CANADA'S OWN ELECTRONICS MAG

electronics toda

APRIL 1979

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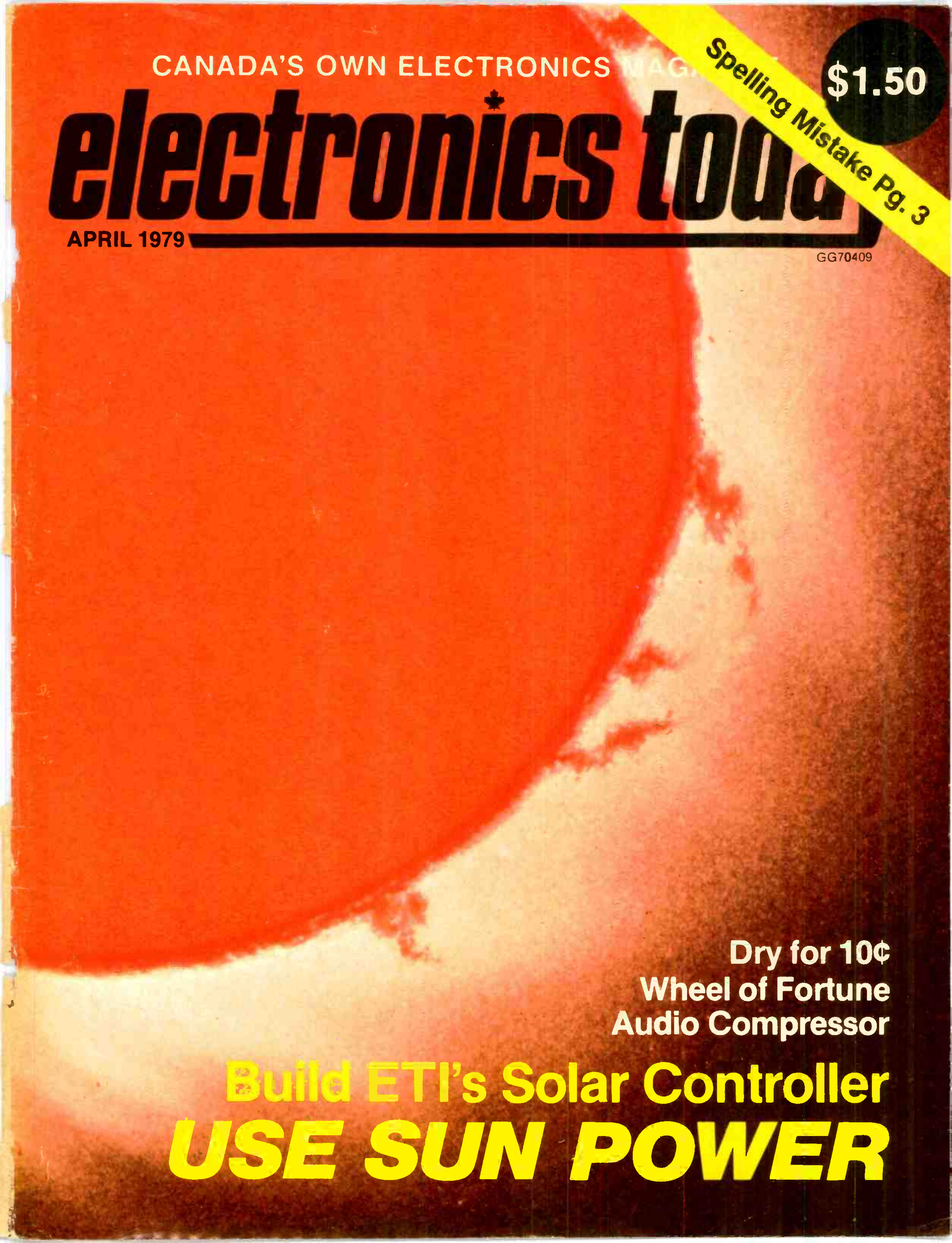
Spelling Mistake Pg. 3



