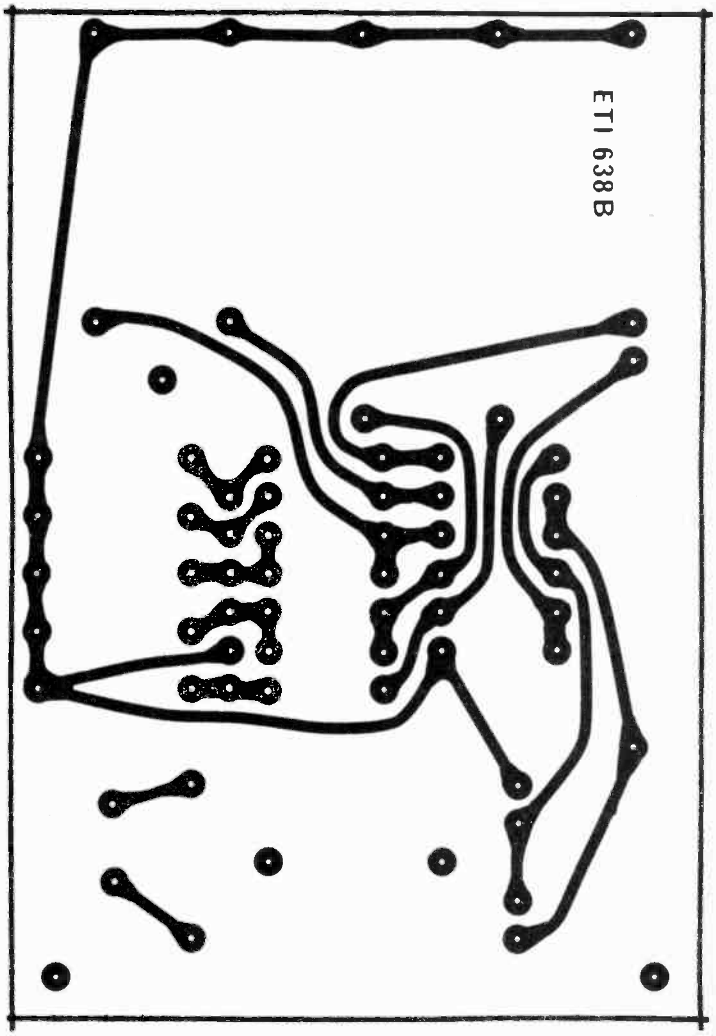
Increasing RV1 raises the level below which high cut will occur. The change from full to zero cut occurs over a range of approx 5 dB input level change.



Foil pattern for pc board – shown full size.

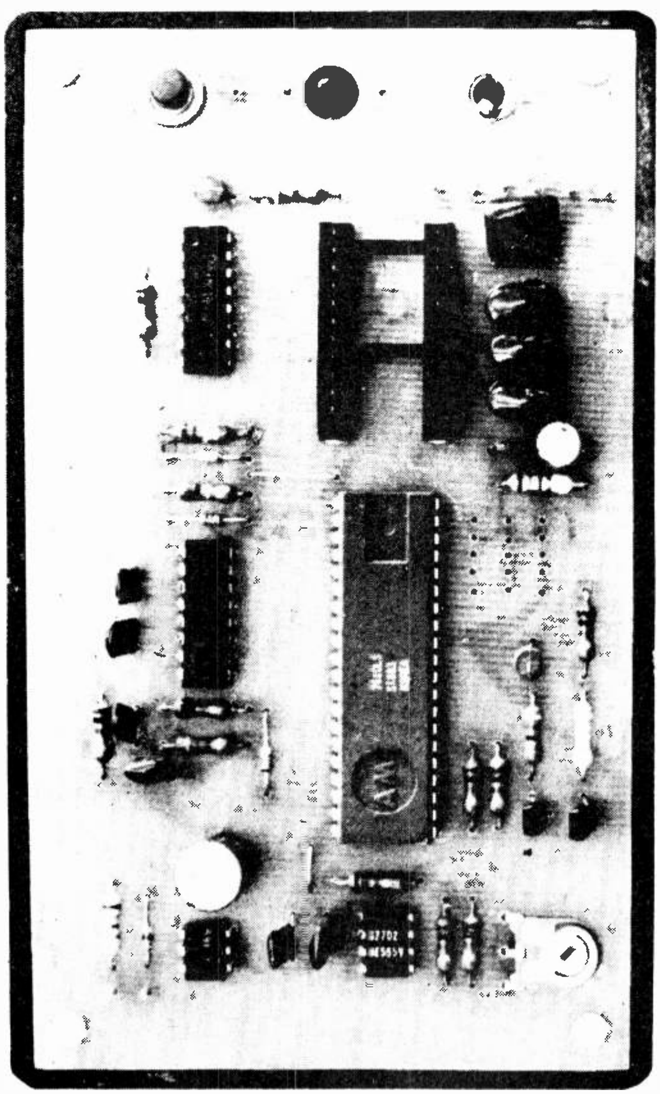


These are the PCB patterns for the EPROM Programmer.



EPROM Programmer

This low-cost device will interface to just about any microcomputer, and requires only simple software to drive it. Based on a design by N.D. Hammond.



MANY OF OUR readers now have microprocessor systems, whether the large kind with keyboard, display and hunks of memory and I/O, or simply a small evaluation kit. Almost all of these systems accomodate a cassette recorder for storing your own programs, but the only drawback is that you have to load the contents of the cassette into RAM before you can use it. Wouldn't it be nice if you could have all those most used routines in ROM somewhere? Again most systems are designed to accomodate ROMs of some sort, frequently the popular 1K byte 2708 EPROM.

Now, you could go to the trouble and expense of having your ROMs programmed commercially, but what a drag waiting (and paying!). So why not build your own programmer, especially since this is made very easy by having the computer you already have do all the brainwork. You may find yourself frequently programming those not-so-expensive 2708s, and also quickly reprogramming them when such action is needed.

Here we present an EPROM programmer which is both simple and not too expensive. It communicates with your micro through a 20mA current loop which almost all systems have always had. It is based upon a design originally from N. D. Hammond.

The programmer is, in fact, slightly different from the original design submitted to us by Mr Hammond; we have replaced some TTL in his design with CMOS and added a data time-out synchronisation facility, on which more later.

DESIGN FEATURES

The objectives of the original design were simplicity of construction and operation, and low cost. Another requirement which must be met is simplicity and versatility of interfacing — one of our bigger headaches is the fact that everyone's system seems to be different.

This project meets these objectives very well. The interface to the user's computer is *serial*, i.e. through a 20 mA current loop. Most computers, except for some evaluation kits, have a suitable serial I/O port, so this is a pretty well universal interface. As a bonus, the UART and a couple of one-shots provide all the necessary timing signals, so the component count is low and cost is low.

A useful by-product of our switch to a completely CMOS design was a spare gate, which we put to good use in providing a 'synchronisation' facility. The idea is that if a supply glitch or noise causes the UART to miss a byte of data, so that the 2708 addressing is out of step with the desired addressing, a ¼ second pause at the end of each cycle will reset the 4040 to zero. This means that only that cycle will be affected and subsequent cycles will be correct, increasing the programmer's tolerance to glitches.

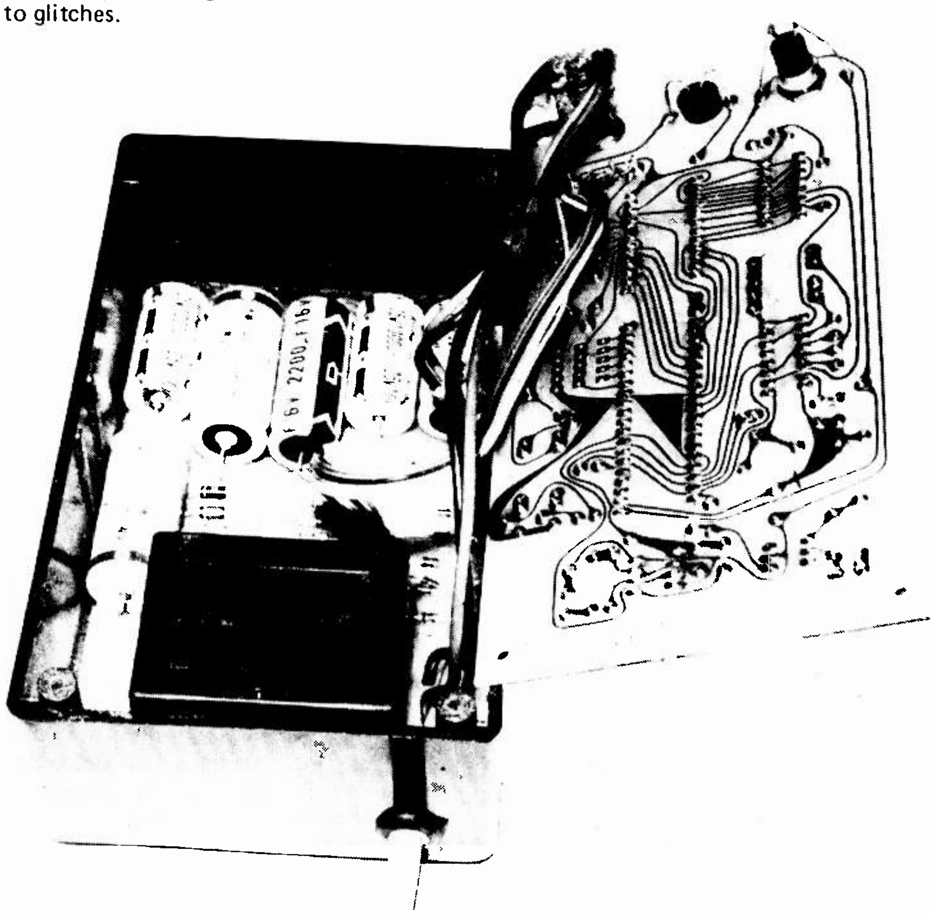
There is one slight penalty that has to be paid — at 300 baud, it will take about 70 minutes to output all 1024 addresses 125 times. This is by no means brilliantly fast compared to the theoretical minimum programming time of 104 seconds but it is a lot better than the several days that would be required by a commercial firm.

Mr Hammond originally supplied software for the 8080, but our tests of the circuit were done on a MEK6800D2, for which we have written a routine, reproduced here. Our routine incorporates a time delay of approximately ¼ second at the end of each run through the 2708 addresses, in order to take advantage of the time-out synchronisation feature. Mr Hammond's 8080 program does not include this facility, but it is easy to add a time delay loop which decrements (say) the BC pair using the DCX instruction.

ADJUSTMENT

Before adjusting the oscillator frequency first fit the links which set the start-stop bit arrangement of UART.

Now with power connected adjust RV1 until IC2 is operating at 4800 Hz.



PARTS LIST

ETI 638A

RESISTORS	all ½W 5%
R1	180R
R2, 3	10k
R4, 5	1k
R6	10k
R7	4M7
R8	180k
R9	100k
R10	470R
R11	10k
R12	1k
R13	10k
R14	33k
R15	10k
R16	47R
R17	180R
POTENTIOMETER	
RV1	25k trim
CAPACITORS	
C1	8n2 polyester
C2—C4	10n polyester
C5	33n polyester
C6, 7	10n polyester
C8, 9	100n polyester
C10	100µ 25V electro
C11, 12	100n polyester
C13	10µ 35V electro
SEMICONDUCTORS	
IC1	4N33 Opto coupler
IC2	555 timer
IC3	MM5303 UART
IC4	4049 Hex inverter
IC5	4040 12 stage counter
Q1	2N3638
Q2	2N3904
Q3	2N3905
Q4	2N3904
D1—D4	1N914
LED1	

MISCELLANEOUS
- PC board ETI 638A
- 24 pin IC socket
- Push button
- Plastic box 158x96x50mm

ETI 638B

RESISTORS	all ½W 5%
R1	1k
R2, 3	120R
R4, 5	47R
R6	470R
R7	100R
CAPACITORS	
C1	470µ 50V electro
C2	2200µ 16V electro
C3—C5	1000µ 25V electro
C6	470µ 50V electro
DIODES	
D1—D6	1N4004
ZD1	27V 1W
ZD2	12V 400mW
ZD3	12V 1W
ZD4	5.1V 400mW
ZD5	5.1V 1W

MISCELLANEOUS
- PC board ETI 638B
- Transformer 120V—15Vct ½A
- Switch DPDT toggle
- 3 wire line cord
- Cable clamp

Kits and parts for this project are available from Northern Bear Electronics: see their ad in this issue for address.

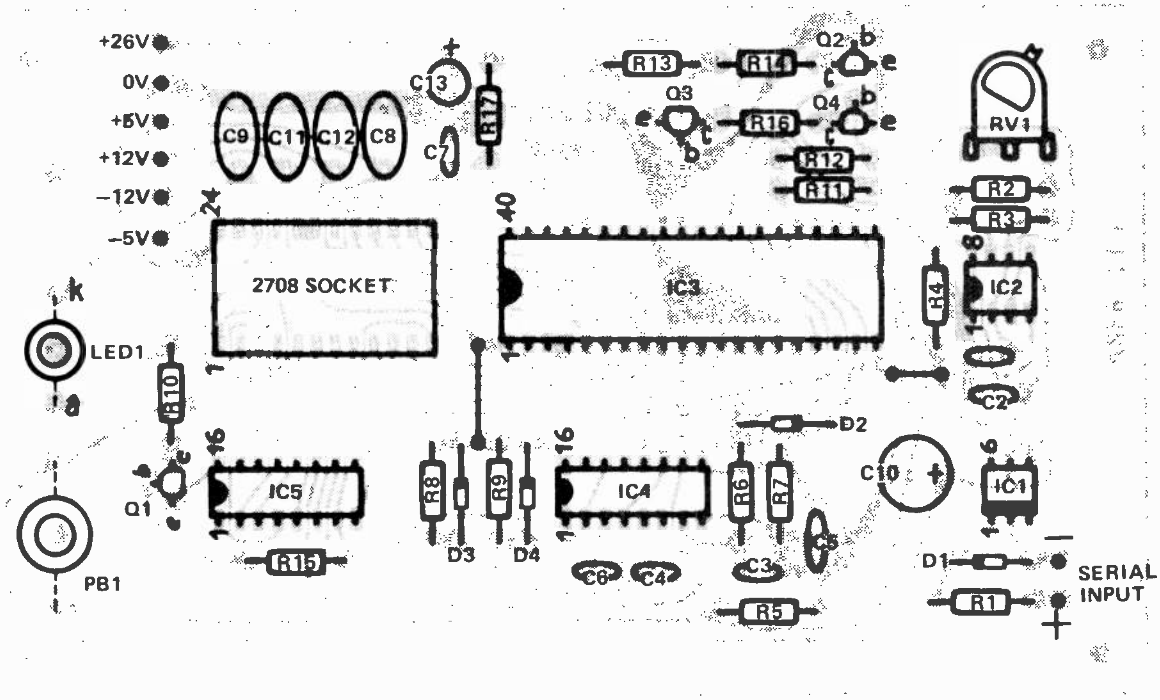


Fig. 1 The component overlay of the main board.

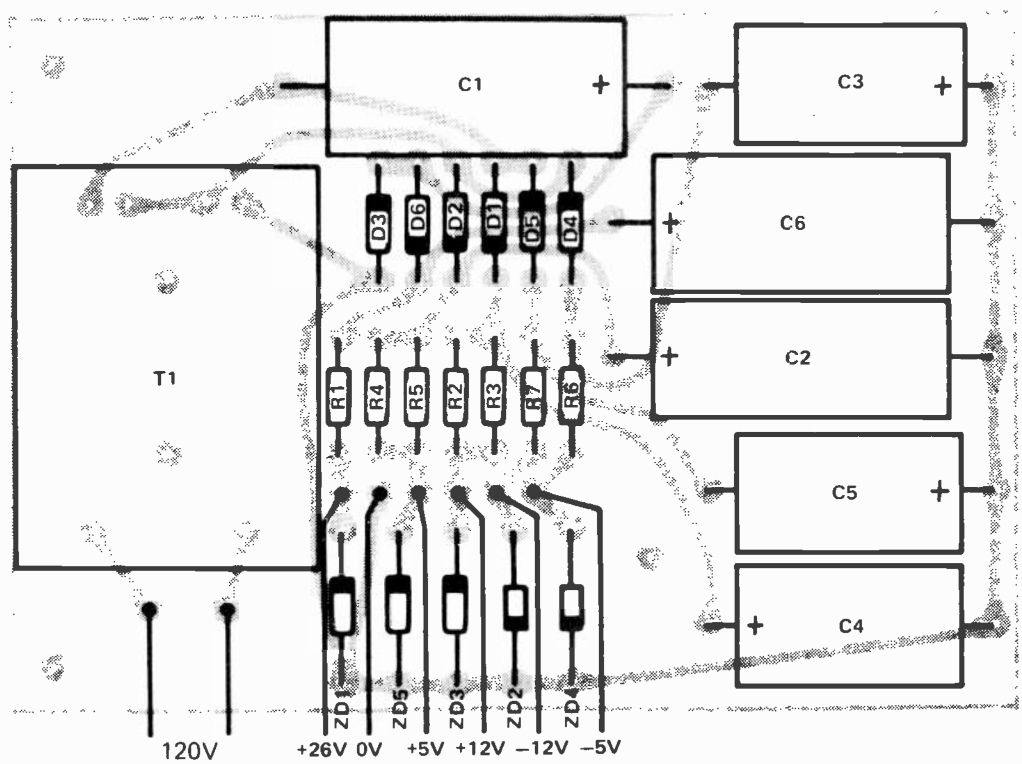


Fig. 2. The component overlay of the power supply.

CONSTRUCTION

We built our prototype into a plastic box with the power supply on one board in the box itself while the logic board was used in place of the lid.

These boards should be assembled according to the overlays provided. Normal handling procedures should be taken with the CMOS ICs and the UART. A good quality socket should be used for the EPROM as it will be used a lot. The pushbutton, LED and power switch are mounted on the logic board and connected from the rear.

With the power switch, due to the closeness of the capacitors on the lower board, the wires should be taken parallel to the pc board and the rear of the switch epoxied over to give protection. The connection between the power supply and logic board can be done with a piece of ribbon cable as the connections follow the same sequence.

We used pc pins for the data input points but a socket could be used if desired.

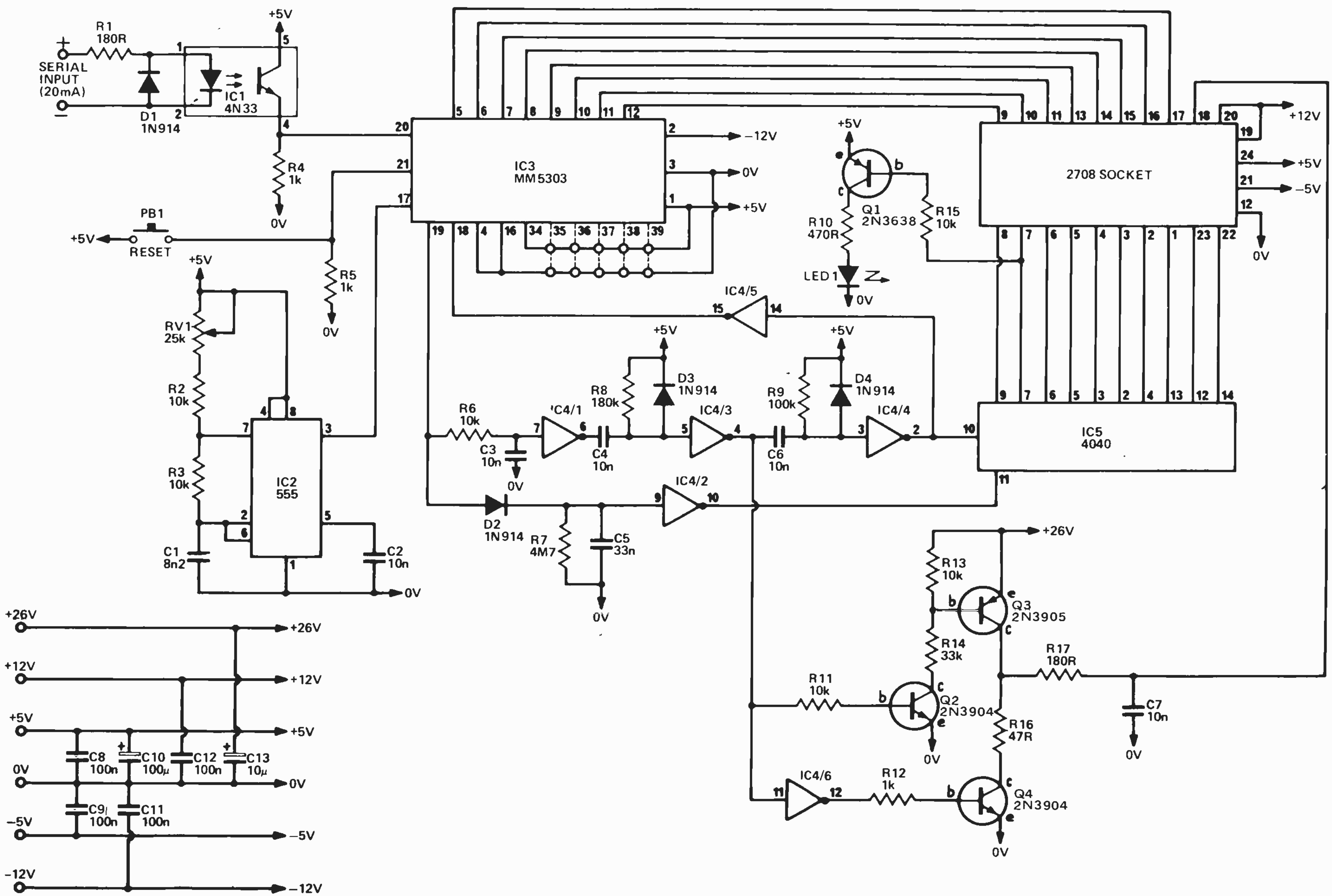


Fig. 3. The circuit diagram of the main circuit.