Dry for 10¢

Wheel of Fortune

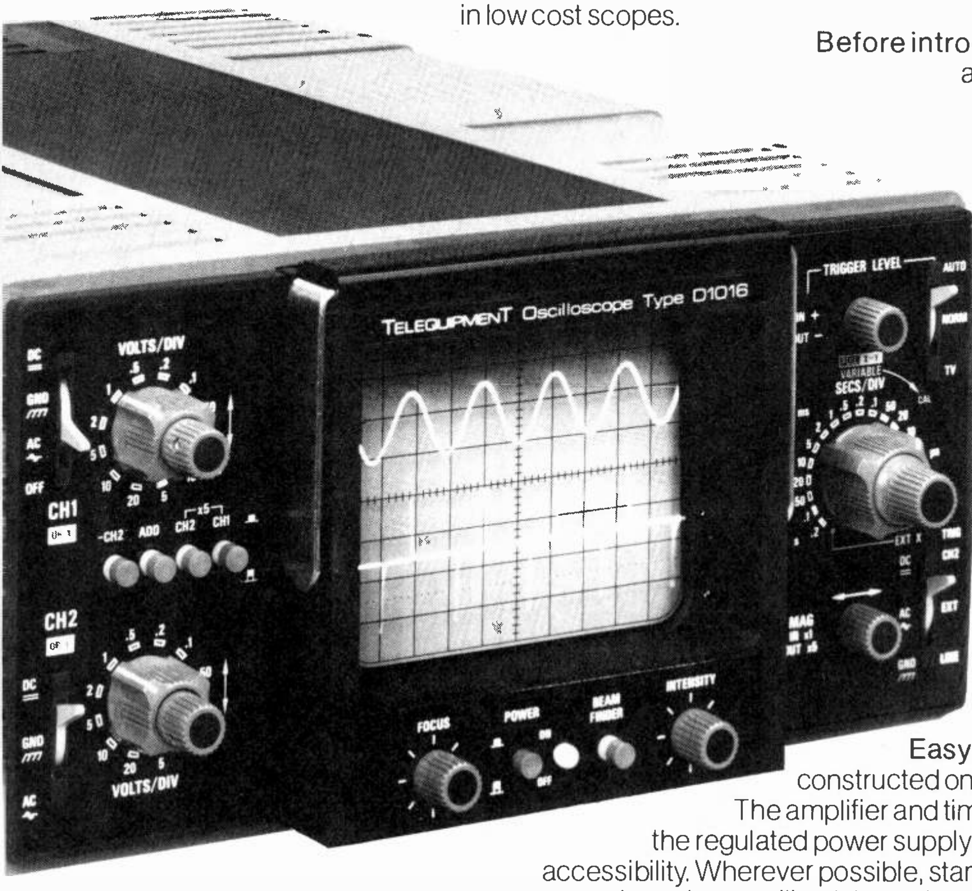
Audio Compressor

Build ETI's Solar Controller

USE SUN POWER

It had to happen... the NEW 1000 series

a new generation of easy-to-use, economy line scopes offering the flexibility that you the customer demanded and from who else but Telequipment, world leaders in low cost scopes.



Before introducing the 1000 series, we conducted an intensive market survey, the results of which were analyzed by our engineering and marketing teams; from this a definite set of parameters emerged. These have all been embodied in our new 1000 series.

A choice of bandwidth: 10 or 15MHz, 5mV sensitivity at full bandwidth and 1mV sensitivity at 4MHz and a choice of modes; Algebraic Add, true X–Y, and X5 gain switching; remember we told you it was flexible.

Easy-to-use: this it certainly is; note the minimum number of controls on the front panel, probably less than any other competitive scope available and, of course, all colour coded for easy reference.

Easy-to-read: note the five inch CRT.

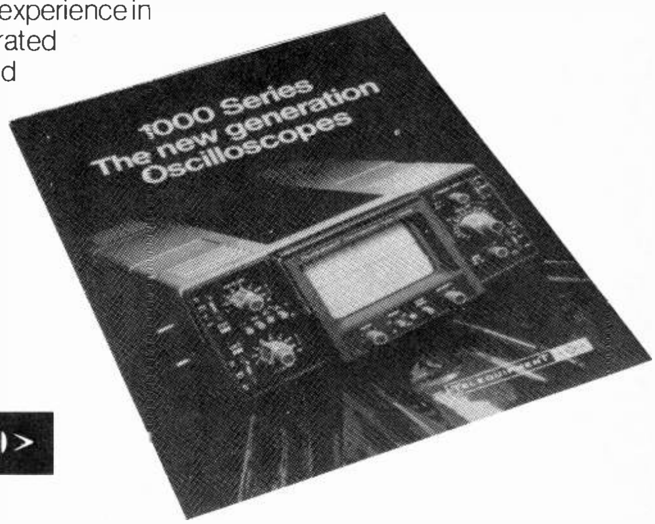
Easy-to-service: primary circuits are constructed on only three boards in a "u" configuration. The amplifier and time base boards pivot around the regulated power supply making for excellent accessibility. Wherever possible, standard commercial components have been utilized throughout, simplifying acquisition.

Lightweight: only 8kg (approx. 17.5lb).

Reliable: here we have called on our many years' experience in the manufacture of low cost scopes. Components are rated in excess of their required values. Automatic insertion and testing reduces human errors. Flow soldering ensures maximum reliability of soldered joints.

Low cost: just check our price list and remember there is a lot more to cost than just the price.

For further information, send for colour brochure.



TELEQUIPMENT

Tektronix Canada Ltd.
P.O. Box 6500, Dept. T
Barrie, Ontario L4M 4V3
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COMMITTED TO EXCELLENCE

Vol. 3 No. 4
APRIL 1979

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INCORPORATING **ELECTRONIC WORKSHOP**

PROJECTS

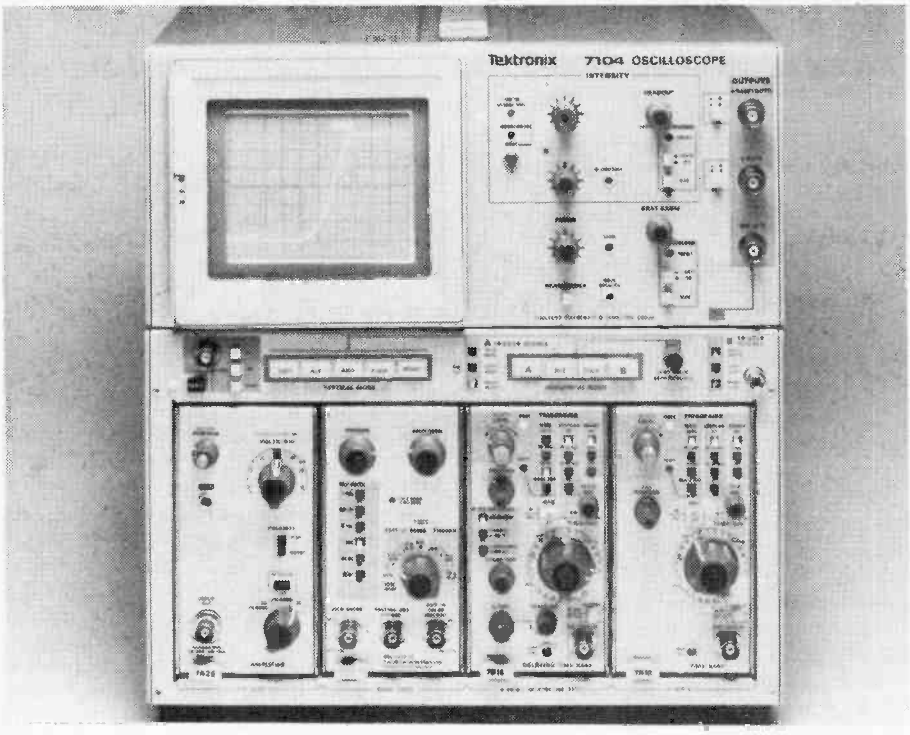
FEATURES

NEWS & COLUMNS

INFO & MISCELLANEOUS

COVER: Taken from artwork by Zigi Kucharski depicting an eclipse. Kindly provided by Ian McGregor, McLaughlin Planetarium, Toronto.