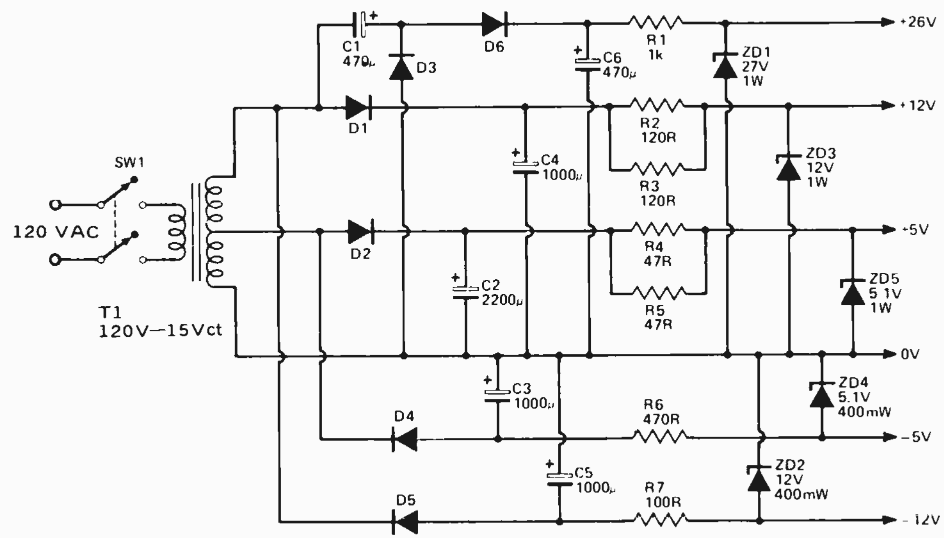


Fig. 4. The circuit diagram of the power supply.

HOW IT WORKS

A fully erased EPROM has every bit set to the "1" state. Programming sets selected bits to "0" To program a 2708 the selected address and corresponding data has to be presented to the EPROM and a 26V pulse applied to the program input pin. To make life more difficult each location has to be selected and programmed in sequence. Also a total time the program input has to be high for each location is 100 ms but the pulse used cannot be less than 100µs or longer than 1ms with about 1 ms recommended. This means that the IC has to be cycled through completely around 100 times for best results!

As we have a computer any way, (otherwise why the need for an EPROM!) we use it to provide the sequencing and timing needed.

The computer is programmed to copy data in its memory (1024 bytes) and sequentially transmit in serial form each byte 125 times. It also pauses for about ¼ second each 1024 bytes.

The serial information is transferred from the 20 mA loop into a 0-5V signal by the opto coupler, IC1, whose output is fed into the input of the UART IC3. This IC then converts this information into parallel form on pins 5-12 which is presented to the EPROM on its data lines. This IC needs a clock input at 16 times the Baud rate (4800Hz for 300 Baud) and IC2 is used for this.

The address lines for the EPROM are supplied by IC5 which is a 12 bit binary counter (we use only the first 10 bits) and this is reset to zero when no data is being received. On pin 19 of the UART we have an output which goes high when the serial data has been received and after this has been delayed by about 100 µs (R6/C3) the output of IC4/1 goes low. This triggers a 1 ms monostable (C4, R8, IC4/3) which drives the transistors Q2-Q4 to provide a 26V pulse to pin 18 of the 2708. At the end of this 1ms pulse a second mono is triggered (C6, R9, IC4/4), the UART is reset (pin 19 goes low again) and the address counter IC5 is incremented. The output (pin 19) of IC3 also charges C5 via D2 when it goes high. This causes the output of IC4/2 to go low allowing IC5 to be toggled (pin 11 of IC5 is the reset line). Provided the output of IC3 goes high regularly corresponding to data being received at 300 Baud C5 does not have time to discharge and the reset line remains low. If there is a pause at the end of a complete cycle the reset line will go high and will correct any error which may have been caused by a possible glitch.

The power indicator LED is driven by one of the outputs of IC5 and is turned on and off quickly indicating data is being received.

THE 2708

At this point we digress to describe the 2708 and the steps involved in using and programming it.

The device is a static 8192 bit EPROM organised as 1024 x 8. It is packaged in a 24 pin DIP with a quartz window which allows the data stored in the memory to be erased by exposure to ultra-violet light.

Reading the device is quite straightforward. The appropriate address is applied at the ten address pins, the chip select pin is taken low and after the appropriate access time (120ns from CS or 450ns from address select) the data is available at the eight output pins.

Fortunately, and in contrast to its predecessors, the 2708 is also simple to program. The chip select pin is taken to the 'write enable' level of +12 V and the applied address is cycled from 000H to 3FFH with the appropriate data applied at each address. After the data and address lines have settled at each address, a 26 V pulse of 0.1 ms to 1 ms duration is applied at the programming pin. The entire cycle of 1024 addresses is repeated until each address has received a minimum of 100 ms program pulse time.

Erasure is the simplest operation of all. The window is uncovered and the chip placed an inch or so away from an ultra violet tube. After half an hour or so, the memory is fully erased (to all '1's) and is ready for re-programming.

OPERATION

A fully erased EPROM has every bit set to the '1' state. Programming sets selected bits to '0'. It follows that a 2708 can be reprogrammed without erasing if there are no cases where a bit must be changed from '0' to '1', otherwise the device must be erased by exposure to ultra violet light. Any 'germicidal' UV tube is suitable for erasing. The chip(s) which are to be erased should be placed about an inch or so from the tube and left for at least half an hour to ensure complete erasure.

To program the device, the pattern to be written should be available in RAM. The programmer is connected to the microprocessor's serial port which is configured for the appropriate signal format selected for the programmer (see table 3). The programmer is then reset to initialize the UART and ensure that the address counter starts at address zero. All that remains is for the microprocessor to output the contents of the selected RAM page, byte by byte at the port. As the programming pulse width is approximately 1ms, the whole 1024 bytes should be output at least 100 times. In practice, this should be increased by 25% or so to allow for the effects of component tolerances.

PROGRAMMER DESIGN

Use of the UART considerably simplifies the software requirements of the system which will drive the programmer, all that is necessary is a program which will output the required memory contents in order and repeat this for the required number of times.

TABLE 1. 6800 EPROM DRIVER FOR D2

```
6800 EPROM PROGRAMMER DRIVER FOR D2

              OUTCH       EQU    E37A
              PAGESTART   EQU    04
              NEXTPAGE    EQU    08
              ACIAS       EQU    8008
              ; INITIALISATION OF ACIA
0000  86 55                      LDA A   # %0101001
0002  B7 80  08                  STA A
              ; MAIN PROGRAM
0005  C6 7D                      LDA B      125
0007  CE 00  00  NEWCYCLE:  LDX PAGESTART
000A  A6 00      NEXTBYTE:  LDA A,    X
000C  BD E3  7A                  JSR  OUTCH
000F  08                         INX
0010  8C 04  00                  CPX  NEXTPAGE
0013  26 F5                      BNE  NEXTBYTE
0015  36                         PSH  A
0016  37                         PSH  B
0017  86 FF                      LDA A     $FF
0019  C6 FF                      LDA B     $FF
001B  5A              LOOP:      DEC  B
001C  26 FD                      BNE  LOOP
001E  4A                         DEC  A
001F  26 FA                      BNE  LOOP
0021  33                         PUL  B
0022  32                         PUL  A
0023  5A                         DEC  B
0024  26 E1                      BNE  NEWCYCLE
0026  3F                         SWI

For Test:
000A  86 XX      NEXTBYTE: LDA A      XX
outputs ASCII character XX
 or
000A  4C         NEXTBYTE: INC A
000B  01                   NOP
outputs incrementing characters.
```

TABLE 3 SIGNAL FORMAT OPTIONS

OPTION		INPUT	UART PIN	LEVEL
No OF DATA BITS	8	NDB2	37	H
		NDB1	38	H
	7	NDB2	37	H
		NDB1	38	L
PARITY	EVEN	NPB	35	L
		POE	39	H
	ODD	NPB	35	L
		POE	39	L
	INHIBIT	NPB	35	H
		POE	39	X
No OF STOP BITS	1	NSB	36	L
	2	NSB	36	H

H=HIGH (+5V) L=LOW (0V) X=DON'T CARE

TABLE 2 – INTERFACE PROGRAM FOR 8080/Z80

```
                ;***** INTERFACE PROGRAM FOR 2708 EPROM PROGRAMMER *****
                ;
                PAGESTART:   EQU   04H          ; HIGH ORDER BYTE OF RAM ADDRESS
                                                ;   TO BE LOADED IN EPROM ADDRESS
                                                ;   ZERO – LOW ORDER BYTE IS ZERO
                NEXTPAGE:    EQU   08H          ; HIGH ORDER BYTE OF PAGESTART + 1024
                CTRL:        EQU   0            ; ADDRESS OF I/O STATUS & CONTROL PORT
                DATA:        EQU   1            ; ADDRESS OF I/O DATA PORT
                ;
                ; INITIALIZATION – NOTE: SYSTEM DEPENDENT.  THIS SEGMENT WRITTEN
                ;  FOR AN INTEL 8251 SERIAL I/O PORT
                ;
0000: 3E 4E                  MVI   A, 4EH       ; MODE INSTRUCTION. SELECT 1 STOP,
0002: D3 00                  OUT   CTRL         ;    8 DATA AND NO PARITY FORMAT
0004: 3E 11                  MVI   A, 11H       ; COMMAND INSTRUCTION. RESET 8251
0006: D3 00                  OUT   CTRL         ;    AND SET TX ENABLE
                ;
                ; MAIN PROGRAM
                ;
0008: 06 7D                  MVI   B, 125       ; NO OF PROGRAMMER CYCLES TO B
000A: 26 04     NEWCYCLE:    MVI   H, PAGESTART ; HIGH ORDER ADDRESS OF BYTE 1 TO H
000C: 2E 00                  MVI   L, 0         ; LOW ORDER ADDRESS TO L
000E:           NEXTBYTE:
000E: DB 00     TESTPOINT:   IN    CTRL         ; READ I/O PORT STATUS
0010: E6 01                  ANI   01H          ; MASK ALL EXCEPT READY BIT
0012: CA 0E 00               JZ    TESTPORT     ; LOOP UNTIL READY BIT SET
0015: 7E                     MOV   A, M         ; MOVE SELECTED BYTE TO ACC
0016: D3 01                  OUT   DATA         ;    AND SEND TO PROGRAMMER
0018: 23                     INX   H            ; SELECT NEXT BYTE TO BE SENT
0019: 7C                     MOV   A, H         ; TEST CONTENTS OF H TO SEE WHETHER
001A: FE 08                  CPI   NEXTPAGE     ;    LAST BYTE HAS BEEN SENT
001C: C2 0E 00               JNZ   NEXTBYTE     ;  IF NOT, REPEAT LOOP
001F: 05                     DCR   B            ; ELSE DECREMENT CYCLE COUNTER
0020: C2 0A 00               JNZ   NEWCYCLE     ; IF NOT FINISHED START NEW CYCLE
0023: 76                     HLT                ; ELSE HALT
```

The New Digital Experimenter's Licence

Canada's Hams go digital, Canada's computer nuts go Ham . . .
Bill Johnson, VE3APZ explains.

DR JOHN DE MERCADO, Director General of Communications Canada's Telecommunications Regulatory Service, has shown that he has his finger on the pulse of amateur radio communications in Canada by the introduction on September 13th of the regulations to create a new certificate, called the 'Digital Amateur Radio Operator's Certificate '.

The new regulations follow many months of proposals, counter-proposals and consultations with amateurs across the country. (See QRM ETI Nov 78.) and give the green light to an exciting new field of experimentation for Canadian amateurs — one in which they can truly lead the world, since no other country has any framework of regulations in which the growth of digital communications is encouraged in the amateur experimental service.

Despite fears to the contrary, very little of the spectrum has been given exclusively to packet use. As may be seen from this month's centre spread fold-out chart (a consolidation of the DOC publication TRC-25 issue 3, which should be referred to for full explanation), only 221.0–223.0 MHz and 433.0–434.0 MHz are exclusively restricted to packet transmission.

Gains made include the addition of wideband FM between 144.1 and 146.0 MHz (previously limited to 3 kHz deviation) and the use of FM television by advanced amateurs. The 1-year experience requirement and proof of competancy still exists for Amateur certificate holders, who may then use FM television when endorsed for TV.

Holders of the new Digital Amateur Radio Operator's Certificate can use all the modes available to other classes above 144.0, (including morse code, on which they have not been examined) but have no privileges below that frequency. An extra benefit that was previously not available to any amateurs before will be accorded the Digital Amateur, in that he will be allowed to use pulse-type emissions in some of the VHF and UHF bands,including pulse TV.

There has been some confusion over the definition of the terms 'packet transmission' and 'pulse modulation' amongst amateurs. Many think that these two terms are synonymous. This is not the case. Packet transmission refers to the sending of very brief packets of digital information, all of which are the same duration and follow a predetermined pattern, or 'protocol'. The packets can be sent using any kind of modulation, and indeed, the demonstrations of packet radio recently by Dr. de Mercado used a standard Motorola Handie-Com walkie-talkie. Instead of the normal voice modulation, these units were modulated with the voiceband frequencies generated by a Gandalf 201B modem, similar to one which might be used over a Bell telephone line. Pulse modulation is a technique where, instead of sending a continuous carrier, only small parts of the RF wave are sent, but these parts are enough to reconstruct the encoded modulation at the receiving end. This type of modulation has several advantages. Some of these are the resultant duty cycle reduction in high-power transmitting equipment, and the possibility of interleaving many transmissions on one transmitter.

Since the new Digital amateur will be examined in the same theory and regulations as the advanced amateur, it is only fair that he be given the advanced certificate if he were to later qualify in the code. The new regulations say that he may do so after one year, by passing code at fifteen wpm.

PREAMBLE	MESSAGE	POSTAMBLE
Who's it from, where it's going, number of message, date and time originated, size and type of packet.	Text, data etc, from "Wish you were here" to "LET A = 10", Any form of data.	Error checking bits, number of nodes this message has been through, service indicators, etc.

Fig. 1. Make-up of a typical packet.

WHAT IS A PACKET?

As I mentioned earlier, there is nothing special, magical, or even new about a packet. A form of packet familiar to most amateurs is the standard ARRL radiogram (for those of you who aren't familiar see p 40-41 of March 78 ETI). These messages include information on origin, destination, handling instructions, number of data words ('Check'), and a simple postamble, which is usually just a signature.

For ease of handling, a packet such as may be found on a packet-oriented network is usually a fixed length or multiples of a fixed unit length. This is not necessarily so, however, since a packet could conceivably be any length provided length information is included in the header. The new regulations, following the view of the Canadian Government that amateurs should be left plenty of room for experimenting and should not be over-regulated, allow any length of packet to be used. As a comparison, Bell Canada's Datapac service uses packets of up to 256 characters (or octets)in length. Datapac is a packet switching system available to commercial computer users.

ALOHA FROM HAWAII

The Canadian Government's amateur packet philosophy is based on a system used at the University of Hawaii to communicate between remotely-located students and their university computer centre. Anybody who has ever sat at a computer console learning to program will tell you that of the two channels between it and the computer, the one that receives the lesser use is the input, since the computer uses the output circuit at its maximum data rate.(People just will never learn to type at 300 wpm.) Another factor is that, in most cases, there is more output generated than input. Since a channel must be designed (and paid for) to handle the highest data rate for which it will be used, then it follows that to use it for anything less is wasteful of resources (and money). In fact, assuming that the human inputs at 3 characters/second (char/s), on a channel capable of handling 2400 char/s 99.9% of the channel's capability is wasted.

One solution would be to put all terminals on a party line, and arrange it so that no two can be transmitting at the same time. Then you could get about eight hundred 3 char/s typists on the same line, and fully use it, but you would then start up another problem. How would the computer know which character came from which typist. And you would have to waste valuable time to do this by adding bits to each character, not mentioning the other problem of preventing two machines from transmitting at the same time and thus garbling each other's characters.

The above introduces one of the principles of the Aloha system – that of common resource sharing. If we can overcome the difficulties, we can get, theoretically, eight hundred 3 char/s typists on a 2400 char/s line. Since we have a 2400 char/s line, why not use it at 2400 char/s by saving up the characters that the user types and only sending them when, say, eighty are stored, or one line on a CRT?

Each transmission will take 33ms. Since each transmission will be equivalent to eighty characters, it will represent 26.6 seconds of typing to the user, and so will have to be sent only every 26.6 seconds. So each user will have to send a 1/30 second transmission once every 26.6 seconds. If all users could be synchronised, then the eight hundred users could be accomodated on the circuit.

The Aloha system uses two 24,000 baud radio channels. As those readers of Bits, Bytes, and Bauds (ETI Canada Sept 77 to March 78) will know, 24,000 baud ASCII represents 2400 char/s assuming eight data, one start, and one stop bit. The input to and output from the computer at the University of Hawaii is via UHF radio. Users at each of the remote sites (student's dorms, homes, etc) have a corresponding radio transmitter-receiver.

As far as the output from the computer goes, there is no problem, since the output for each terminal could be put into a packet with the desired terminal's address and sent out to it when the traffic for other terminals has been sent and the transmitter is free. Thus there will be a steadier and steadier flow of data coming from the computer until such time as there are too many terminals on the system requesting too much information. Then a backlog and delays will occur because the computer compiles data faster than it can send it.

However, the input side of the communications system is an entirely different kettle of fish. Here we have data from as many as several hundred different locations wanting to be sent via as many transmitters to be received by the computer. We simply can't poll all these remote stations by signal from the central computer because it would take a complete third radio channel to do so with duplicate equipment at both ends. We could possibly allow each station to transmit only in a certain time slot, but there would have to be one central timing source, such as WWVH and all stations would have to be able to receive it. Also, if any station were to be off the air, that time slot would be wasted.

CLEVER ERRORS

The solution to this dilema arrived at by U of H is not one that would

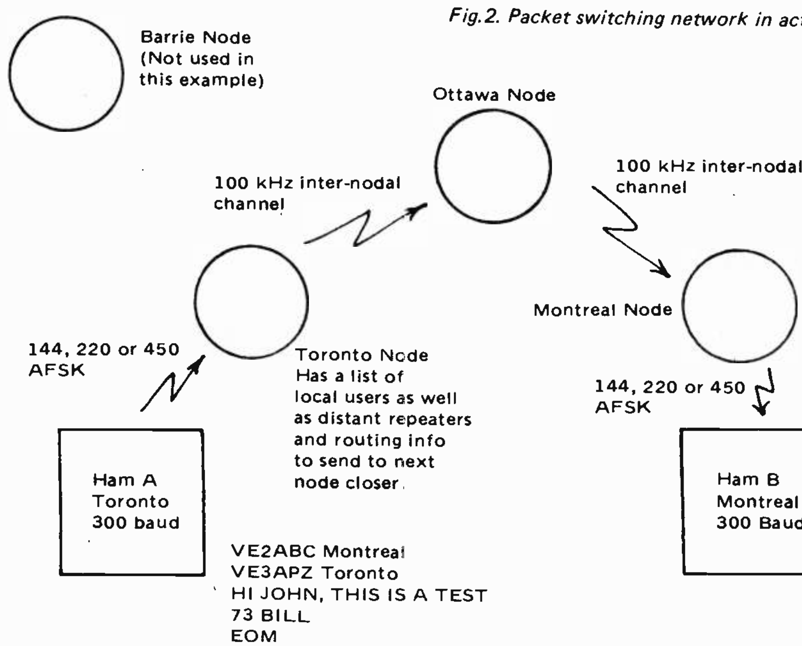


Fig.2. Packet switching network in action.

appear most logical to all but those who have closely studied the problem. The Aloha system actually allows terminals to transmit independently of each other, and uses mathematics of probability to determine the number of times that stations will interfere with each other, and thus destroy each other's data, for a given number of users on their channel. The maximum number arrived at for the Aloha system is 344, just less than half the 800 maximum users of the synchronised system.

Because the terminals may interfere with each other, the error-checking information in the packet header is used by the Central computer to determine whether a packet was received correctly or whether a retransmission should be requested. The sending terminal holds each packet in its own memory until the central computer sends it an acknowledge packet to say it received it OK, at which time the memory is re-used. The sending terminal will retransmit the packet if requested by the central computer, or if no reply is heard within a preset time limit. (The latter will be the case if a packet was damaged badly enough to obliterate its addressing information).

WHAT ABOUT PACKET SWITCHING?

Canada has already led the way into a new era of Data Communications based on packet switching. The CCITT (Comite Consultatif International de Telephone et Telegraph - international standards body) has recognized Bell Canada's packet switching protocol SNAP (Standard Network Access Protocol) as an international standard and designated it as X.25. So far, we have seen how a packet system can be used to send messages to one host computer from many terminals, but let us assume that the scenanio is slightly different—say, several thousand amateurs all across the country wishing to send simple radiograms to each other.

The concept of forming these messages into packets can make a very efficient system if the formatting for onward transmission is done by local club-owned stations in a fashion similar to that where local repeaters now relay VHF/UHF signals for onward transmission. Much has been said in the past about linking between repeaters but as I have said in my standard talk on repeaters and microprocessors (which I have given at several Toronto area radio clubs over the last few years) they will never come to anything if not used for packet switching since audio links of two or more hops require considerable numbers of inter-repeater trunks to be of any use. The present repeaters themselves could even house all the computer and interface requirements for a local node. Each city would have to have at least one node, whether it be at a club-owned repeater or a local amateur who allows other amateurs to go through his node.

POTATOGRAMS

For the simple purpose of sending radiograms, no packet would need to be formatted by ham 'A' , (see Fig. 2). He would merely send, on a 300 baud full duplex line, the call-sign and city of the destination ham plus his own. Suitable punctuation would delimit this, which would be followed by the message, a signature, and 'EOM' or a similar signal to denote the end-of-message. Since the line would be full-duplex, his printer would only print a character after it had been sent to the computer, accepted and returned, so he would know if their were any errors introduced in the circuit and correct them. Thus, he does not even have to count the words. The local node then takes his message, encodes it into the standard, agreed format for the network complete with all error checking bytes, etc., and sends it to the node next closest to the destination like a 'hot potato'. After going through several nodes, the packet will reach its destination node, at which time it will be converted back to its original form, and sent on to the destination ham's machine upon receipt of his auto-call answerback.

This shows only one use for packet switching in amateur service. There are many, such as program swapping, remote telemetry, digital voice encoding, to name but a few. Pretty soon our certificates will be based on how many nodes we have worked with a possible multiplier for each different data rate used. Remember, the future starts today—don't miss it!

To stay up to date pull out the new Amateur Radio Spectrum Allocations chart . . . in the centre of this month's ETI.

ETI Index Volume Two – 1978

Latest Ham Spectrum Allocations

Band Desig.	Frequency (MHz)	Amateur	Advanced Amateur	Digital Amateur
160	1.800–2.000	A1	A1,A3,F3 (FM3)	The Amateur Digital Certificate does not authorise any operation below 144.0 MHz The holder can however after one year's station operation, obtain an advanced ham certificate simply by passing the 15 wpm Morse test, since the theory and regulations knowledge required for the Digital certificate includes the requirements of the Advanced. This will allow him to use all bands and types of emission for which an Advanced Certificate is required, in addition to those allowed by his Digital certificate.
80	3.500–3.725		A1,F1	
75	3.725–4.000		A1,A3,F3 (FM3)	
40	7.000–7.150		A1,F1	
40	7.150–7.300		A1,A3,F3 (FM3)	
20	14.000–14.100		A1	
20	14 100–14.350		A1,A3,F3 (FM3)	
15	21.000–21.100		A1	
15	21.100–21.450		A1,A3,F3 (FM3)	
10	28.000–28.100		A1	
10	28.100–29.700	2*	A1,A3,F3 (FM3)	
6	50.000–50.050		A1	
6	50.050–51.000	A1,A2,A3,F1,F2,F3 (FM3)		
6	51.000–52.000	A0,A1,A2,A3,F1,F2,F3,A4,F4 (FM3)		
6	52.000–54.000	A0,A1,A2,A3,F1,F2,F3,A4,F4 (FM15)		
2	144.000–144.100	A1		
2	144.100–145.500			
2	145.500–145.800	A0,A1,A2,A3,A4,F1,F2,F3,F4 (FM15)		A0,A1,A2,A3,A4,F1,F2,F3,F4,P0,P1 (FM15)
2	145.800–148.000			
	220.000–220.100			
	220.100- 220.500	Any except for pulse-type emissions (PBW10) (FM15)		All modes inc. pulse (PBW10) (FM15)
	220.500–221.000	Any except for pulse-type emissions (PBW100)(FM15)		All modes inc. pulse (PBW100)(FM15)
	221.000–223.000	Packet transmissions only – no pulse (PBW25)		Packet transmissions only—pulse inc (PBW25)
	223.000–223.500	Any except for pulse-type emissions(PBW100)(FM15)		All modes inc. pulse (PBW100)(FM15)
	223.500–225.000	A0,A1,A2,A3,A4,F1,F2,F3,F4 (FM15)		
	420.000–433.000	A0 to A4,F1 to F4 (FM15)1*	A0,A1,A2,A3,A4,A5,F1,F2,F3,F4,F5, (FM15)	
	433.000–434.000	Packet transmissions only, no pulse (PBW100)		Packet transmissions only—pulse inc.(PBW100)
	434.000–434.500		A0 to A5,F1 to F5	A0 to A5,F1 to F5, (FM15),P0,P1,P2,P3
	434.500–450.000		A0,A1,A2,A3,A4,A5,F1,F2,F3,F4,F5 (FM15)	
	1215–1300	A0,A1,A2,A3,A4		A0 toA5,F1 to F5, P0 to P7 & P9
	2300–2450	1*	A0 to A5	
	3300–3500	F1,F2,F3,F4 (FM15)	F1 to F5 (FM15)	A0 to A5, F1 to F5 P0 to P5,P9, (FM15)
	5650–5925			
	10000–10500			
	24000–24010	Any mode except for pulse emissions (FM15)		All modes inc pulse (FM15)
	24010–24050	A0 to A4,F1 to F4 (FM15) 1*	A0 to A5, F1 to F5 (FM15)	A0 to A5,F1 to F5, P0 to P5,P9 (FM15)
	24050–24250			

KEY TO TRANSMISSION MODES

A0: Unmodulated carrier; A1: Carrier wave telegraphy; A2: Tone modulated c.w. telegraphy; A3: Amplitude modulated phone; A4: A.M. facsimile; A5: Television.
F1: Frequency shift keying; F2: Frequency modulated tone keying (Morse or teletype); F3: F.M. phone; F4: F.M. facsimile; F5: F.M. television.
P0: Pulse emission, no modulation (eg: radar); P1: Telegraphy, teletype; P2: Telegraphy by on/off keying of audio modulated carrier, or by on/off keying of pulse modulated carrier; P3: Telephony by pulse modulation (Pulse amplitude, pulse width, pulse time, etc.); P4: Facsimile by pulse modulation; P5: Television by pulse modulation; P6: Four frequency diplex telegraphy; P7: Multi-channel voice frequency telegraphy; P8: There is no P8; P9: Any other pulse-type transmission.
The restrictions are on bandwidth, and the station must identify itself, either in Morse code, or the id may be in ASCII code in the packet "header".
FM3: Maximum deviation on any mode of F.M. not to exceed 3kHz.
FM15: Maximum deviation on any mode of F.M. not too exceed 15 kHz.
PBW10: Packet transmission, bandwidth limited to 10 kHz.
PBW25: Packet transmission, bandwidth limited to 25 kHz.
PBW100: Packet transmission, bandwidth limited to 100 kHz.

NOTES:
1*: May be allowed to use A5 and F5 after one year's operation and demonstration of competence.
2*: May be allowed to use A3 and F3 (FM3) on 28.1 — 29.7 MHz on endorsement after 6 months of activity below 50 MHz.
Prepared by Bill "BJ" Johnson, VE3APZ

Electronics Industry in Canada?

Report on report which says sock pulling up is required

IT WAS WITH great interest that we read the report of the Task Force on the Canadian Electronics Industry. Released in Toronto on September 6th, it contains numerous useful and informative concepts and views on our electronics industry, and some strong suggestions for the future.

KEY REPORT CARRIES WEIGHT

The report was commissioned originally by the federal government's Ministry of Industry Trade and Commerce. Chaired by Mr. Larry D. Clarke (Chairman of Spar Aerospace Products Ltd.,), the Task Force was composed of key people from management and labour position, and also representation from the university and provincial government view points. The report is one of 23 similar documents on sectors of industry, intended to keep the MITC in touch, and to advise them on possible future courses of action. As such then it has the potential for far reaching effects, hopefully in a positive direction for the large number of our readers who are involved in some way with the electronics industry.

THE REPORT

For the benefit of those readers who have not got a concrete mental picture of the electronics industry, we will start with a look at this, drawn from the report and also from the 'Sector Profile-The Canadian Electronics Industry', appended to the report.

FIRST THE BAD NEWS

Overall, Canada's electronics industry has had consistently the worst trade balance of all six countries studied; Japan, USA, Germany, UK, and France being better. That is, we import a heck of a lot more than we export, and it has been getting worse to the point that in 1976 (latest figures provided) we imported US$1267 million more than exported, while Japan was doing US$ 8 billion the other way. (More figures are available in the report, we're skimming the high (low?) points). In other words, Canada was relying on her traditionally strong, but unskilled labour intensive and diminishing natural resource industries, and on borrowing money.

NOW THE WORSE NEWS

The report indicates that Canada's electronics industry as a whole is sick, victims of insufficient home market for sufficient mass production of consumer goods here to compete price-wise with imported goods, and (really part of the same problem) insufficient protection in the way of tarrifs, or preferential purchasing plans by governments or institutions.

SOME GENERAL CHARACTERISTICS

There are over 700 companies in Canada making electronics products, of which 80% are in Quebec and Ontario producing 90% of the products. These companies are chiefly located near cities where they have access to 'a supporting technological infrastructure' and skilled labour. The report notes however that there is little need for location in any particular area in Canada (hence more regional development is possible).

Size: Most companies (70%) have less than $1 million in annual sales, (1976 again) with only 8% above $25 million. Northern Telecom, the largest at over $1 billion represents 30% of the total and is only medium sized by international standards. 30 electronic companies in the world are larger, 15 of which exceed Canada's total domestic demand! Needless to say, it's challenging to compete with them.

Research and Development: The electronics industry is the largest employer of technical and scientific brainpower, 25% of all R&D expenditure being in electronics. Looking at it another way, in electronics, an average of 4% to 5% of sales is spent in R&D versus 1% in other industries.

Naturally, this large R&D characteristic ties in with long development large R&D capital (equipment and facilities) investment, and public investment in training and nurturing skilled and educated people.

Foreign Ownership: 20% of Canadian electronics firms are foreign owned, with 55% of the industry's sales (80% it it weren't for Northern!). This obviously implies that on average the foreign owned ones are the larger, 72 of the top one hundred for starters!

A LOOK AT SECTORS

For the purpose of making the industry a manageable concept to think about, the report identifies and describes several major 'sub sectors'.

Consumer Products: An extremely price sensitive field, where anything we can make some other nationa can make more, cheaper. TV manufacturing has collapsed, and it's unlikely that any electric consumer products are profitably produceable in Canada.

Components: A somewhat loose grouping, ranging from resistors to LSI chips. Again bad news in the mass production department, especially at the resistor end. IC's require lots of R&D, and not much return in the Canadian market with difficult international competition (remember Micro-Systems International?).

Our best bets are relatively small volumes of complex, highly specialized or custom components.

Telecommunications: One of our fortes since we have the world's second largest amount of long distances. Northern Telecom is the star, with a large home market and world leadership in many aspects of communication technology.

Other Communication: Dating back to the establishment of Canadian Marconi in 1903, this field includes commercial public broadcasting equipment and installation, radar, microwave systems, and various defense and space projects. Canadian suppliers have been losing ground as suppliers in Canada, but increasing exports. Small size tends to hinder the credibility and bargaining stance of Canadian owned firms in this subsector.

Computers and Office Equipment: Fast changing field, our own companies are mostly into computer peripherals and specialised data processing systems. More successful are the branch manufacturing plants of foreign companies. Some potential appears to be in the computer support and software fields.

Control and Instrumentation: A very broad area is covered here, populated by a small number of large multinational companies, and a large number of small Canadian companies. Strong growth, especially with increase of small computers in control applications. World trade has been inhibited by 'non-tariff barriers' of major nations. ('buy-at-home' policies etc).

Systems Electronics: This subsector was felt by the Task Force to be that having most potential for growth in Canada and upon which much attention should be lavished to cultivate expertise.

The area is said to cover 'the integration of a variety of electronic equipment into a system, usually designed to monitor an activity or process and to initiate corrective and control functions.' This is distinct from the specialization in just one or two types of *subsystem* by many firms today. 'The strength of companies which do systems integration'.....'is their ability to tie together subsystem technologies, often combined with strong software capabilities in the solution of highly complex problems.' Few such companies exist today in Canada, although several subsystem people have evolved some system capability.

Much of the product is (again) custom, not requiring huge manufacturing facilities. However, the market is up and down, hence the prospective systems company needs to have some stabilizing mechanism for the down periods.

WHAT WAS FOUND

Against this brief overview of what's going on now, let's consider what the report had to say about the future.

WHY?

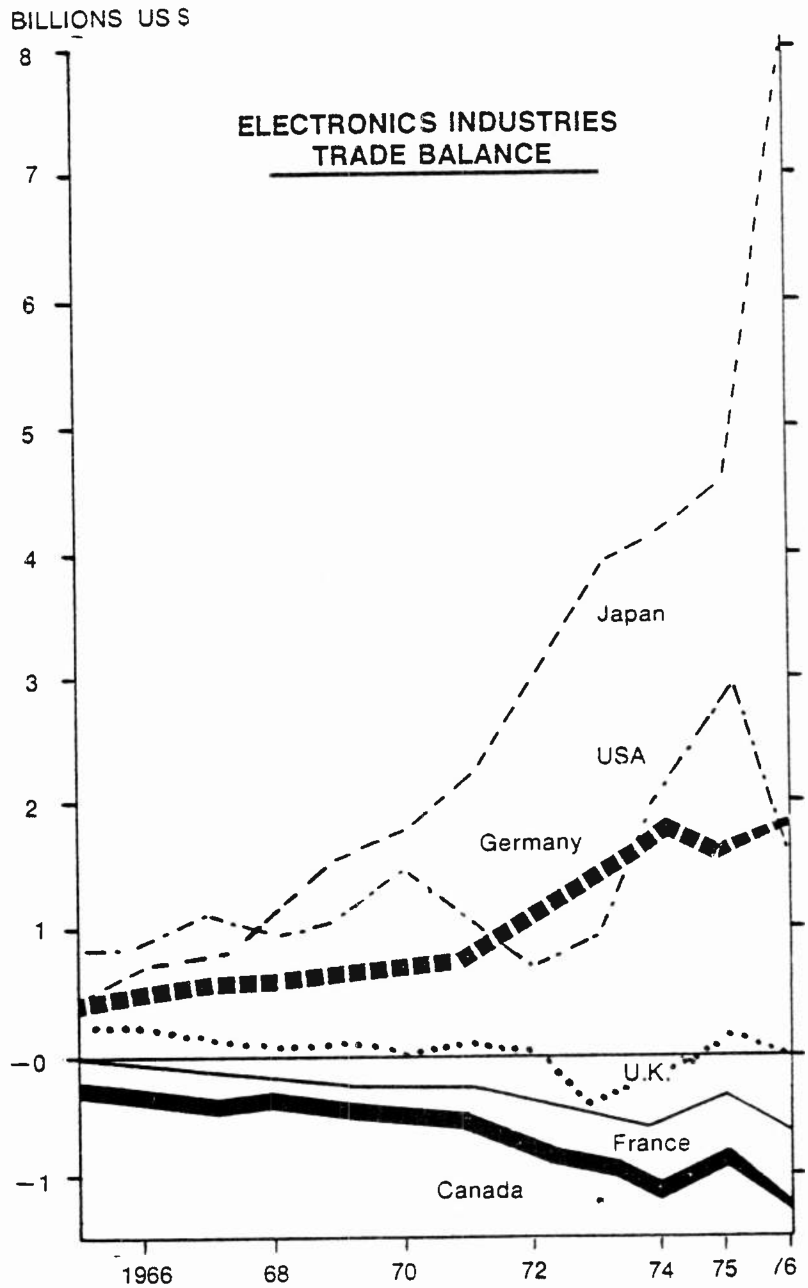
First, why do we need an electronics industry if it's so difficult? Apart from the fact that there are a lot of Canadians who through interest want jobs in electronics, the report points out that the electronics industry is important to Canada as a nation for several reasons.

We need the capacity for technological innovation in order to produce internationally competitive goods so that Canada can make some money. Electronics is an opportunity.

Studies show that high technology industries grow fast both in sales and employment. Hence if approached properly they represent a good investment.

As a non-natural resource based industry itself electronics does not depend on something that we're going to run out of, and hence provides for our future viability as a nation.

Electronics (eg systems) supports other industries (eg natural resources exploration, processing) and hence enables us to exploit these more efficiently and profitably. For Canada



It would almost look funny . . . . if the bottom line wasn't labelled "Canada" this particularly applies also to transportation and communication. It is a strategically important industry.

Finally, it is an opportunity to provide 'high quality' employment to Canadians hence raising the overall quality of life here.

WHAT SHOULD WE AIM FOR?

As may already have been gathered, we should aim for strengthening those areas in which we are already leaders, and those of strategic importance. This includes 'systems electronics' and telecommunications (which is a system too!). These give us opportunities not only in Canada but internationally as well, especially in such areas as the middle east. In addition these companies as primary focuses of attention would be customers of subsystem and even component companies. We must obviously develop strongly at home that which we wish to be recognised for as exports, and here we already see our good position in telecommunications for example.

Regional development of the industry in Canada would be boosted by these fields, as they are by nature oriented towards local requirements. Companies based already in unusual locations are already demonstrating that you don't have to be in Toronto, Ottawa or Montreal to make it.

HOW DO WE DO IT?

First, let's look at the list of problems faced by Canadian companies.

—Obtaining financing is very difficult and high risk associated with unique or complex projects is a problem particularly in estimation of software costs. In addition, a long investment period before payback.

—High cost of making bids for contracts.

—The financial vulnerability of Canadian companies compared to international giants impedes the ability to compete in an open market, whether here or elsewhere.

—Sporadic availability of projects and long time between project definition and its implementation. This tends to mean that technical teams drift apart and do not keep up with the team's would-be field of expertise. Alternatively, the cost of keeping the team together is high.

—Inexperience in business, and lack of credibility to foreign buyers.

—The existing, evolved collection of companies, if viewed as a structure is inefficient as a whole due to fragmentation of resources and duplication of capabilities.

—Rapid obsolescence of technology and products leads to fast changing market.

RECOMMENDATIONS

A lengthy list of recommendations was gleaned from the report, upon which we have tried to impose some organization.

R & D: In this R & D intensive industry government's influence in the past has been poor due to assistance programs being of a short term or 'stop—go' nature, and concentration on basic research, rather than applied research (you can often get the technology from elsewhere, but it's you who have to apply it to your product) and in general a lack of matching assistance to the needs of the assistee. The government(s) should examine not just who to assist, but how to assist.

Companies should be encouraged to seek mergers that benefit their overall scope, particularly in R & D, but also in marketing. Even links with foreign companies can be beneficial.

Fiscal Incentivies: A number of tax adjustments are suggested to influence companies in the 'right' direction, promoting particular activities, and investment in certain areas and oriented toward longer term returns. A useful analogy is the incentive schemes for films, or oil and gas. The shortage of capital would be alleviated by adjusting taxes to improve the risk-reward ratio.

Buy Canadian First: A policy recommended to all levels of government and institutions to encourage a future strong electronics industry. This would involve studying the overall economic effect of purchases (not just the direct cost), co-ordinating government departments in their purchases, basically figuring out what to encourage and then doing it when purchasing.

Some assistance and understanding toward the industries more delicate parts would be helpful, such as planning for the smooth flow of contracts to help project teams stay together, and perhaps more flexible or versatile contracts themselves. A more interactive approach is desirable.

Home Markets: A stable growing home market is essential as a base from which to work, it is claimed. Other countries have tarrifs and other trade barriers (such as buy-at-home-first programs) in order to keep their electronics industries healthy. Although Canada's electronics industry feels it could survive in a no-barrier world, it would like some sort of barriers while building up some strength. Currently Canada has none.

Foreign Interactions: A number of proposals related to import and export money matters were forwarded in the report. Import duties should protect and encourage our production, while not making essential imported items more expensive. An example is large computers, perhaps essential for use by one Canadian electronics firm, yet should they be subject to tariffs to encourage some other firm to produce them here? There should be some recognition for that manufacturing which we will resign ourselves to having take place elsewhere.

Competitive financing needs to be available for international competition. Some notes were also made about the exchange rate of our dollar, a topic not limited to electronics of course. There is also the issue of current international discussions regarding tarrifs and other barriers.

Finally, the Task Force felt that, on the subject of foreign ownership, it is not so much the ownership, but the 'corporate behaviour' which is important. Accordingly an extensive code of behaviour is appended to the report.

CONCLUSIONS

Basically, the Canadian electronics industry is in trouble if we don't get our collective act together. This means government,industry, labour, education, the works. An initial direction has been pointed out, and it rests with the Ministry of Industry Trade and Commerce to form the plan and co-ordinate the activities.