NEWS DIGEST



1GHz Scope

Tektronix Canada have announced a new general-purpose plug-in oscilloscope compatible with the standard 7000-series. Among the important technical features are: 1 GHz bandwidth, horizontal (X-Y) bandwidth of DC to 350 MHz, risetime of 350 picoseconds (or less), calibrated sweepspeeds to 200 picoseconds/division, high-visibility trace, photographic writing speed of 20 cm/nanosecond, full-size display (8 x 10 0.85 cm divisions, full sweep-triggering capabilities to 1 GHz, vertical sensitivity of 10 millivolts/div to 1 volt/div.

Three new plug-in units were introduced specifically for the Model 7104: Model 7A29 Vertical Amplifier, Model 7B10 Time Base, Model 7B15 Time Base.

To quote the Tektronix Press Release:

"Although one-Gigahertz in a general-purpose oscilloscope is a very impressive specification, the new Model 7104 represents far, far more of an advance than one would guess bymerely looking at the bandwidth spec. It took state-of-the-art advances at almost every turn before we were able to produce a one Gigahertz general-purpose oscilloscope. Advances in crt design were among the major pacing items. We had to develop and incorporate a distributed horizontal deflection system, a meshless scan expansion lens and a micro-channel plate electron multiplier before this scope could become a reality. These things have never been pulled together in a production instrument, until now. Other advances that were required from very high speed integrated circuits (using processes proprietory to Tektronix) an entirely new system of pc board layout; because his scope is, after all, a microwave system. The entire internal design uses micro-stripline layout techniques that never have been required at lower bandwidths. We even needed to develop an entire system of interconnects. This system uses metallized elastomer contacts to lower reflection losses and mismatches that would occur with any previously available technology. We use this same basic technology in relays and switches within the Model 7104, also, for the same reasons."

For additional details, descriptive literature or ordering information, contact: Tektronix Canada Ltd, PO Box 6500, Barrie, Ontario. L4M 4V3. Or call Jane Amstrong, Marketing Communications, on 705-737-2700, extension 48.

IEEE Show

The International Electrical, Electronics Conference and Exposition is scheduled for Toronto's Exhibition Place, October 2, 3 & 4, 1979. Papers will be presented in the areas of Communications, Power Systems, Biomedical Applications, Computer Applications, Electronics and Alternate Energy Systems. A number of tutorials will also be held including sessions on Fiber Optics and Microcomputers.

For further information regarding technical papers, exhibits and registration contact the International Electrical, Electronics Conference and Exposition, 1450 Don Mills Road, Don Mills, Ontario, M3B 2X7.

Digital Trig Multipliers

Two new trigonometric multipliers (vector generators), the industry's first such devices, have been introduced by Analog Devices.

Models DTM1716 and DTM1717 will accept either AC or DC analog reference signals plus a 12 or 14-bit digital representation of an angle (θ) and provide outputs of both the sine of θ times the analog input signal and the cosine of θ times the analog input signal.

The devices can be used in a number of applications, such as low-frequency spectrum analyzers (quadrature circuits), coordinate rotation in radar systems and machine-tool control and point-of-position indicators and polar plots on cathode-ray tubes.

The engineer can now easily implement designs based on a variety of vector operations such as frequency modulation, phase modulation and double sideband suppressed carrier amplitude modulation. The DTM1716/1717 will generate ultra-low frequency signals, ppi waveforms, invariant sine/cosine signals, and can perform spectrum analysis. Analog Devices claim that "no similar products exist which are DC-coupled or accurate to +0.1%. Additionally, with 2.5 kHz at full accuracy, customers are not restricted to either DC or 60 Hz or 400 Hz signals, but can process signals with triangular or square-wave references, common in many aircraft applications."

Prices start at $275 in the US. For Canadian prices contact Tracan Electronics Corp, 558 Champagne Drive, Downsview, Ontario, M3J 2T9. Phone 416-633-0052.

Another LCD DMM

A new hand-held, LCD, precision digital multimeter selling in Canada for $198 is available from Webster Instruments Ltd. The new Data Precision model 935 is a full-function, 3½ digit DMM with 0.1% accuracy.

The meter offers 20 ranges of DC or AC voltage and current and resistance measurements, including both high and low resistance excitation capability. Ranges, functions, and excitation level are selected using pushbutton switches, allowing one-handed operation. Measurements including appropriate polarity sign and decimal points and a warning indicator for low battery voltage are displayed on a 3½ digit, 0.5" high, liquid crystal display.