It will be a challenge, since it seems unusual for a government ministry to prepare for a long term goal, but unfortunately actions based on short term improvement will not be adequate and can be destructive.

The report recommends a number of actions directly to the MITC. These boil down to: Plan for the future, incorporating specific objectives by which to measure progress, then implement the plan.

Again it is emphasised that the rescue of our electronic industry is a medium to long term project, with little to justify expenditures on a short term basis. Will the government be farsighted enough to follow up on the recommendations? If it's not I'll see you in California.

Copies of the report are available from the Ministry of Industry Trade and Commerce, which has branches in major cities, head office at 235 Queen Street, Ottawa, Ontario K1A 0H5.

CANADIAN PROJECTS BOOK NO. I

5W Stereo
Overled
Bass Enhancer
Disco Modules
Metal Locater
GSR Monitor
Fuzz Box
Mastermind
Reaction Tester
Burglar Alarm
Injector-Tracer
Digital Voltmeter

HEART-RATE MONITOR

By clipping an illuminated bulb to one side of your ear-lobe and clipping an LDR to the other side, you can monitor the changing translucency of the tissue as blood spurts through the blood vessels. The signal from the ear-lobe detector is cleaned up and squared off and then fed to a frequency-to-voltage convertor which, after buffering, drives an analogue meter. this project is not meant for use as a serious diagnostic instrument. It can be used by those experimenting in biofeedback or by sportsmen in training.

DOUBLE DICE

A project to get you started in CMOS digital electronics. A decade counter is made to divide the output from an oscillator by six. The dice rolls while a button is pressed and continues to roll (now slowly) for a short while after release. Consumption from the battery is so low that we use no on-off switch. The results are truly random.

TOUCH ORGAN

What's so neat about this project is that it is all on one PCB. Twenty-seven touch-switches are laid out on the copper side of the board to give a full two-octave keyboard and tremolo switch. There ae two voices available, and a volume control. The project is easy to build, uses 12 ICs and runs from a 9V battery.

PHASER

The effect of the phaser or phlanger will be well-known to readers who are interested in popular music. The ETI phaser achieves the desired effect by splitting an audio signal into two paths and re-mixing the components after one has undergone a phase change. This change takes place in six RC networks, each capable of 180° shift at high frequencies. This gives a comb-shaped response (3 minima) for the unit as a whole. The characteristic whooshing sound occurs when we change the resistive elements of each RC section (using a 4049 as six sets of complementary FETs) under voltage control from a triangle-wave oscillator.

AUDIO LIMITER

This stereo device uses a 4049 CMOS hex-inverter IC to provide enhancement-mode FETs for use in a voltage-controlled attenuator circuit. The project can be used to limit audio peaks to prevent amplifier clipping, to reduce the dynamic range of a signal for recording, or as a voltage-controlled volume control for remote or automatic operation.

SOUND-LIGHT FLASH

This project senses a change in light or sound and, after a predetermined delay, operates a photographic flash unit. You can photograph glass shattering, any violent impact, splash, clap, explosion, etc.

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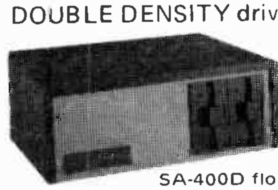
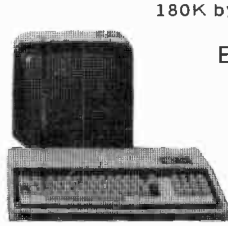


$3424. with 16K RAM

SA-400D floppy diskette drive
180K bytes per diskette



EXIDY SORCERER Computer

8K $1360.
16K $1730.
32K $2120.

Professional keyboard, Z80 CPU, 30 x 60 character display, 512 x 240 graphics, ROMPAC BASIC standard. Assembler, PILOT and APL optional.

Principles of Video

Video for the home user and small group finally appears to be taking off. This article from Sencore explains the principles you need to know to understand your recorder, or as a basis for learning to service them.

ANY TAPE recorder, whether an audio or video recorder, must be able to convert an electronic signal to a magnetic signal that is used to magnetize a layer oxide that coats the magnetic tape. The magnetic tape is pulled past a recording head which is nothing more than an electromagnet. The recording head consists of a u-shaped piece of metal that has a coil wrapped around it. The coil (which receives a signal from some type of amplifier system) causes a magnetic field to build and collapse within the metal in step with the signal applied at its coil. The open end of the u-shaped metal head is a very narrow slit called the "head-gap". This head-gap is the portion of the head that makes contact with the tape. The magnetic flux lines passing between the two parts of the head-gap also pass through the tape that is in direct contact with this area of the head, causing the magnetic particles on the tape to be magnetized. The amount of magnetization is directly related to the amount of current passing through the head coil at the instant it is in contact with the tape.

This process is reversed during playback. The tape (with the varying magnetized sections created during recording) is pulled past the head. The changing magnetic levels on the tape cause a current to be induced in the head coil which is passed to very sensitive amplifiers. These amplifiers then increase the signal level sufficiently to produce an audio or video output.

FREQUENCY LIMITS OF THE DIRECT RECORDING SYSTEM

A direct recording system is one that feeds the output of the recording amplifiers directly to the head without any other signal processing other than equalization. A direct recording system has both high and low frequency limits that are determined by the width of the head gap and the relative speed between the tape and the recording head. The output voltage of the playback head is determined by the rate of change of the magnetic field produced by the moving tape. The faster the magnetic field changes, the higher will be the output voltage. If, for example, the frequency is doubled, the rate of change is also doubled, and the output voltage is doubled. The maximum output voltage occurs when the wavelength of the signal on the tape is twice as long as the width of the head-gap. As the frequency decreases (and the tape wavelength increases) from this optimum point, the output voltage decreases at a 6 dB per octave rate. An octave is simply a doubling (or halving) of the frequency. The output versus frequency is shown in Fig. 2.

There is also a loss of output voltage at higher frequencies. The combination of the head-gap width and the head-to-tape speed determine the highest frequencies that can be recorded. The recording head can only record a signal when the wavelength of the recorded material on the tape is longer than the width of the head-gap. The reason for the high-frequency loss is shown graphically in Fig. 3.

The top drawing (in Fig. 3) shows the tape being pulled across the recording head at a fixed rate. This example shows a signal whose wavelength is longer than the width of the head-gap. As the tape moves past the head, the changing magnetic field causes the induced electric current in the head coil that we need for an output from the

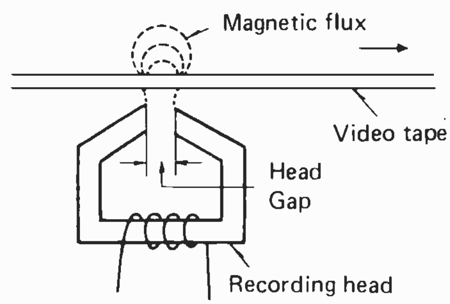


Fig. 1 — The record/playback head is simply an electromagnet. The small slit is called the head-gap and is the portion of the head that actually contacts the tape.

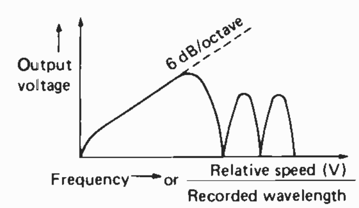


Fig. 2 — A recording head has a 6 dB per octave rolloff below its optimum frequency point.

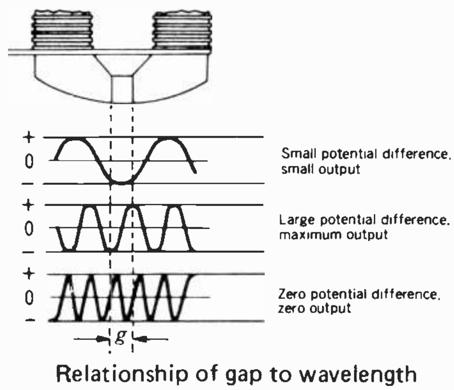


Fig. 3 — Cancellation reduces the output of the head if the wavelength of the signal on the tape is shorter than twice the gap width.

playback head. As the frequency of the recorded signal increases, the wavelength of the signal becomes shorter. If the wavelength of the signal is shorter than twice the head-gap, cancellation begins to occur. This cancellation will produce total cancellation, and a zero output, when the wavelength of the recorded signal is the same as the gap-width because the signal will show both a positive and negative amount of change at the same time. Therefore, the output voltage drops rapidly as soon as the recorded signal wavelength becomes less than twice the gap-width.

We can increase the upper cutoff frequency by either reducing the gap-width, or by increasing the tape-to-head speed. If we halve the gap-width, we double the upper cut-off frequency because smaller wavelengths may be recorded before cancellation takes place. If, on the other hand, we double the tape speed (holding the gap-width constant) we again double the upper frequency limit because the wavelength of a given frequency signal is now twice as long on the tape. But, in either case, the total bandwidth that can be recorded is not increased because of the 6 dB per octave rolloff that takes place at the lower frequencies.

In practical terms, a direct recording system allows 9 octaves of range before the low frequency noise or high frequency cancellation renders the output of the playback head unusable. If, for example, the lowest frequency we want to record is 30 Hz, the highest frequency a direct recording system will record is 15,000 Hz. If we raise the lower limit to 60 Hz, our upper limit is 30,000 Hz, etc.

RECORDING BIAS SIGNAL

The total frequency range of our recording system may be increased with the use of a high-frequency bias signal. This signal is used in most audio recorders to produce a more even output over the desired ranges of input signals. The bias signal (which is typically 100 KHz in an audio deck) in effect becomes a carrier signal to increase the low-frequency response of our system. The drawing in Fig. 4

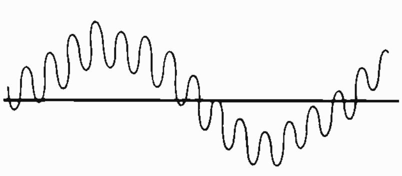


Fig. 4 — The use of a bias signal increases the low-frequency output becuase it acts like a carrier signal.

shows how a low-frequency signal AM modulates the bias frequency. Since the carrier produced by the bias frequency is a fixed frequency, the voltage output of the playback head remains the same while the modulation envelope carries the information we wish to record. A bias system improves the recording bandwidth. It will not, however, produce a wide enough bandwidth for direct video recording.

Video recording requires an extremely wide frequency bandwidth. The frequencies conatined in a video waveform extend from essentially DC to 4 MHz. This represents 18 octaves of frequency response, which is greater than either a direct or a bias frequency recording system can handle. In addition to the wide frequency response required for the B & W portion of the video waveform, we must also make sure that the phase relationships of the chroma subcarrier accurately duplicate the original composite color signal during playback. Video tape decks use two different systems for recording the wide bandwidth required for the B & W information and the accurate phase information needed for color. We will discuss each in later sections.

THE SPINNING VIDEO HEAD

The first thing we need to record video information is the ability to record frequencies up to 4 MHz. We have already discussed the fact that the high frequency limits of a magnetic tape

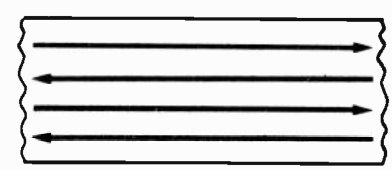


Fig. 5 — Audio tape decks record the signal in paths running parallel to the tape edge. Such tape formats are called "longitudinal".

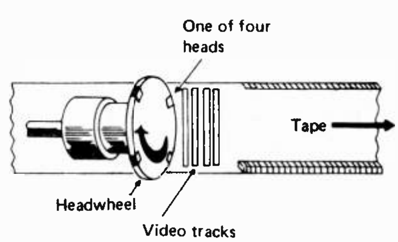


Fig. 6 — The quadraplex format uses 4 heads to record stripes that are perpendicular to the edge of the tape.

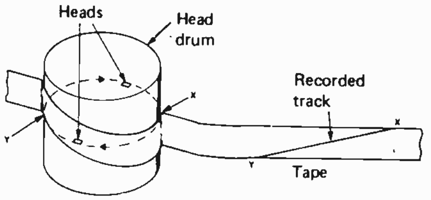
recording system are determined by both the size of the head-gap and the relative head-to-tape speed. There are physical limitations that come into effect if we only control the head-gap width. Let's say, for example, that we wish to design a system that will have a tape speed of only 3 3/4 inches per second to keep the cost of our tape as low as possible. The wavelength of the signal on the tape at this speed in only 0.0000009" (9/10,000,000) for a frequency of 4 MHz. This means that the gap should be half this width or 0.00000045". Even if it were practical to produce a gap this small, any wear on our head would soon widen the gap and result in a loss of high-frequency response.

We mentioned that we can increase the upper frequency cutoff point by increasing our head-to-tape speed. An early attempt to produce a low-cost video recording system used a fixed-head format with a tape speed of 100 inches per second. This system proved to be impractical. A single hour of recording required 30,000 feet of tape! And, any mechanical malfunction in the tape transport mechanism resulted in tape literally spilled all over the room.

Up to this point we have been thinking of tape decks with fixed heads. The tape is pulled past the head-gap at a fixed rate and the signals are recorded in a path that runs parallel to the edges of the tape. This method of recording known as a "longitudinal" recording system. Almost all audio tape decks use a longitudinal recording format. The audio signals of a video tape system are recorded with a fixed head just like a standard audio tape deck and are therefore longitudinal. The electronic circuits of the audio section of a video tape deck are very similar to an audio deck.

You should notice that we have been saying that the "relative" tape-to-head speed is important, not necessarily the actual speed of the tape moving from the supply to the takeup reel. A more practical method of increasing the head/tape speed involves moving the tape at a relatively slow speed while a special spinning head is used to record the information. Commercial broadcast video tape decks, for example, use 4 heads mounted on a disk that spins at 240 revolutions per second. The head disk is mounted perpendicular to the direction of tape travel and the tape is moved past the spinning disk. The video information is recorded in stripes that run perpendicular to the edges of the tape. The spinning disk moves the heads past the tape at a relative head-to-tape speed of 1500 inches per second. This system is known as the "quadraplex" system. The cost of both the equipment and the tape make these systems impractical for home use.

The introduction of the "helical scan" or "slant track" recording system reduced the cost of video tape recorders and at the same time, greatly reduced the amount of tape necessary for one hour of recording time. The helical scan formats use one or two spinning video heads contained in a cylinder that has a slanted (helical) tape push wrapped around it. The tape is passed across the head(s) at an angle which results in a recording path that falls in parallel, diagonal lines as shown in Fig. 7. The tape widths used by various helical scan recorders run from 1/4" to 2 inches. The most common tape widths for video cassette recorders (VCR) are 1/2" for the Beta and VHS formats, and 3/4" for U-Matic recorders.



(a) Tape wrap around drum (b) Resulting recorded track

Fig. 7— A helical scan tape deck pulls the tape past the spining heads at an angle resulting in a slanted video track on the head.

The heads of a two-head system are spinning at 30 revolutions per second. This means that one complete field (262½ lines) of video information is recorded in one tape stripe. Two stripes produce one complete interlaced frame (525 lines) of video information. NOTE: Some video recording systems (such as Sanyo "V-Corder") do not record every field of video information. The basic theory of operation remains the same in this "skip-field" recording system except that the same information is repeated two or three times during playback. Table I shows the different tape speeds and head-to-tape speeds for different video tape formats.

PREVENTING SIGNAL CROSSTALK

Proper playback is possible only when a single recorded track is played back at one time. Provisions must be made in the design of a video tape format to prevent the video heads from playing more than one signal track at a time. If part of a second signal path is picked up during the tape playback, a condition known as "crosstalk" is present. Crosstalk is present in an audio tape deck that has an improperly adjusted head which plays back the desired signal and part of another signal on the tape. Video crosstalk will cause a noisy picture.

Two systems are used to prevent video crosstalk. The first system uses "guard bands", which are simply blank areas between each stripe of video information. This system is used in the U-Matic and most reel-to-reel formats. The greatest disadvanatge to the use of guard bands is that no information is recorded on the guard bands which means that more tape per minute must be used. Eliminating these guard bands increases tape efficiency by "squeezing" the individual stripes of video information closer together.

TABLE I
TAPE SPEED vs. HEAD SPEED

FORMAT	TAPE SPEED	HEAD SPEED
Quad	15 ips	1500 ips
U-Matic	3.75 ips	400 ips
Beta 1-Hour 2-Hour	 1.57 ips .78 ips	 272 ips 272 ips
VHS 2-Hour 4-Hour	 1.34 ips .65 ips	 228 ips 228 ips

ELIMINATING GUARD BANDS

If you have worked with audio tape decks, you have most likely encountered a loss of high frequency response due to improperly aligned playback heads. A tape head will provide its highest signal output if the angle of the gap of the playback head is exactly the same as the recording head. An audio head is aligned by adjusting the position of the head with the head "azimuth" adjustment which simply tilts the head slightly. Both the Beta and VHS VTR formats use two video heads located 180° apart on the video head disk assembly. Two heads are used to allow one head to be in contact with the tape while the other one is located on the back side of the video drum as shown in Fig. 8. The first head records one field of information, and the second head records the next field of information as the heads spin. Thus, the individual stripes of information are recorded alternately by the two video heads.

SERVICE VIDEO EQUIPMENT

WITH THE DECLINE in TV service work many service shops are turning to other areas to supplement their business. Increasing numbers of video machines are now being sold, and as, any complex electro-mechanical devices, are sure to need servicing and 'tune-ups'. Sencore, being very involved in the service equipment business forecasts that a healthy business will develop but say that many shops currently are not able to lay out the many thousands of dollars for the equipment thought necessary for the task.

Sencore claims however that much less investment is actually required than commonly thought. The key they say is a comprehensive TV-VTR-Video Analyzers such as their VA48. Such an instrument is not bought solely for VTR service but is used also for TV and MATV duty. Hence it represents less of a commitment in the area of video recording, which Sencore feel will take 2 to 2½ years to 'mature', but in the meantime provides useful capability in other service areas while establishing a service company as being able to handle VTRs.

In addition, Sencore recomends the following instruments:

1) Dual trace scope, allows comparison of two waveforms, convenient for tracing signals from input to output, particularly useful in trouble-shooting critically timed circuits such as servo stages. Requirements ar at least 5MHz bandwidth, bright trace, and stable display at vertical and horizontal TV line frequencies. (Here there is much to be said for the few scopes which have built in sync separators for triggering purposes).

2) Frequency counter is needed for setting reference oscillators and for adjusting servo circuits.

3) Digital Voltmeter. As well as the troubleshooting of the electronics, a low resistance range is useful for measuring the resistance of video heads and rotary transformers.

4) Transistor Tester. This is handy to have since many discrete transistors are used in VTRs, up to several hundred in some cases!

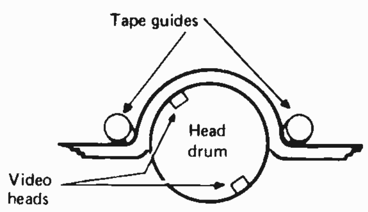


Fig. 8 — Two video heads are used so one is always in contact with the tape.

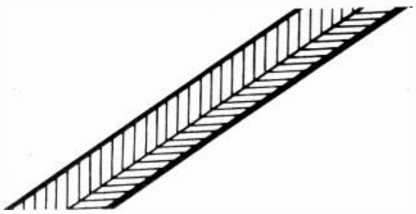


Fig. 9 — Alternate video stripes are recorded at different angles to minimize crosstalk.

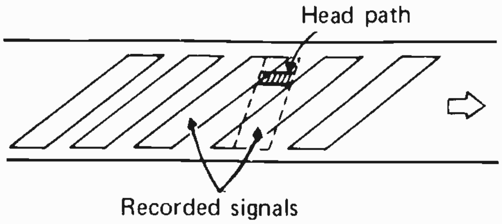


Fig. 10 — The head must follow the same playback path the recording head traced for a sharp, snow-free picture.

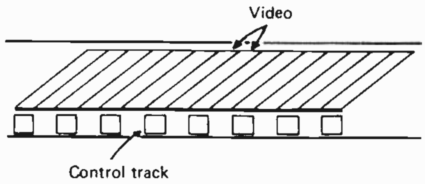


Fig. 11 — One control track pulse is recorded for every two video stripes as a playback reference.

The gap in each head is set at a 7° (6° for VHS) slant. The slant of one head is exactly opposite the other. This means that the azimuth angle of each stripe information differs by 14° from the next adjacent stripe. The result of this 14° azimuth shift is that each head will pick up the signal that was recorded at the correct angle but reject the crosstalk information recorded at the other angle. Thus, the need for the wasted tape required for guard bands is eliminated.

NOTE: Azimuth cancellation is maximum at the higher frequencies is used for recording the B & W portion of the signal. Additional crosstalk rejection is required for the color signals. We will cover this when we discuss the color processing circuits.

VIDEO HEAD ALIGNMENT

There are several reasons that the playback head must exactly follow the same path on the tape as was followed during recording. The main reason is that the best signal pickup (resulting in a better signal-to-noise ratio) depends on the playback head following the center of the recorded path. Another important reason is that many VTR owners want to be able to play back a tape on one machine that was recorded on another machine. We will discuss some of the features of modern VTR systems to achieve these two important points.

First, the head must trace the recorded tracks at exactly the same angle during playback and recording. If the head takes a slightly different angle, the result is an increase in playback noise in either the top or bottom of the picture as the head begins to lose contact with the recorded signal path. The angle of the recording and playback path is determined by the diameter of the video drum, the path around the drum, the angle that the tape approaches the drum, and the speed of the tape as it passes the spinning video heads. Each of these variables is related to the tape transport mechanism. Proper tape angles require very accurate tape guides. Proper tape speed requires synchronous motors and precise tension adjustments on both the supply reel and the takeup reel to prevent the tape from stretching a different amount during recording and playback.

In addition to the mechanical alignment of the tape path, the machine must "know" exactly where each recorded path begins and position the spinning heads (during playback) to follow these paths. Modern tape decks using "zero guard bands" formats must also "know" which of the two video heads was used to record each of the tracks so that the same head is used during playback. If the machine could not determine this, the wrong head (with the improper head azimuth angle) could be used during playback with a resulting loss in output level due to the azimuth cancellation we discussed earlier.

THE VIDEO HEAD SERVO

All video tape systems that use spinning video heads use a signal known as a "control track" as a reference to position the heads properly during playback. This track is a series of pulses recorded on the edge of the tape by a head that is fixed along the tape path a precise distance from the video recording drum. All VTR formats discussed in this article use a control track signal made up of a 30 Hz signal that is formed by recording every other vertical sync pulse. We do not use every sync pulse because two heads are used to record one complete frame (two fields) of the video waveform. Let's see why this is important by calling one of the video heads "A" and the other head "B".

Each video head records every other field (262.5 lines) of the video signal. In our example, let's say that the "A" head records the odd numbered fields, 1, 3, 5, etc., and the "B" head records the even numbered fields, 2, 4, 6, etc/ We need each recorded path to be played by the same head on playback as was used during recording, so let's record a pulse on the tape each time the "A" head just begins to record its path, and repeat this procedure each time the "A" head is in this position. We then use an electro-mechanical servo system to adjust the position of the spinning head during playback. The "A" playback head should be in the same position every time our control track head picks up one of the pulses that was recorded at the beginning of the "A" head path. If the head is not in the proper position, our servo circuit simply makes speed adjustments until the head is properly positioned. The control track then acts like the sprocket holes found in a movie film. The function of both the control track and the sprocket holes is to reference the tape (or film) during playback. In either case, we are simply supplying a reference that can be used for proper synchronization.

This is exactly how the control track is used. It provides a reference that is used to position the spinning video head during playback. The vertical sync pulses are used to generate the control track pulse because they are already used for other control functions inside the machine during recording and are properly timed to function as the control track signal.

RECORDING THE COMPOSITE VIDEO SIGNAL

Now that we have an understanding of the spinning video head, let's see how we use it to record the luminance (B & W) and chroma (color) signals. We have explained how the spinning head allows signals with frequencies up to 4 MHz to be recorded. *But, we still have a 6 dB per octave rolloff for lower* *frequencies.* This means that we are still limited to 9 octaves of frequencies that can be recorded. The lowest frequency that can then be recorded with the spinning head is 8 KHz. Complete video information can only be recorded if we include the 60 Hz sync pulses and the DC levels represented by a totally black picture. We need another system to get the full 18 octaves of frequencies needed for video recording.

All VCRs use an FM signal to record the luminance information and a separate recording system to record the color information. The first advantage of the FM system is a high immunity to noise. The signal level can fluctuate greatly (in amplitude) due to head wear, dirty playback heads, worn tapes, etc. These variables are eliminated because an *FM system does not depend on signal amplitude* above a certain minimum detectable level.

A second advantage to the use of the FM system is that a DC signal level simply represents a constant frequency. If you will recall our discussion of the output voltage of a video head, you will rememeber that the output voltage from the head is dependent on a *change* in the magnetic level. A fixed magnetic level (as recorded by a DC signal) will provide no output. The FM carrier, on the other hand, will provide an accurate output for any DC level.

The main reason that the FM system is used, however, is that it allows the 18 octaves of video information to be recorded. Let's take the Beta format as an example.

The FM modulation system uses the tips of the sync pulses as a reference. This reference produces the lowest modulation frequency of 3.5 MHz. The video information is used to modulate the FM carrier to a higher frequency. The upper limit for the Beta format is 4.8 MHz for the 100% white recording level. We now have defined the frequency response limits that we need. The FM carrier will only change 1.3MHz to record the entire video signal. *This represents a frequency change of less than 1 octave* which is well within the limits of a spinning recording head. We do not provide pre-emphasis to the higher frequency video information because an FM modulator has an increased noise factor with higher modulation frequencies. A simple FM demodulator is used to recover the luminance information during playback.

We find the need to add one more stage for a reliable playback signal to compensate for the small periods of time that the spinning video head loses contact with the tape oxide. These

Fig. 12 — An FM carrier allows the entire video spectrum to be recorded with less than 1 octave of bandwidth.

carrier "dropouts" would produce annoying flashes on the TV CRT because the FM carrier is missing for a short period of time. These dropouts are caused by small particles of dirt on the tape surface or damaged segments of tape. The dropouts are replaced with a circuit known as a "dropout compensator" (called the DOC) which simply inserts a small segment of the previous horizontal line during the time that the carrier is missing.

THE "COLOUR UNDER" SYSTEM

We could record the color information at the same time as the luminance information, but find that the phase relationships of the chroma signal are what determine what color is reproduced by the TV and are, therefore, very important.

Phase errors are caused by several mechanical factors. First, the speed of the video head is not absolutely constant. The head is controlled by a servo system which adjusts the speed slightly to make sure the head traces the same path on playback as when the tape was recorded. These slight variations would cause the colors to shift if the chroma was recorded directly with the video. This type of phase distortion is called "phase jitter" or "servo error".

Tape tension becomes a second cause of phase error. The tension of the tape is constantly changing as the amount of tape on the take-up and supply reels change. Tension differences are also present when a tape is played back in a different machine than was used for recording. As the tension changes, the tape stretches different amounts. If the tape stretches, for example, the horizontal sync pulses are slightly farther apart

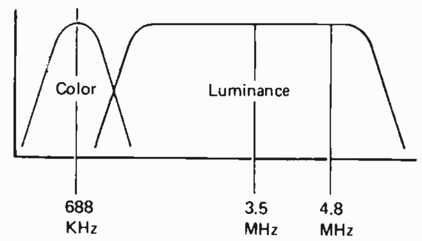


Fig. 13 — The frequency of the chroma information is converted to a lower frequency by hetrodyning.

and the color subcarrier frequency is slightly lower than desired. If the tension is decreased, the opposite happens. This type of color subcarrier frequency error is known as "timebase" error and can also cause changes in the color.

The effects of both phase-jitter and timebase error are minimized with the "color-under" recording system. This recording system converts the color signal to a frequency of about 700 KHz by simply mixing the 3.58 MHz chroma signal with an oscillator during recording. The chroma is then recorded directly (but at the lower frequency) along with the FM luminance signal we have already discussed. Now, you may think that this frequency is too low to record with the same head used for the FM signal. This is not true, however, because the FM signal acts as a bias signal to increase the efficiency of the recording head at this lower frequency.

During playback, the low-frequency color information is converted back to the NTSC color frequency (3.58 MHz) by again mixing it with an oscillator. During playback, however, this oscillator does not operate at a fixed frequency. Phase correction circuits are used to compensate for the slight frequency changes that may affect the color playback. The horizontal sync pulses (recovered from the FM signal) are used to indicate the amount of phase jitter or timebase error and are used to correct the chroma frequency. The result is a close duplicate of the original chroma information.

ELIMINATING COLOUR CROSSTALK

We discussed crosstalk in our explanation of the luminance recording system. The FM signal used to record our B & W detail is recorded at two different azimuth angles to allow "zero guard band" recording. *Azimuth recording only attenuates the crosstalk* *of the higher recorded frequencies.* Since the chroma information occupies a frequency range of 188 KHz through 1.19 MHz (500 KHz above and below 688 KHz), we do not get enough cancellation of adjacent tracks on playback. We need additional crosstalk rejection to provide a noise-free color picture.

Both the Beta and the VHS formats use a system of phase shifts to prevent color crosstalk. The phase of each line of color information is changed compared to the previous line. The Beta format simply inverts the phase of every other horizontal line when one (of the two) video heads is recording a field of information. The other head records the chroma information without this line-by-line inversion.

During playback, the phase correction circuits re-invert the line-by-line chroma information for every other field to restore the original phase relationships. A "comb filter" is used to cancel out any crosstalk. We will discuss this filter in the next section.

The VHS system uses a similar system with one modification. Rather than inverting the phase of every other line, the phase of each line is advanced by 90° in one field and delayed by 90° in the other. This means that we have a total of 4 different phase angles (as compared to 2 for the Beta format) to make phase cancellation possible. Again, the proper phase angles are restored during playback and a comb filter is used for cancellation of the crosstalk signal.

THE COMB FILTER

The comb filter is a device that can separate two signals that have a fixed phase relationship. The comb filter will provide two outputs, one that passes only those signals that are *in phase* with each other, and the other that passes only those signals that are *out of phase* with each other. This fact leads to two important applications in a video tape system. The first application allows the rejection of color crosstalk using the phase processing techniques we just described. The second allows the separation of chroma from the luminance information as it comes from the TV station with better effectiveness than the bandpass amplifier found in a color TV receiver. Both applications depend on the fact that the phase of the chroma information changes each horizontal line. Let's see how this works.

The chroma subcarrier of the NTSC signal is inverted every horizontal line. This means that the phase of one line is shifted 180° from the phase of the previous (and following) line. This line-by-line phase inversion results in "frequency interleaving". Frequency interleaving simply means that the frequency of the color subcarrier (and all of its harmonics) falls between the harmonics of the luminance information. This frequency interleaving is determined by the color subcarrier frequency (3.579545 MHz) and the horizontal sweep frequency (15,734.26 Hz). Really, all this means is that the two frequency are related to each other in such a way that the required phase-inversion take splace when the two signals are phase-locked together as they are at the TV station. With this phase inversion in mind, let's first look at how the comb filter is used to eliminate color crosstalk.

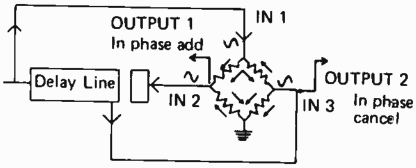


Fig. 14 — The comb filter separates phase-related signals by means of phase addition and cancellation. Output 1 passes only signals that are in phase in 2 adjacent lines and output 2 passes those that have a 180° phase shift.

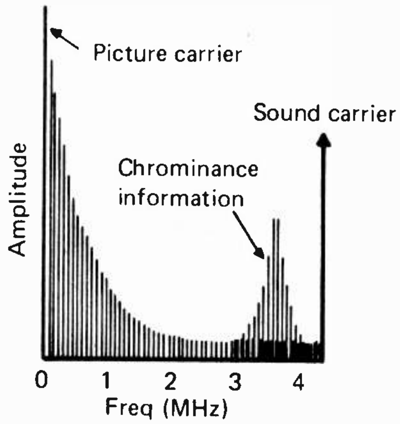


Fig. 15 — The line-by-line phase inversion of the chroma signal causes frequency interleaving which allows the comb filter to be used to separate the chroma information.

The phase shifting that is produced by the VCR during recording and playback in both the Beta and VHS format results in *crosstalk information that is a continuous phase for every line.* The two formats produce this continuous phase crosstalk information with slightly different signal processing as explained previously, but the results are basically the same. Since the unwanted crosstalk information has a continuous phase, and the desired chroma signal is phase-inverted line-by-line, the comb filter will separate the signal from the crosstalk.

The comb filter simply consists of a delay line (designed to delay the signal by one horizontal line) and a resistor bridge. The bridge has three input points and two output points. The first input is for the non-delayed signal, and the other two for the delayed signal. One of the output terminals will provide a signal only if the delayed and non-delayed signal are both the same phase, and the other will provide an output if the two signals are 180° out of phase. This second output provides the desired chroma signal without the crosstalk. The reason that the two signals are separated is that *the delayed signal is taking a different path* around the resistive bridge than the non-delayed signal as shown in Fig. 14. The left-hand side of the resistor bridge adds the two signals if they are the same phase. The signals are canceled if they are out-of-phase. The right-hand side of the bridge has the delayed signal flowing the opposite direction through the resistors and is therefore inverted 180°. Now, the signals will add only when they are of opposite polarities.

The second application of the comb filter is used by Sony in their two-speed machines to separate the luminance from the chroma information during recording. Previous video tape recorders used a low-pass filter to separate the luminance signal which was then used to produce the FM signal that is recorded. The chroma signal was separated with a bandpass filter similar to that used in a TV receiver. This system produced satisfactory results in the Beta format decks that only had the standard play recording speed, but the low-pass filter restricted the high-frequency portion of the video signal. When the two-speed machine was introduced, Sony added a separate video equalization circuit for the 1-hour and 2-hour recording speeds. Since the high video frequencies suffer more from a poor signal-to-noise ratio than the lower frequencies, it is desirable to have more high frequency information at the output of the stages that separate the luminance and chroma information. The comb filter is once again used to obtain the higher video frequencies that were lost in the low-pass filter.

This application takes advantage of the interleaving that is part of the NTSC color signal to allow signal separation by phase detection. The low-pass filter used in earlier 1-hour machines restrict the video frequency response in the areas where the luminance and chroma information share the same frequency band, and thus restrict the highest video frequencies to about 3 MHz. The luminance information of a composite color signal is not phase-inverted every other line, but the chroma information is. This means that the comb filter's in-phase output node provides the high frequency luminance information, and the out-of-phase output provides the chroma information. The comb filter used for this separating is the same one that is used for crosstalk rejection during playback. Switching of the input and output connections results in the dual usage of the same filter.

The use of comb filters for both crosstalk rejection and signal separation brings up a very important need in the signals used for VCR service. *The color signals produced by most color-bar generators do not phase-lock the color information to the horizontal sync pulses like a TV station does.* This means that the phase relationships from one line to the next do not necessarily contain a line-by-line phase inversion. Keep this in mind when thinking about what is needed in a signal source for VTR servicing.

This article was reprinted from 'Sencore News' written by Greg Carey, Chief Field Engineer. For more information on servicing video, and on Sencore's line of equipment, contact Sencore's Canadian representatives Superior Electronics, 1330 Trans Canada Hwy. S., Montreal, Quebec H9P 1H8.

Getting Into Video

Video recording doesn't have to be as expensive as you think! This is part one of a series in which Steve Rimmer tells how to get on TV without putting footprints all over the cabinet.

This is the first in a series of articles by Steve Rimmer on knowing about video recording, and how to get into this exciting hobby if you're short on dollars but long on practical common sense. In the series Steve will be covering first the basics of the various machines which may be encountered. In future parts Steve tells how to get a machine, particular models available, talks about modifications and accessories, and how to get and keep your machine alive.

THE THREE INCH high man on your screen boasts "you're watching television, but I'm watching "Selectavision" ", and gets ina plug for one of a number of the latest generation of relatively low-priced video tape recorders, perhaps the first to successfully make popular the notion of the home VTR. The new, compact machines have sprung up like dandelions in the past few years, with names like "Betamax", Selectavision". "VHS", "NEC" and a constantly expanding galaxie of others, all offering the convenience of re-arranging the television broadcasting schedule to suit the viewer's timetable. However, in reality, the home VTR offers considerably more; the prospect of compiling a library of favorite movies or programs for later enjoyment, rental of videotaped motion pictures still too fresh out of the can to be relegated to the networks (a service already in existance in some areas of the United States), a teaching tool both for formal students and for those involved in "learn-at-home" programs, and as a creative medium, offering the artist an opportunity to use the phosphor screen as a canvas. All this technological expansiveness has but a single drawback; the thousand dollar-plus price tag attached to these machines puts them out of the financial reach of all but the most fanatic devotees of the groove tube.

However, there is a way around that seemingly insurmountable hassle. Read on.

HEADSPINNING

Video, the electronic signal which defines the shapes on the screen, is simply a voltage which varies in amplitude with respect to time, just like a more familiar audio signal. The distinction between the two lies predominately in the bandwidth occupied by the former; a sprawling four and a half MHz, as opposed to about fifteen kHz for hi-fi sound. Therefore, recording picture information is, in principle, at least, no different than putting ones voice on a cassette. All that needs to be done is to increase the upper frequency limit of the recording medium.

The high frequency response of magnetic tape is directly proportional to the speed of the recording (or "writing") head with respect to the metallic surface of the tape. Keep this wordy definition in mind, for it does not necessarily mean the same as simply "high frequency response is improved by speeding up the tape". However, to illustrate the point, let us consider doing just that: taking a hypothetical "audio" recorder and increasing its tape speed until it is suitable for recording a video signal. What we have just developed is something called "longitudinal scan".

Longitudinal scan VTRs were the first attempts to produce practical video recording equipment. They worked in a manner similar to audio recorders. With the exceptions that the record heads had much narrower gaps, the tape speeds approached one hundred inches per second, and the video was layed down on the tape in multiple parallel tracks with an arrangement which switched tracks and changed the direction of tape travel whenever one or the other of the reels was full, thus extending the playing time past the five or six minutes it took to zip through a reel of tape at these breakneck speeds. As might be expected, there were a few problems with this system.

The primary difficulty was the bandwidth. Whereas a standard 525 line television picture can be squeezed into as little as a 1MHz, it winds up looking the worse for wear. However, to coax much more space out of a long scan VTR would have meant increasing the tape speed beyond the point of practicality. The demand of the television broadcasting industry was for 4.5 MHz machines, which were quite out of the question.

The second drawback of this system lay in maintaining accurate tape speeds and vertical tape positioning at these velocities. If either of these two factors was allowed to vary by even a small degree, the resulting video signal, on playback, would waver in amplitude and/or frequency, be distorted or vanish completely in extreme circumstances. However, at one hundred inches per second, the forces placed upon the tape guides were considerably greater than those encountered at the speeds used to record audio, making them much more prone to misalignment, and the machines much more susceptible to malfunctions.

Lastly, at the speeds required in long scan video recording, tape life was rather brief. Very often it ended abruptly in a shower of brown confetti due to a worn brake or dirty relay which failed to start or stop something at precisely the right moment.

Longitudinal scan VTRs were abandoned early in the game and have seldom been heard from since, except briefly, a year or so ago, when the German-based firm BASF began to tinker with one as an entry into the blossoming home video market. It never did get into production.

AMPEX '56

In 1956, Ampex introduced the first practical video tape recorder, the VR-1000. It received an "Emmy" as an outstanding achievement in television. It used two inch wide tape and recorded by a technique called "Quadruplex". This entailed the use of four tape heads mounted on a drum which revolved with its axis parallel to the tape. The heads, then, described diagonal tracks across the tape as it moved past the spinning drum. While the speed of the drum was quite high, the tape could be allowed to procede at quite a reasonable pace, about the same as that of a high fidelity audio recorder. The result was a high tape to head speed, with the actual tape speed through the machine kept low.

Quadruplex became, and still is, the standard of the broadcast industry.

Broadcast machines, however, suffer from two major drawbacks: They have all the compactness and portability of a mountain, and you pay dearly for every inch.

In the early sixties, Ampex and a few other firms came up with a third type of VTR, the helical scan machine. It did not have the bandwidth of the Quadruplex system, so it did not have much of a future in the broadcasting world, but its smaller size, relative portability and drastically reduced price tag quickly endeared it to schools, industry and other concerns which needed the

capabilities of a television system, but could not justify the expense of a full studio setup. It employed a single head which spun horizontally in a large drum. The axis of the drum, then, was vertical. The drum, itself, did not move, but rather had a narrow slit all the way around its circumference through which the pole pieces of the head protruded. The recording machine was made with one reel slightly higher than the other and the tape was brought around the drum in a broad spiral or "helix" (hence the name) such that, once again, the rapidly spinning head described repeating diagonal tracks across the tape as it moved past. The actual tape speed on a helical scan VTR was typically in the area of ten inches per second, but the effective speed of the head with respect to the tape could be as high as one thousand inches per second, resulting in bandwidths approaching four MHz.

The extreme popularity that the helical scan VTRs soon found, prompted a number of improvements in their design. Tape width shrank from one inch to three quarter inch to half inch and even to quarter inch audio tape on a few of the new Akai portable VTRs. Because this type of recording did not require the massive machinery entailed by the Quadruplex system, it became possible to build entire "mini TV studios" so small as to be as portable as a movie camera and operable by a single camera person. In recent years, the two reels were enclosed in a cassette and, now, the cassette plugged into the home VTR.

They *still* cost a furtune, though.

ONE INCH TAPE: FOR EXPERIMENTERS

The immediate advantages of one inch tape may escape the engineer, because the present state of the arts has permitted the use of narrower guages yielding comparable, if not better, results for several years. However, machines using one inch wide video tape were extremely popular for over a decade after their initial introduction and are only now being replaced by the newer cassette models. Literally millions were manufactured, millions of VTRs that are now looking for new homes. The subtle advantage of one inch tape, then, at least for the electronics experimenter who wants the capabilities of a video tape recorder but cannot afford one of the newer ones, is the price. Often available for as little as fifty dollars, these obsolete machines offer a very economical introduction to the world of television recording.

Besides which, at about ten times the size of the average stereo recorder, they make brilliant paperweights.

Video groups are invited to write to Steve, (care of ETI) and we will publicize their existence and activities to help put more interested hobbyists in contact. In addition, any individuals with used video equipment they wish to get rid of are welcome and encouraged to advertise it in our Marketplace section. See also classified ads in future issues.

Next month: How to capture one.

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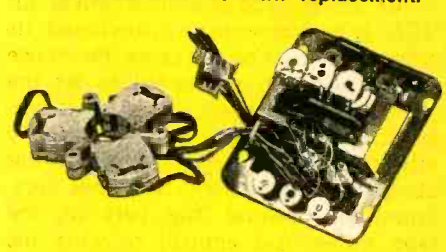

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Service News

Video's going to be big; learn to service it now and stay ahead.

ON SEPTEMBER 27, 1978 the Metropolitan Toronto Television Service Association, a chapter of the Ontario Television Electronics Association, held their first general meeting of the new season at the Dufferin/401 Holiday Inn. This meeting was open to anyone in the trade, and if only because of the burgeoning interest in digital electronics the sponsors had every right to expect a large turn-out. Unfortunately in spite of a last-minute telephone campaign by members of the executive the audience was somewhat smaller than expected, 60-70 technicians braving the early evening showers to attend.

The guest speakers in order of appearance were: Mr. George Hess, Zenith Radio Corp; Mr. Scotchmer, Panasonic; Mr. Ruben Claros, Sony of Canada Ltd.,; Mr. William Dykstra, George Brown Collegiate.

Mr. Hess talked at some length about VCR (video cassette recorder) and its expected impact on the domestic service field. He then proceeded to let the VCR speak for itself, using a pre-programmed video tape. It was extremely informative but the time allotted was obviously insufficient for this presentation, however the part of the tape shown was enough to whet the interest of the audience.

The point of Mr. Scotchmer's address was to explain the fast inroads that digital logic circuitry has already made into the domestic service field, and to point out that this is only the beginning, and in his opinion anyone wishing to remain in the electronics service field must immediately begin to upgrade his technical knowledge.

Mr. Claros, the regional service manager of Sony, continued in the same vein, stressing the importance of constant upgrading merely to remain abreast of technical development in the electronics field. He spoke at some length about a pulse code audio system, a prototype of which the Sony Company kindly supplied for demonstration.

During the intermission various pieces of equipment were demonstrated by the speakers, including the VCRs, a breadboard mock-up of the control system for an electronic oven, a Panasonic VCR, and of course the Sony pulse code modulation audio unit.

Following the intermission Mr. William Dykstra gave an extremely interesting talk on the absolute necessity of further education in the field of digital electronics, and pointed out that the practising technician must be prepared to give some of his time to self-improvement, and asked for a out that the practising technician must be prepared to give some of his time to self-improvement, and asked for a show of hands to indicate how many of the technicians present would be prepared to attend a course on digital electronics at his collegiate in the immediate future. The show of hands was overwhelmingly in favour and Mr. Dykstra asked if a number of those present would be prepared to attend at George Brown College on the following Tuesday to arrange the mechanics of the course. I am happy to report that some 15 or so people met and on October 24th the first class started with a full enrolment. This is a 20 week course, 3 hours a week, a total of 60 hours. With the enthusiasm shown, a second course will be started on January 11, 1979, and will then run parallel to the first.

Subsequent conversations with Mr. Dykstra and some of the other speakers left no doubt in my mind that a great deal was accomplished. In spite of all the speakers stressing the importance of learning as much as possible about digital electronics, I could not help wondering as to how many of those present would be prepared to give more than mere lip service to Mr. Dykstra's proposals regarding a 20-week course. I was surprised and delighted at the positive response, and the executives of the Association must take much pride in the end result. The only criticism, and that a small one, that I have about the meeting, is that there was not quite enough time to examine the equipment on display. In spite of this the MTTSA are to be congratulated on their foresightedness in planning the agenda, and of course a very special vote of thanks should go to the speakers who gave so freely of their own time.

Mr. David Van Ihinger, the Vice-President of the Association, blamed the smaller than anticipated turn-out on insufficient publicity, and with that in mind I would be most grateful for information on any future seminars of interest to the service technician. I will endeavour to publish it. Please bear in mind I will need approximately 8 weeks notice.

All the best.

R.C.

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QRM QRM QRM

Bill Johnson VE3APZ sticks up for Amateur Radio

As we approach 1979, and the World Administrative Radio Conference that it brings, amateurs around the world are thinking very hard about what they are going to suggest to their respective governments as being their frequency requirements for the next twenty years.

Certainly, the pressure on the shortwave bands may be said by some to have been partly alleviated by the transfer of many trans-oceanic point-to-point circuits to a rapidly-expanding system of orbiting satellites and the increasing use of VHF frequencies by marine and aeronautical stations, but there are growing pressures being placed on our frequencies from many areas. One of these areas is the broadcasting service. Anybody who has tried to listen to the amateurs on the 40 metre band in the last decade has seen it slowly become a wasteland, almost totally useless at times because of the clutter of broadcasting stations vying for a piece of the action.

40 LOST?

It is feared in many quarters that the 40 metre band has been forever lost by the amateurs. All that is required are changes to the International Master Frequency list, which will in all probability be totally unrecognisable after WARC 79 to those who know it now. The reason is quite simple — it's a well-founded principle known as 'squatter's rights'. The broadcast stations have been encroaching on our frequencies for years — so slowly as to go almost unnoticed and unchallenged. When all frequencies come up for review, the broadcasters will merely point out that the frequencies are actually theirs because they have been using them unchallenged for so many years. If they had all decided to start operations on a previously uncluttered 40 metre band one morning, the resultant change would have caused every amateur in the world to go running to his government complaining. But the change was gradual. Slowly, more and more broadcasters started up and the inconvenience increased only slightly with each one. Most people just sighed and said 'that's life'.

The ARRL has an ongoing program called the 'intruder watch'. Very few amateurs even know what it is.ARRL will supply any interested amateur, free of charge, with triplicate forms with which he can make standardised reports on any intrusion into the amateur bands that he hears. Even fewer hams fill them in.

10 TOO??

If the case of the broadcasters isn't enough to make the adrenalin start to flow, this one should: have you listened to the 10 metre band lately? (That's 28 MHz Fred) You should find a little CW, some SSB, and perhaps a little AM from amateurs that have converted a retired GRS radio. These are OK — you'll hear proper callsigns being sent by these. Take a closer look at the others — the ones that are using tactical callsigns. At a glance, they would appear to be military stations using callsigns that may change by the day or the hour for some obscure strategic purpose. Do military stations use that kind of sloppy procedure, that foul language, and that stupid 10-code? How come they are there? Don't they belong on the well-organised 40 channels of bedlam just a little way down? The answer, of course, is that they do, and they obviously know it. That's why they don't give their callsigns whenever they go 'above the 40'. If you listen on any good communications receiver in a large metropolitan area such as Toronto, you will find them scattered around well above the highest channel and some even above 28 MHz — into the 10 metre amateur band. If the amateurs of Canada don't do something about this, we will gradually lose our assignment above 28 MHz as the number of GRS operators increases — just as we have all but lost 40 metres. Every amateur should be perseverant in searching them out, and if he can't be bothered to write to anybody about it, them he could at least make a simple phone call to the local Communications Canada office. Like any government department, CC attacks the areas that concern the most people. That way, they please a lot of the people, most of the time, without being heroic and hiring more men or making the existing ones work a 20-hr day. So, if next Monday the CC staff come into their office and see their switchboard lit up with calls, and all those calls are from irate amateurs who want to complain about the intruders in the ten metre amateur band, then they are not about to let it go by without a thorough investigation.

79

The next year is going to be a very trying one for amateurs around the world. People from all walks of life are going to be saying 'what on earth do we need the radio amateurs for'. The answer, without getting into the honourable history of amateur radio, without mentioning the thousands of occasions where amateur radio has been the only communications for isolated people when disaster has struck, is a plain and simple one. The airwaves are a natural resource. Just as the forests of Canada are, they are there for the occupants of this planet to use and enjoy. All around the world, governments are setting aside huge areas of land, and passing laws that guarantee its preservation for future generations to use and enjoy. Well so it is with the spectrum. Amateur radio is a tremendous hobby like no other in the world, bringing people of different nations together like no other. Just as parks must be preserved for people to go to and get away from the city, parts of the spectrum must be set aside for the man on the street, the student, the experimenter. Here they all meet and exchange ideas, conduct experiments, and generally help to make the future better.

For those who want to help preserve what little spectrum space we have, write to the Amateur Radio Relay League, Main St., Newington, Conn. USA 06111, and tell them that you want to join the intruder watch.

Preparation at Home

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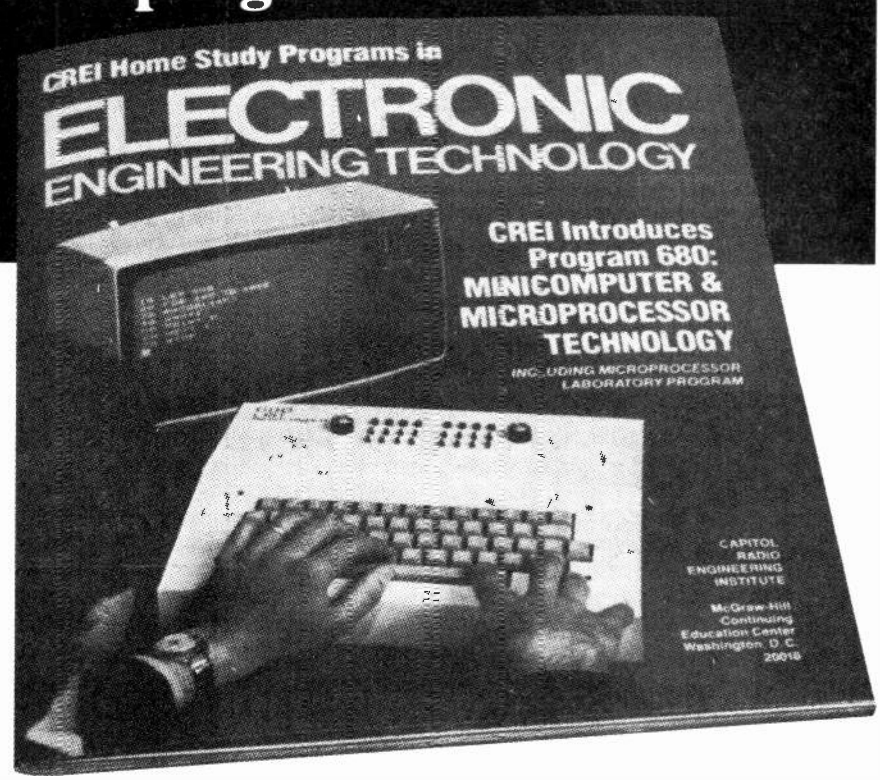

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Shortwave World

John Garner on what to connect to the back of your receiver.

WHEN A RADIO signal reaches the target area, it then comes completely under the control of the Shortwave Listener. The quality of signal picked up will depend completely on the type of antenna that has been erected, because it should be remembered, that the antenna will make the difference as to whether it is a good or bad signal which is being fed to the receiver. It should always be kept in mind that, good results can be obtained from an inexpensive receiver by erecting a good antenna, and conversely, a good expensive receiver is not much use without an antenna. Or in other words, the receiver is only as good as the antenna to which it is attached.

NOISE

In the target area the enemy of any incoming signal is noise. It is noise that tends to deteriorate the listening quality of the radio signal. This noise comes from many sources, but there are various ways of combating it. The first type of noise is receiver noise. This depends on the type of receiver being used, that is, its circuit and the components used in that circuit. Therefore, an SWL when buying a receiver should obtain one that gives him a high signal to noise ratio. The second type of noise is radio noise. This noise is made up from man-made noise (QRM, in Ham jargon) , and natural noise (QRN), which in itself is made up from atmospheric and extra-terrestrial sources. The man-made noise is generated from sources such as electrical appliances and apparatus like electric drills, electric saws, car ignition systems, etc. The natural noise is composed of signals generated by electrical storms or radio signals coming in from cosmic sources. These two types of noises are more difficult to overcome. However, by the use of a high-gain, directional type of antenna, it is possible to obtain a stronger radio signal, thereby giving a better signal to noise ratio for feeding into the receiver.

If you are no longer satisfied with the performance of your receiver, then start by improving your antenna conditions. A good antenna is the best rf amplifier. Modern receivers, both stationary and portable, are equipped with ferrite and/or telescopic antennae. These usually permit reception of strong signals, ferrite antennae even making it possible to amplify the desired signal, in a manner of speaking, and to suppress signals coming from other directions. In no case can the performance of these built-in aerials be compared to that of good external ones. Shortwave signals are frequently very weak and subject to interference and propagational disturbances. If the signal strength is so low that a telescopic antenna is incapable of raising it appreciably above the noise, then a length of 5 metres of insulated wire will, in most cases, bring about a marked improvement. Fitted with a plug, it is then plugged into the antenna jack of the receiver. Indoors, the antenna should be suspended near the window. If the receiver is located inside a concrete building, then the wire must be suspended outside its walls because the steel reinforcing bars inside the concrete walls will screen off the radio waves.

GROUND

A good ground helps considerably to improve receiving conditions. The ground jack is usually to be found near the antenna jack. Fit a plug to one end and connect the other end to your cold water pipe after you have cleaned the corroded surface with a knife or emery paper. Remember, the water pipe must not be interrupted by plastic parts, which is frequently the case at watermeter connections. If so, bring a wire up from the ground side of the meter. (The plastic part is usually there to protect against excessive corrosion where pipes of two different metals would otherwise connect, so it's best not to simply wire them together.)

You may also build a good ground yourself by burying a metal plate of about I square metre in size or driving metallic rods, about I to 1.5 metres long into the soil. The ground wire is soldered either to the rod or to the plate and the other end is connected to the ground plug on your receiver.

These two procedures, using a wire as an antenna and a good ground, will considerably enhance the signal field strength on the whole shortwave range. A further improvement can be attained with an outdoor antenna.

SUMMARY

Remember the following points:

I. The higher an antenna is suspended — the better its performance.

2. Use only uninterrupted lengths of copper wire.

3. Suspend the antenna wire over ceramic insulators strung to tensile strong and weather-proof fishing line.

4. Lead the antenna-feeder from the insulator closest to your window through an insulating tube (ceramic, glass or plastic tube) through the window frame.

5. Do not disregard the lightning protection regulations of your area. Lightning protection is necessary and not expensive. Ask your local radio

dealer or other skilled personnel at a radio and TV repair shop. Do not take a chance of damaging your receiver or setting your home on fire by neglecting this important device.
6. Use a good ground.
7. The longer the antenna wire the greater the signal enhancement but also interference from undesired stations.

An improvement of antenna performance can be achieved with a tuned or resonant antenna. The tuned antenna has a certain horizontal pattern of radiation (or reception) and is particularly sensitive to signals from certain directions. Signals from other directions are suppressed. The most simple forms of tuned antennae are the longwire, the dipole and the windom antenna. An antenna tuner is also a useful accessory for improving reception. I will discuss some of the basic antenna designs and tuners in the next issue or two.

Before dipping into the mailbag, I would like to take this opportunity to wish all of our readers a very Merry Christmas. I hope jolly old St. Nick will be good to you and perhaps bring you that new receiver you have been wishing for.

SHORTWAVE MAILBAG

Steve Byrns of Thetford Mines, Quebec writes: 'I'm building a four element beam for my SWL receiver. If my elements are ¼ wavelength with .2 wave length spacing how many dB gain should I expect?'

First of all, I wouldn't recommend a beam antenna for shortwave listening since beams are basically only good on one frequency and SWLs want to listen to all bands. A beam would be fine if you're only interested in one band. I would expect a gain on Steve's beam of about 7-9 dB.

I just received a 50 plus page catalog from WSI Sales Co., 18 Sheldon Ave. N., Kitchener, Ont, N2H 3M2. This catalog covers SWL equipment as well as Ham radios and accessories. Readers can obtain this catalog free from the above address.

Send your questions about Shortwave radio to the mailbag. I will try to answer them. The address is John F. Garner, P.O. Box 142, Thunder Bay, Ont. P7C 4V5.

Thanks to Radio Canada International and Radio Berlin International for their information on antennae, much of which was used in this month's article.

Until next month, 73 and good listening.

Calculator NIM

Entertaining brain-teaser for programmable calculators.

THIS MONTH we have a calculator version of the well known number strategy game NIM. In the original version two players would start with a pile of sticks and they would take turns removing sticks from the pile, the rules allowing only 1, 2, or 3 sticks to be removed at each turn. The player to pick up the last stick loses the game. This game has been adapted for the Commodore PR100 programmable calculator.

After loading the program switch to the run mode and press GO TO 00. No data need be entered into the memory registers; however memories 0, 1 and 2 are used by the program. Enter a random integer into the display as a seed, preferrably between 4 and 8 digits in length. Press R/S to start the program running. The calculator will generate and display a 'random' integer between 15 and 25 inclusive, to be used as the starting number for the game. Now it's your turn to make a move. Suppose the random integer the calculator is displaying is 20. You are allowed to enter a number that is one, two or three less than the displayed number. So you can enter 19, 18 or 17; suppose you enter 18 into the display. Press R/S and the calculator will make its move by subtracting one, two or three from 18. It displays its result, say 17; and then it's your turn again. You and the calculator take turns reducing the displayed number by 1, 2, or 3 until either you or the calculator is left with 1. If you are left with 1 and it is your turn you have lost the game. Here is an example to show how a typical game might end: The calculator displays 8. You enter 6 and press R/S. The calculator responds with 5. You enter 2 and press R/S. The calculator responds with 1 and you have lost.

The game requires considerable insight and some luck to win. Even an accomplished player cannot win every game but he should be able to win about 75% of the time. A novice will lose nearly every time at first because the calculator is programmed to win if possible. After several games a beginner should begin to see patterns developing in the game. Keep track of your responses and the calculator's responses and you should be able to figure out how the calculator is outwitting you.

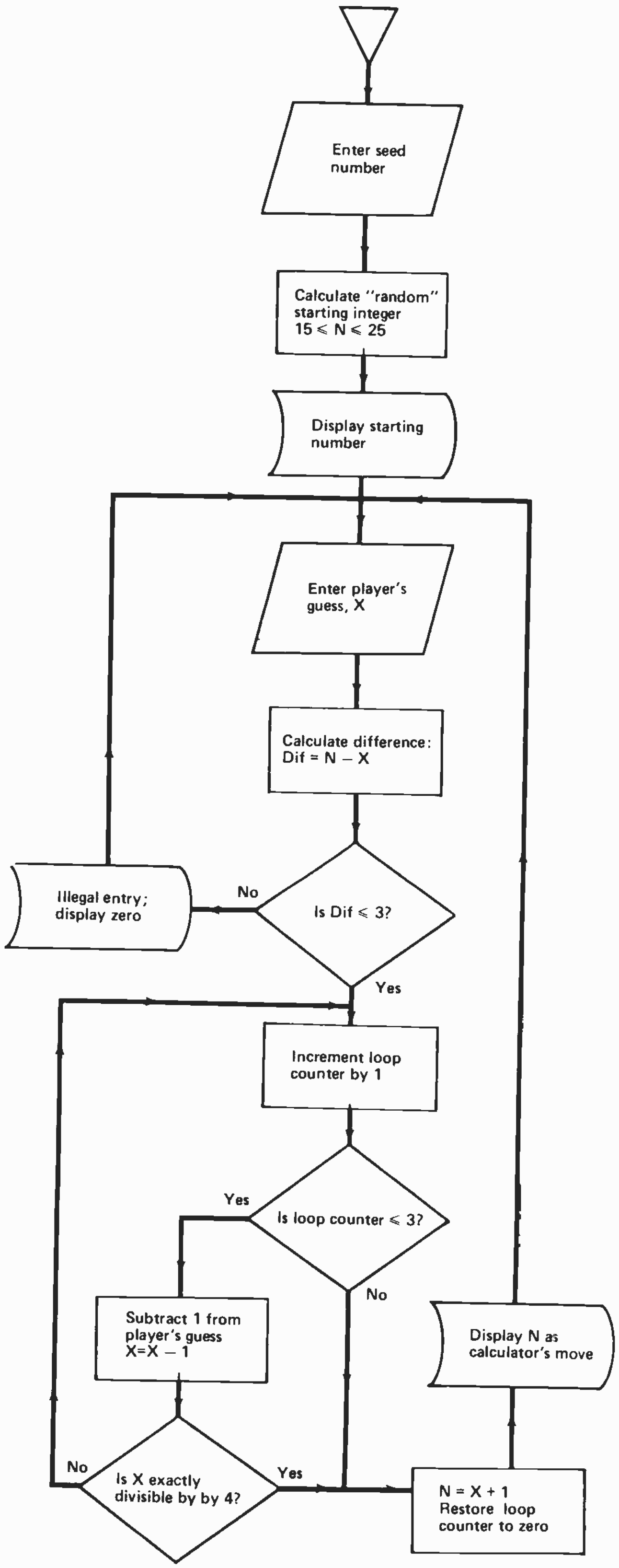
To start a new game press GO TO 00 and enter a new seed integer as before.

The program will detect certain illegal player entries to prevent you from cheating! For example if the calculator is displaying 15 you enter 11 as your response it will refuse to play your game and will simply display a zero until you make a legal response of 14, 13 or 12.

PROGRAM

Line Num.	Key Codes	Key push
00	22	sin
	74	x
	72	5
	84	+
	82	2
	91	0
	95	=
	21	F
	52	INT
	51	M
10	82	2
	13	R/S
	51	M
	91	0
	85	—
	52	MR
	82	2
	55	x – y
	85	—
	71	4
20	95	=
	15	SKIP
	14	GOTO
	73	6
	61	7
	81	1
	21	F
	84	M+
	81	1
	52	MR
30	81	1
	85	—
	71	4
	95	=
	15	SKIP
	14	GOTO
	72	5
	63	9
	81	1
	21	F
40	85	M–
	91	0
	52	MR
	91	0
	85	—
	81	1
	75	÷
	71	4
	94	+/–
	95	=
50	21	F
	51	FRAC
	15	SKIP
	14	GOTO
	72	5
	63	9
	14	GOTO
	82	2
	72	5
	91	0
60	51	M
	81	1
	52	MR
	91	0
	14	GOTO
	91	0
	63	9
	91	0
	14	GOTO
	81	1
70	81	1

FLOW CHART


Enter seed number
Calculate "random" starting integer 15 ≤ N ≤ 25
Display starting number
Enter player's guess, X
Calculate difference: Dif = N − X
Is Dif ≤ 3?
No
Illegal entry; display zero
Yes
Increment loop counter by 1
Is loop counter ≤ 3?
Yes
Subtract 1 from player's guess X=X − 1
No
Is X exactly divisible by by 4?
No
Yes
N = X + 1 Restore loop counter to zero
Display N as calculator's move

Tech Tips

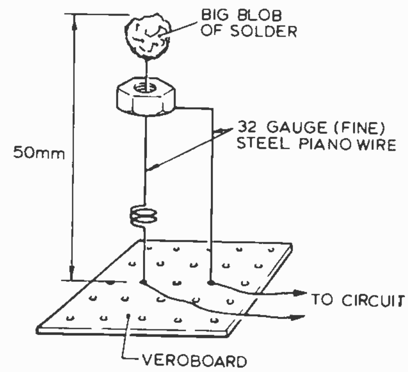
Motorcycle Burglar Alarm

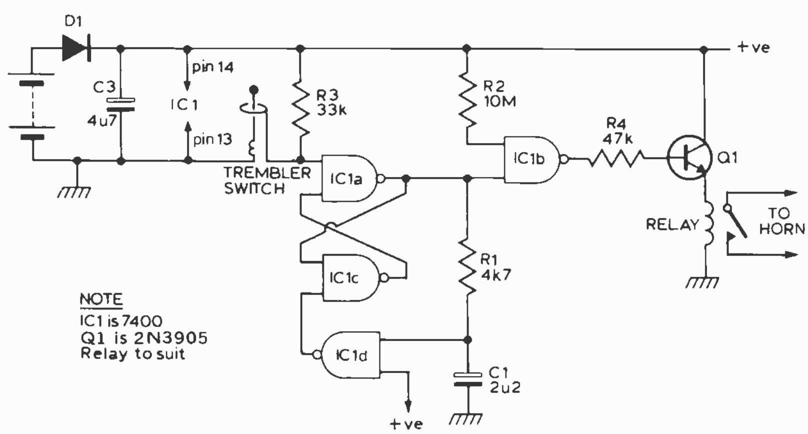
N. Hone

Currently available motorcycle alarms are either very expensive or ineffective. This circuit provides protection against theft, or tampering with the machine.

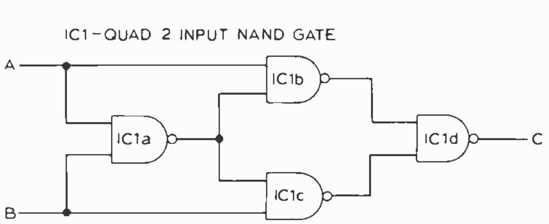
The alarm, a cross coupled latch is activated by a trembler switch (whose construction is shown), which will sound the alarm for 5 seconds before resetting. As the device is very sensitive, there is a 10 second delay (set by R2, C2) which gives enough time for the trembler switch to stop oscillating, and the keys to be removed. D1 and C3 prevent the supply to the circuit dropping when horn draws a high current and pulls the battery voltage down.

Tech Tips is an ideas forum and is not aimed at the beginner. ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible, and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI Tech Tips, Unit 6, 25 Overlea Blvd., Toronto, Ontario, M4H 1B1



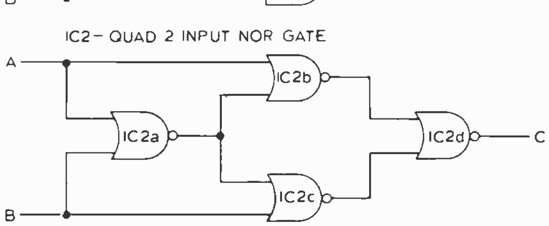


Exclusive OR and NOR gates D. S. Smith



TRUTH TABLE

A	B	C
0	0	0
0	1	1
1	0	1
1	1	0



TRUTH TABLE

A	B	C
0	0	1
0	1	0
1	0	0
1	1	1

When constructing logic circuits which need either an exclusive OR gate or exclusive NOR gate, and one is not available, the following arrangement of NAND or NOR gates can produce the required results. The circuits can be constructed using standard TTL or CMOS gates.

THE

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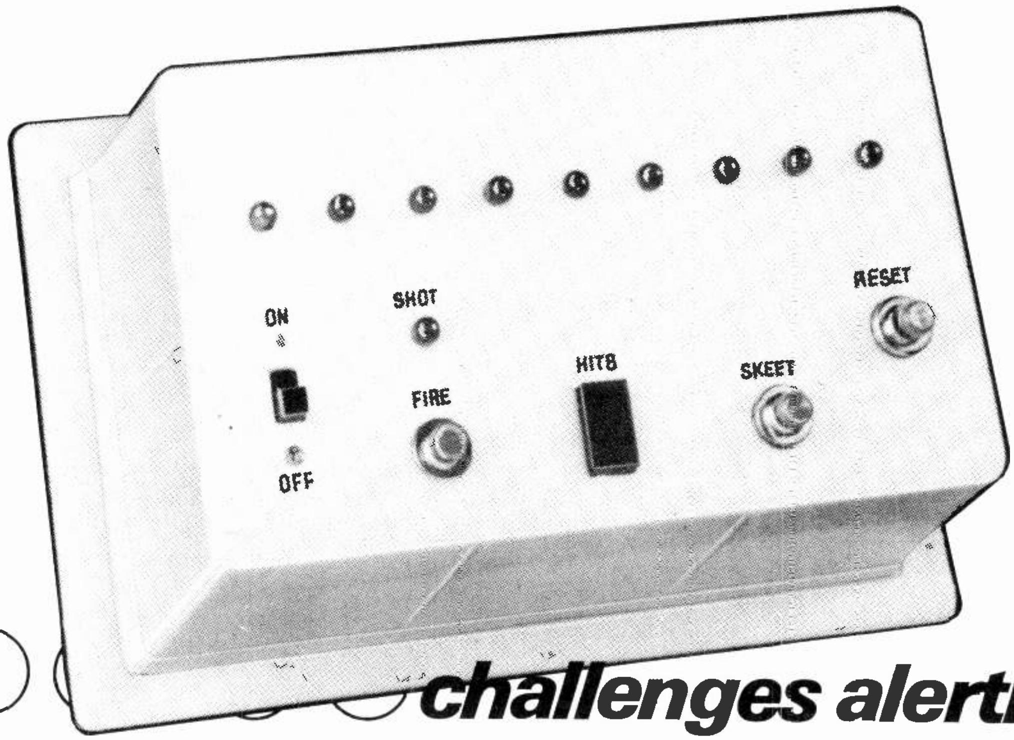

challenges alertness

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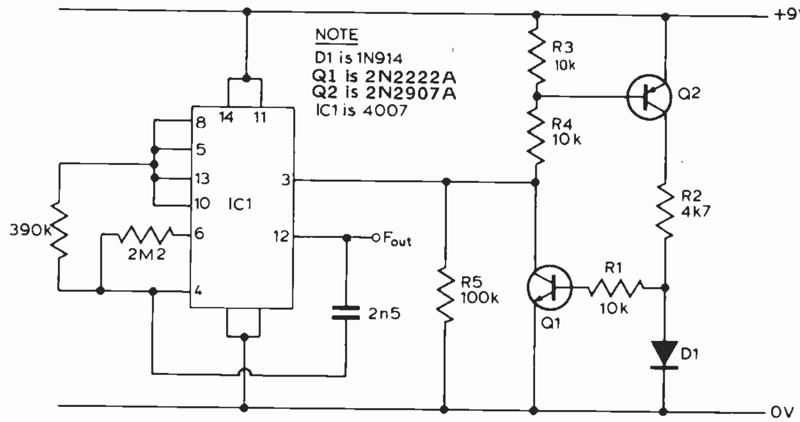


Temperature to Frequency Convertor

P. Reynolds

This circuit uses the fact that when fed from a constant current source, the forward voltage of a silicon diode varies with temperature, in a reasonably linear way.

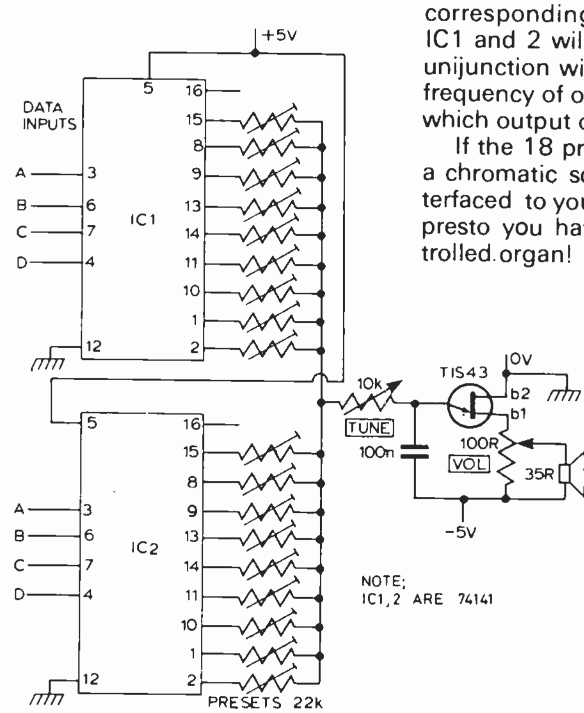
Diode D1, and resistor R2 form a potential divider, fed from the constant current source. As the temperature rises the forward voltage of D1 falls tending to turn Q1 off. The output voltage from Q1 will thus rise, and this is used as the control voltage for the CMOS VCO. With the values shown, the device gave an increase of just under 3HzC^{-1} (between 0°C and 60°C) giving a frequency of 470Hz at 0°C.

BCD Tone Generator

P. Bailey

When one of the binary codes in the table is set up on the data inputs, a corresponding preset connected to IC1 and 2 will be grounded, and the unijunction will start to oscillate. The frequency of oscillation depending on which output of the ICs is grounded.

If the 18 presets are tuned to form a chromatic scale and the inputs interfaced to your MPU data bus — hey presto you have a simple MPU controlled organ!



NOTE No.	CODE (BINARY) HGFE DCBA
1	0000 0001
2	0000 0010
3	0000 0011
4	0000 0100
5	0000 0101
6	0000 0110
7	0000 0111
8	0000 1000
9	0000 1001
10	0001 0000
11	0010 0000
12	0011 0000
13	0100 0000
14	0101 0000
15	0110 0000
16	0111 0000
17	1000 0000
18	1001 0000

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Simple Car Alarm
Simple Lock

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Guitar Fuzz
Fuzz Box
Waa Waa
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Universal Meter
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Fast Half Wave
Simple Chopper
Noise Rejecting SCR Trigger
Phase Shifter

SIGNAL GENERATORS

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Variable Duty cycle
Fast Edge
FET
Improved Multivibrator
Variable Duty cycle
Stable R C
Cheap (CMOS)
Simple TTL XTAL
Uncritical XTAL
Pulse
Zero Crossing
Simple Pulse
Needle Pulse
Stable Linear Sawtooth
Zener
Noise
Pink
Simple Relaxation
Triangle with independent slope
Exponential
Widerange Multivibrator
Multiple Waveform
Linear Sweep
Step Frequency
Beeper
7400 Siren
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Sound Effects

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NI CAD Discharge
Current Limiting

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GO NO GO Diode Tester
Zener Check
GO NO GO Transistor Tester
Quick JFET Test
Current Gain Tester
Basic Transistor Tester
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Crystal Checker
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Electronic Switch
Sound Operated 2 Way
SPST Switch Flip Flop
Two Signals on one Wire

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3 Step Level
Light Level
Bargraph Display
Fuse Failure
Blown Fuse
Back Up Lamp
OC Lamp Failure
FM Tuner Station
Current Flow
Disco Cue

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Dancing Lights
Low Frequency Strobe
Flasher
Ultra Simple

POWER CONTROL

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Zero Crossing Sync
Train Controller
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Full Wave SCR Control

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Simple Hazard Light
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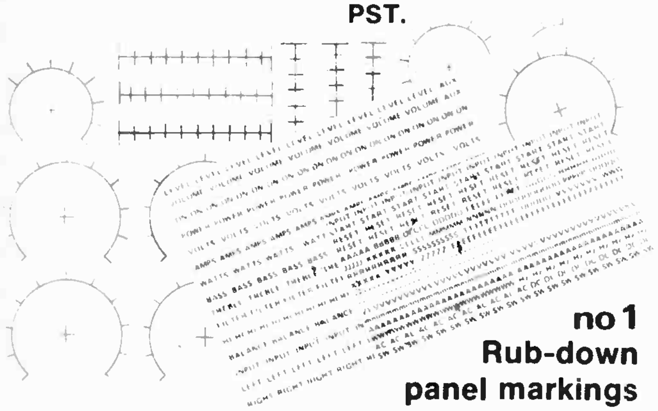

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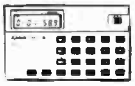

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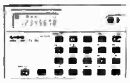

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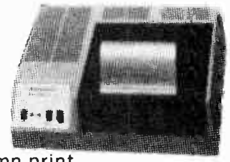

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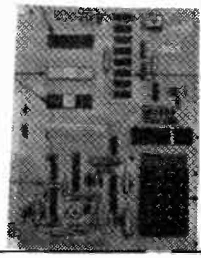

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CONTENTS

CONTENTS

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PART II PREAMPLIFIERS, MIXERS AND TONE CONTROL

PART III POWER AMPLIFIERS AND SUPPLIES

PART IV HYBRID CIRCUITS

Shortwave/ Transistor/ Audio IC

Above are the contents pages for these three pocket-sized books. The books were published in England by Babani Press & Bernards (Publishers) Ltd., and we now have stocks in Toronto for ETI's readers. Titles, authors and Canadian prices (including postage) are as follows:

'Shortwave Circuits & Gear For Experimenters & Radio Hams' by B.B. Babani, $2.60.
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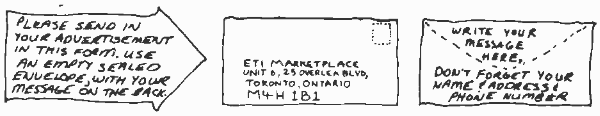

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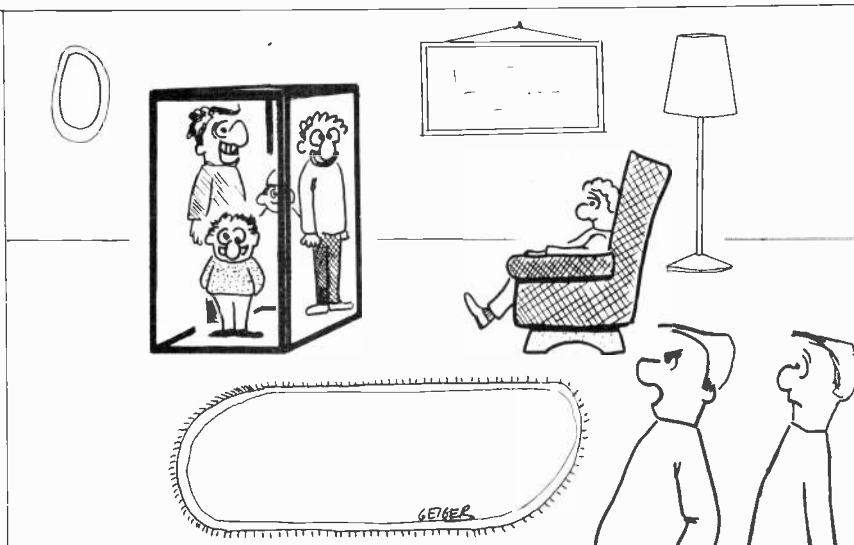
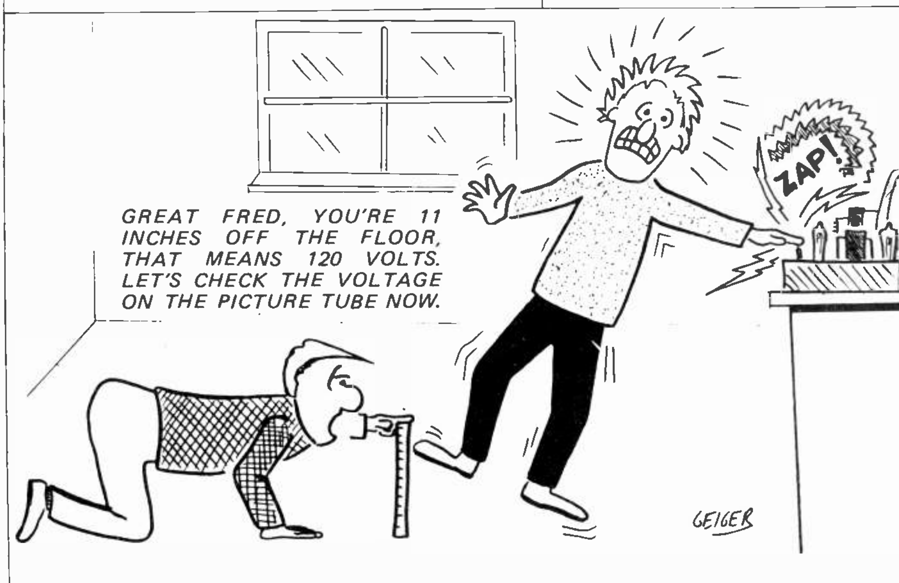
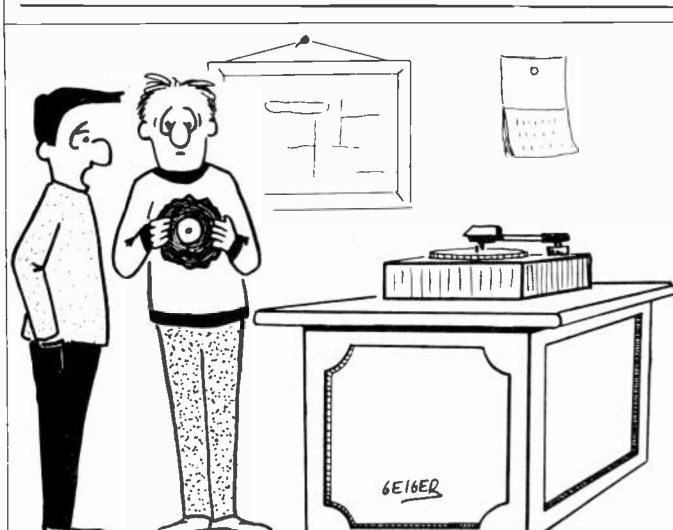


THAT'S THE TROUBLE WITH KIDS TODAY — THE MINUTE THEY RUN OUT OF THINGS TO DO, THEY JUST SIT AND WATCH THE IDIOT BOX.



GREAT FRED, YOU'RE 11 INCHES OFF THE FLOOR, THAT MEANS 120 VOLTS. LET'S CHECK THE VOLTAGE ON THE PICTURE TUBE NOW.

ACTUALLY, WE ONLY KEEP ALL THIS FANCY LOOKING STUFF OUT HERE TO IMPRESS THE CUSTOMERS. IN THE BACK ROOM WE USE A SLEDGE HAMMER AND A CROWBAR.



IT'S REALLY PROBABLY A GOOD PHONOGRAPH, SAM, I THINK YOU JUST HAVE TO ADJUST THE TRACKING WEIGHT . . . 25 LBS IS A LITTLE HIGH YOU KNOW.

I DON'T THINK IT'S A REPUTABLE PLACE, GEORGE. I ASKED FOR A DEMONSTRATION OF ONE OF THEIR REC-ORD PLAYERS, AND THE ALBUM THEY USED WAS CALLED "FAMOUS DOG WHISTLES".

You Too Can Look Like This

This is our old T-shirt (in the photographs)


They're here! ETI's new Canadian-made polyester-cotton T-shirts are now in our office awaiting your order. These are really top quality — not cheap foreign shirts that fade and shrink when you wash them. They're nice and long to stop draughts around your midriff. Colour scheme is blue with white design.

Fill out this coupon and send to ETI T-Shirts, **Unit Six, 25 Overlea Blvd., Toronto, Ontario, M4H 1B1.**

Please send me _____ ETI T-Shirts, sizes as indicated. I enclose $_______.

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ETI Project File

Updates, news, information, ETI gives you project support

PARTS PARTS PARTS

We are continually beseiged with letters from readers asking where they can get parts in their area. Since we can't take a country-wide tour to check where all the elctronics parts-places are, how about sending us a note on any stores you have found useful, what they are good for (if you own the place you can contribute too!) and so on. At some time in the future we would like to help out the "lost" readers by publishing a rundown of where to get what.

PROJECT FILE is our department dealing with information regarding ETI Projects. Each month we will publish the Project Chart, any Project Notes which arise, general Project Constructor's Information, and some Reader's Letters and Questions relating to projects.

PROJECT NOTES

Since this magazine is largely put together by humans, the occasional error manages to slip by us into print. In addition variations in component characteristics and availability occur, and many readers write to us about their experiences in building our projects. This gives us information which could be helpful to other readers. Such information will be published in Project File under Project Notes. (Prior to May 78 it was to be found at the end of News Digest.)

Should you find that there are notes you wish to read for which you do not have the issue, you may obtain them in one of two ways. You can buy the back issue from us (refer to Project Chart for date of issue and see also Reader Service Information on ordering). Alternatively you may obtain a photocopy of the note free of charge, so long as your request includes a self addressed stamped envelope for us to mail it back to you. Requests without SASE will not be answered.

PROJECT CONSTRUCTOR'S INFORMATION

Useful information on the terminology and notation will be published each month in Project File.

ETI Project Chart

ISSUE DATE	ARTICLE
Dec 77	50D50 Amplifier
Jan 78	Neg.
Feb 78	Note: T
Dec 77	Spirit Level
Jan 78	Neg.
Dec 77	Egg Timer
Jan 78	Neg.
Jan 78	Option Clock & Neg.
July 78	Note: S
Jan 78	LED Pendant
May 78	Note: C
Jan 78	Compander & Neg.
Feb 78	Tachomonitor
Apr 78	Neg.
Feb 78	LCD Panel Meter
Apr 78	Note: C
Apr 78	Neg.
Feb 78	CB Power Supply
Mar 78	Hammer Throw
June 78	Neg.
Apr 78	Computer PSU & Neg.
Apr 78	Audio Delay Line & Neg.
Mar 78	True RMS Meter
Apr 78	Neg.
May 78	Note: N
Feb 78	Freezer Alarm
Apr 78	Neg.
Apr 78	Neg.
Mar 78	Home Burglar Alarm
Apr 78	Gas Alarm & Neg.
May 78	White Line Follower
June 78	Neg.
May 78	Acoustic Feedback Eliminator
June 78	Neg.

ISSUE DATE	ARTICLE
May 78	Add-on FM Tuner
June 78	Neg.
June 78	Audio Analyser
June 78	Ultrasonic Switch & Neg.
June 78	Phone Bell Extender & Neg.
July 78	Proximity Switch
Aug 78	Neg.
July 78	Real Time Analyser MK II (LED)
Aug 78	Neg.
July 78	Acc. Beat Metronome.
Aug 78	Neg.
July 78	Race Track
Aug 78	Neg.
Aug 78	Sound Meter & Neg.
Dec 78	Note: N
Aug 78	Porch Light & Neg.
Aug 78	IB Metal Locater & Neg.
Aug 78	Two Chip Siren & Neg.
Sept 78	Audio Oscillator
Nov 78	Neg.
Sept 78	Shutter Timer
Nov 78	Neg.
Sept 78	Rain Alarm
Oct 78	CCD Phaser
Nov 78	Neg.
Oct 78	UFO Detector
Nov 78	Neg.
Oct 78	Strobe Idea
Nov 78	Cap Meter &Neg.
Nov 78	Stars & Dots
Nov 78	CMOS Preamp & Neg.
Dec 78	Digital Anemometer
Dec 78	Tape Noise Elim
Dec 78	EPROM Programmer

Canadian Projects Book

Audio Limiter	Metal Locator
5W Stereo	Heart-Rate Monitor
Overled	GSR Monitor
Bass Enhancer	Phaser
Modular Disco	Fuzz Box
G P Preamp	Touch Organ
Bal. Mic. Preamp	Mastermind
Ceramic Cartridge Preamp	Double Dice
Mixer & PSU	Reaction Tester
VU Meter Circuit	Sound-Light Flash
Headphone Amp	Burglar Alarm
50W-100W Amp	Injector-Tracer
Note: N Apr. 78	Digital Voltmeter

Key to Project Notes

C:- PCB or component layout
D:- Circuit diagram
N:- Parts Numbers, Specs
Neg:- Negative of PCB pattern printed
O:- Other
S:- Parts Supply
T:- Text
U:- Update, Improvement, Mods
***:- Notes for this project of complicated nature, write for details (enclose S.A.S.E., see text)

PROJECT CHART

This chart is an index to all information available relating to each project we have published in the preceding year. It guides you to where you will find the article itself, and keeps you informed on any notes that come up on a particular project you are interested in. It also gives you an idea of the importance of the notes, in case you do not have the issue refered to on hand.

Every few months we print a pull out section in the magazine which may be used as a photographic negative for making printed circuit boards (as described in our January 78 issue). Each edition of this sheet contains projects from the preceding few issues. Information on where to find which negative is included in the chart.

Write to: Project File
Electronics Today International
Unit 6, 25 Overlea Blvd.,
TORONTO, Ontario
M4H 1B1

Component Notations 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 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 0.1uF is 100n, 5600pF is 5n6. Other examples are 5.6pF = 5p6, 0.5pF = 0p5.

Resistors are treated similarly: 1.8M ohms is 1M8, 56k ohms is 56k, 4.7k ohms is 4k7, 100 ohms is 100R, 5.6 ohms is 5R6.

Kits, PCBs, and Parts

We do not supply parts for our projects, these must be obtained from component suppliers. However, in order to make things easier we co-operate with various companies to enable them to promptly supply kits, printed circuit boards and unusual or hard-to-find parts. Prospective builders should consult the advertisements in ETI for suppliers for current and past projects.

Any company interested in participating in the supply of kits, pcbs or parts should write to us on their letterhead for complete information.

READER'S LETTERS AND QUESTIONS

We obviously cannot troubleshoot the individual reader's projects, by letter or in person, so if you have a query we can only answer it to the extent of clearing up ambiguities, and providing Project Notes where appropriate. If you desire a reply to your letter it must be accompanied by a self addressed stamped envelope.

Sound Level Meter Notes

In the Sound Level Meter which appeared in our August 78 issue it has been found that some non-linearity occurs in the meter circuit due to the offset current of IC3. It is recommended that this IC be replaced by a CA3140 which has the same pinout. In this case C14 is no longer needed and can be omitted.

Equaliser Kit!

Dominion Radio were first to finally come out with an equaliser kit. See their ad in this issue for more details.

Another Equaliser Kit!

See how popular this project is! Second to announce an Equaliser kit is a company named "Chips". They are also advertising in this issue. By the way, we published the original project in Oct 77 issue if you are interested.

---

4 ETI Publications

Projects Books 3 & 4 now sold out.

Send your order, with payment (not cash), to

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Toronto, Ontario
M4H 1B1

Please specify which publications you require, and print your name and address clearly.

Canadian Projects Book No. 1 — $3.00

Top projects from the early issues of ETI's Canadian edition, plus some of the projects from the UK edition's issues which were distributed in Canada in 1976. All projects use parts available in Canada. Those projects from UK edition have been completely re-worked in Canada for Canadian constructors Includes a series of modular disco projects, plus games, biofeedback, metal locator, etc.

Circuits No. 1 — $5.00

A brand new concept from the house of ETI. More than 100 pages packed with a wide range of experimenters circuits Based on the 'Tech Tips' section carried in the overseas editions of ETI, Circuits 1 is the first of a series of specials — produced for the enthusiasts who know what they want, but not where to get it! Circuits 1 will also act as a catalyst for further development of ideas, ideal for the experimenter The collection of more than 200 circuits is complemented by a comprehensive index, making searches for a particular circuit quick and simple Also, similar circuits can be compared easily, due to the logical layout and grouping used throughout Last and by no means least, Circuits 1 has no distracting advertisements in the main section!

Electronics — it's easy Volume 1 — $3.50*

The best introductory series to electronics ever published in a magazine Volume three completing the series, will be available in a few months Volume One introduces electronics to the beginner by going through the systems approach, basic concepts, meters and measurements, frequency and wavelengths, electronics and communication, capacitance and inductance, capacitive and inductive reactance, resistance, capacitance and inductance in combination, detection and amplification, elements of transistor amplifiers, emitter followers and DC amplifiers, and basic operational amplifiers

Electronics — it's easy Volume 2 — $3.50*

Volume Two introduces the sources of power, simple power supplies, how regulated power supplies work, general purpose supplies, generating signal waveforms, generating non-sinusoidal waveforms, all about electronic filters, more about filters, introducing digital systems, the algebra of logic, integrated circuit forms of logic functions, digital sub-systems, counters and shift registers.

$6.00 For Both*

Reader Service Information

Editorial Queries

Written queries can only be answered when accompanied by a self-addressed, stamped enveloped, and the reply can take up to three weeks. These must relate to recent articles and not involve ETI staff in any research. Mark your letter ETI Query.

Projects, Components, Notation

For information on these subjects please see our Project File section.

Sell ETI

ETI is available for resale by component stores. We can offer a good discount and quite a big bonus, the chances are customers buying the magazine will come back to you to buy their components. Readers having trouble getting their copy of ETI could suggest to their component store manager that he should stock the magazine.

Back Issues and Photocopies

Previous issues of ETI-Canada are available direct from our office for $2.00 each. Please specify issue by the month, not by the features you require. The following back issues are still available for sale.

1977
February
[redacted]
May
June
July
[redacted]
September
[redacted]
November
[redacted]

1978
January
February
March
April
May
June
July
August
September
October
November

We can supply photocopies of any article published in ETI-Canada, for which the charge is $1.00 per article, regardless of length. Please specify issue and article. (A special consideration applies to errata for projects, see Project File.)

Some people have problems buying ETI at the newsstand. But no matter who you are or where you live you can have your personal copy of ETI delivered every month — by taking out a subscription. Use the card opposite.

If someone else has beaten you to it, and there's no card, then send your subscription order on your own paper. We need to know your full name and address (including postal code). We will accept your personal cheque or money order, or we can bill Mastercharge or Chargex for which we need your account number, signature, and card expiry date. Mail the whole lot to: ETI Subscriptions Dept., Unit 6, 25 Overlea Blvd, Toronto, Ont. PLEASE DO NOT RISK SENDING CASH. Allow six weeks for subscription to start.

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1N753A	6.2v	500 mW Zener	.25
1N758A	10v	"	.25
1N759A	12v	"	.25
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7443	.45	74151	.65	74H11	.25	74S08	.35	74LS74	.35
7444	.45	74153	.75	74H15	.45	74S10	.35	74LS86	.35
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SN7407	29	SN7432	20	SN7472	29	SN7496	69	SN74141	99	SN74163	59	SN74186	8.99	SN74265	59	SN74426	.50
SN7408	17	SN7433	26	SN7473	24	SN7497	1.89	SN74142	2.50	SN74164	59	SN74S188A	1.50	SN74273	1.69	SN74490	1.59
SN7409	17	SN7437	.24	SN7474	24	SN74100	1.35	SN74143	2.60	SN74165	59	SN74190	57	SN74276	89		
SN7410	14	SN7438	.24	SN7475	34	SN74104	75	SN74144	2.60	SN74166	99	SN74191	57	SN74278	1.99		
SN7411	24	SN7439	1.55	SN7476	29	SN74105	75	SN74145	69	SN74167	2.29	SN74192	55	SN74279	59		
SN7412	19	SN7440	14	SN7480	.49	SN74107	30	SN74147	1.35	SN74170	1.59	SN74193	55	SN74283	89		
SN7413	35	SN7442	49	SN7481A	1.09	SN74109	34	SN74148	1.15	SN74172	5.75	SN74194	59	SN74284	2.95		
SN7414	.40	SN7443	.85	SN7482	79	SN74110	39	SN74150	65	SN74173	1.09	SN74195	37	SN74285	2.95		
SN7416	27	SN7444	70	SN7483A	64	SN74111	49	SN74151	42	SN75174	59	SN74196	74	SN74290	64		
SN7417	27	SN7445	.59	SN7484A	99	SN74116	1.35	SN74152	2.95	SN74175	68	SN74197	74	SN74293	64		
SN7420	14	SN7446A	74	SN7485	89	SN74120	1.15	SN74153	42	SN74176	74	SN74198	1.19	SN74298	89		
SN7421	24	SN7447A	74	SN7486	29	SN74121	35	SN74154	79	SN74177	74	SN74199	1.19	SN74351	1.79		

TTL LOW POWER SCHOTTKY PLASTIC DUAL-IN-LINE I.C.'s

Part No	Price	Part No	Price	Part No	Price	Part No	Price	Part No	Price	Part No	Price	Part No	Price	Part No	Price
SN74LS00	16	SN74LS32	21	SN74LS90	45	SN74LS145	1.05	SN74LS175	49	SN74LS245	1.40	SN74LS298	94	SN74LS377	1.35
SN74LS01	18	SN74LS33	24	SN74LS91	99	SN74LS147	1.50	SN74LS181	1.80	SN74LS247	95	SN74LS299	2.25	SN74LS378	79
SN74LS02	16	SN74LS37	24	SN74LS92	45	SN74LS148	99	SN74LS183	2.70	SN74LS248	90	SN74LS314	11.50	SN74LS379	1.25
SN74LS03	18	SN74LS38	24	SN74LS93B	45	SN74LS151	45	SN74LS190	69	SN74LS249	90	SN74LS315	13.00	SN74LS381	2.95
SN74LS04	19	SN74LS40	19	SN74LS95A	59	SN74LS153	45	SN74LS191	69	SN74LS251	49	SN74LS323	4.50	SN74LS385	5.50
SN74LS05	19	SN74LS42	45	SN74LS96	99	SN74LS155	66	SN74LS192	60	SN74LS253	49	SN74LS324	99	SN74LS386	35
SN74LS08	18	SN74LS47	89	SN74LS107	30	SN74LS156	60	SN74LS193	60	SN74LS257	45	SN74LS325	2.75	SN74LS390	1.69
SN74LS09	19	SN74LS48	85	SN74LS109	30	SN74LS157	42	SN74LS194A	59	SN74LS258	49	SN74LS326	2.80	SN74LS393	1.40
SN74LS10	16	SN74LS49	75	SN74LS112	30	SN74LS158	49	SN74LS195A	49	SN74LS259	95	SN74LS327	2.70	SN74LS395	1.55
SN74LS11	18	SN74LS51	16	SN74LS113	32	SN74LS160	59	SN74LS196	84	SN74LS260	29	SN74LS347	80	SN74LS396	1.35
SN74LS12	19	SN74LS54	19	SN74LS114	32	SN74LS161	59	SN74LS197	84	SN74LS261	1.35	SN74LS348	1.25	SN74LS398	1.99
SN74LS13	35	SN74LS55	19	SN74LS122	45	SN74LS162	59	SN74LS207	18.00	SN74LS266	35	SN74LS352	99	SN74LS399	1.50
SN74LS14	49	SN74LS63	1.49	SN74LS123	67	SN74LS163	59	SN74LS208	18.00	SN74LS273	1.09	SN74LS353	99	SN74LS424	4.50
SN74LS15	19	SN74LS73	32	SN74LS124	1.35	SN74LS164	60	SN74LS214	11.50	SN74LS275	3.49	SN74LS362	5.50	SN74LS445	95
SN74LS20	16	SN74LS74	26	SN74LS125	42	SN74LS165	99	SN74LS215	13.00	SN74LS279	39	SN74LS365	39	SN74LS447	90
SN74LS21	19	SN74LS75	36	SN74LS126	42	SN74LS166	1.50	SN74LS221	89	SN74LS280	1.95	SN74LS366	39	SN74LS490	1.70
SN74LS22	19	SN74LS76	32	SN74LS132	60	SN74LS168	99	SN74LS240	1.69	SN74LS281	4.95	SN74LS367	39	SN74LS668	69
SN74LS26	23	SN74LS78	32	SN74LS133	29	SN74LS169	99	SN74LS241	1.69	SN74LS283	69	SN74LS368	35	SN74LS669	69
SN74LS27	19	SN74LS83A	59	SN74LS136	33	SN74LS170	1.34	SN74LS242	1.64	SN74LS290	65	SN74LS373	1.29	SN74LS670	2.75
SN74LS28	22	SN74LS85	77	SN74LS138	48	SN74LS173	59	SN74LS243	1.64	SN74LS293	69	SN74LS374	1.29	SN74LS673	9.00
SN74LS30	16	SN74LS86	45	SN74LS139	48	SN74LS174	49	SN74LS244	1.69	SN74LS295A	1.55	SN74LS375	45	SN74LS674	9.00

CMOS

Part No	Price	Part No	Price	Part No	Price	Part No.	Price	Part No	Price	Part No	Price	Part No	Price	Part No	Price	Part No	Price
CD4000BE	17	CD4015BE	69	CD4027BE	39	CD4046BE	99	CD4070BE	29	CD4093BE	40	CD4519BE	47	CD4556BE	65	40163PC	99
CD4001BE	17	CD4016BE	35	CD4028BE	57	CD4047BE	95	CD4071BE	21	CD4104BE	2.25	CD4520BE	69	CD4581BE	2.25	40174PC	89
CD4002BE	17	CD4017BE	62	CD4029BE	74	CD4049BE	33	CD4072BE	21	CD4502BE	85	CD4522BE	99	CD4582BE	79	40175PC	89
CD4006BE	87	CD4018BE	69	CD4030BE	35	CD4050BE	33	CD4073BE	21	CD4507BE	45	CD4526BE	99	CD4584BE	60	40192PC	1.19
CD4007BE	17	CD4019BE	39	CD4033BE	1.45	CD4051BE	54	CD4075BE	21	CD4508BE	2.25	CD4527BE	1.09	CD4585BE	90	40193PC	1.19
CD4008BE	75	CD4020BE	69	CD4034BE	2.25	CD4052BE	54	CD4076BE	79	CD4510BE	88	CD4528BE	69	40014PC	59	40194PC	1.10
CD4009BE	39	CD4021BE	69	CD4035BE	64	CD4053BE	54	CD4077BE	25	CD4511BE	99	CD4531BE	74	40085PC	1.09	40195PC	1.10
CD4010BE	39	CD4022BE	69	CD4040BE	74	CD4060BE	99	CD4078BE	21	CD4512BE	59	CD4532BE	1.19	40097PC	60		
CD4011BE	17	CD4023BE	17	CD4041BE	74	CD4066BE	44	CD4081BE	21	CD4514BE	1.95	CD4539BE	99	40098PC	60		
CD4012BE	17	CD4024BE	49	CD4042BE	59	CD4067BE	1.95	CD4082BE	21	CD4515BE	1.95	CD4543BE	1.39	40160PC	89		
CD4013BE	32	CD4025BE	17	CD4043BE	57	CD4068BE	21	CD4085BE	69	CD4516BE	69	CD4553BE	4.50	40161PC	99		
CD4014BE	73	CD4026BE	1.39	CD4044BE	55	CD4069BE	21	CD4086BE	69	CD4518BE	79	CD4555BE	65	40162PC	89		

LINEAR INTEGRATED CIRCUITS

Part No	Price	Part No	Price
LM301AH	39	LM709CN-14	34
LM301AN-8 (Mini Dip)	29	LM723CH	49
LM304H	79	LM723CN-14	35
LM305AH	99	LM725CH	2.40
LM305H	69	LM725CN-8	1.50
LM307H	39	LM741CH	45
LM307N-8 (Mini Dip)	38	LM741CN-14	34
LM309K (T03)	1.69	LM741CN-8 (Mini Dip)	29
LM311H	74	LM747CN-14	49
LM311N-8	49	LM1488D	74
LM318H	1.50	LM1489AD	74
LM318N-8	1.25	LM1495N-14	1.25
LM323K	5.50	LM1496N-14	99
LM324N	54	LM2240CN-14	1.50
LM339N	49	LM3046N-14	58
LM555N-8 (Mini Dip)	29	LM3081D-14	1.40
LM556N-14	49	LM3302N-14	49
LM567CN-8	89	LM3403N-14	82
LM709CN-8 (Mini Dip)	35	LM3900N-14	59
		LM4136N-14	75
		RC4151N-8 (Mini Dip)	79

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7900 Series T0-3/LM320K	1.95	1 Amp Negative 5,6,8,12,15,18,24 Volts

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8214	3.95	8251	4.95	6820	3.95
8216	1.95	8253	12.95	6850	3.65
8224	2.95	8255	4.95	6852	4.75
8226	1.95	8257	10.95		
8228	3.95	8259	14.95		

UV EPROM

Part No 2708 Price $8.95

MOS Static RAM's

Part No			Price
2114	4K (1Kx4)	450NS	$8.00
2102LFPC	1K (low power)	450NS	$1.49

MOS Dynamic RAM's

Part No			Price
4060	4K	300NS	$4.50
416	16K	250NS	$13.95

UART's

Part No	Price	Part No	Price
AY5-1013A	$4.50	AY3-1015	$5.75

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