Full protection for overvoltage, overcurrent, and high voltage transients is provided. A standard 9V alkaline transistor battery will power the meter for over 200 hours of continuous use. An optional AC line adapter is available for AC line operation on the bench.

The price includes test leads, battery, and instruction manual, one-year warranty, certificate of conformance to NBS Standards and factory test report (but not duty or taxes).

The $198 price includes test leads, battery, and instruction manual, one-year warranty, certificate on conformance to NBS Standards and factory test report (but not duty or taxes).

Tricky Consumer Business

Bally Manufacturing are to stop making consumer pinball machines. They say they have been losing $100 on every unit sold. They also say they have made no money in the video game business despite sales of 28,000 units.

1500V Transistor

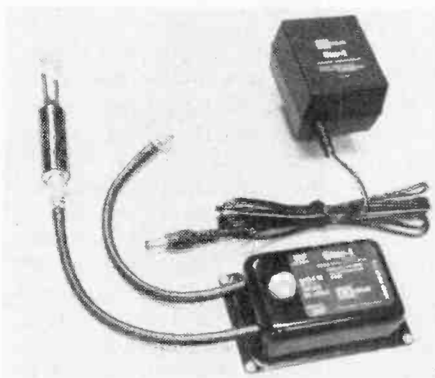
Motorola has introduced a new high-voltage power switching transistor, the MJE12007. Rated at 1500V CEX and 2.5 amps, the horizontal deflection transistor is specifically designed for use in small-screen CRT terminals or televisions.

The new NFN transistor is one of the highest voltage-rated (750 V CEO) power transistors available in a plastic package. The device also features a switching speed of less than 1.0 us at 2.0 amps, and a rated power dissipation of 65 watts at 25°C case.

US prices (100-up) are $2.25 each, from Motorola distributor stock.

Another Cable-UHF Converter

Delhi Metal Products Ltd, a subsidiary of General Instrument Corporation, has introduced a VHF to UHF block converter for cable TV. The three-part system consists of a power supply, the



converter unit (mounted at the back of the TV set) and a 300 to 75 ohm transformer for the UHF terminals. All VHF channels 2 to 13, mid-band A to I and super-band channels J to R are converted to UHF channels 44 to 79.

Last year this idea was used in a product marketed by Philips.

For information contact Delhi Metal Products Limited, 65 Waverly St, Delhi, Ontario, N4B 1E8. Phone 519-582-0710.

In-Car Video

Sony have come up with a quarter-size version of their Betamax VCR for use in automobiles.

$10,325 LCR Meter

This new 4½/5½ digit microprocessor-based LCR meter from Hewlett-Packard can measure inductance from 100.00 nanohenries to 1000.0 henries; capacitance from 1.0000 picofarads to 1.00 farad; R, Z, ESR and X from 100.00 milliohms to 10.000 megohms. D, Q, G & B and O are also measured.

More details from Hewlett-Packard (Canada) Limited, 6877 Goreway Drive, Mississauga, Ontario, L4V 1M8.

RCA's SK Line

RCA's Consumer Electronics Division recently announced that they will no longer be selling SK semiconductors. However, this does not mean that RCA SK semiconductors will not be available in Canada.

Superior Electronics Inc. has been marketing SK semiconductors since November 1977 and will continue to stock, promote and supply them to Canadian distributors. Superior Electronics say the RCA decision in no way affects the availability of the product line to the Canadian marketplace.

For further information and a copy of the RCA SK Semiconductors' Cross-Reference Guide write: Superior Electronics Inc, Parts & Accessories Division, 1330 Trans Canada Hwy South Montreal, Quebec, H9P 1H8.

Westworld Is Coming

At a time when many concerned people are campaigning for less violence in entertainment, one company (Realtime Simulation Systems of Inglewood, California) is using modern technology to highten the realism of fantasy-killing. The company has designed a War Simulation Park where laser guns and electronic scorekeeping are used to give the violence-freak an interactive outlet for his emotions. Participants will wear laser-stopping visors to protect their eyes and will be armed with 10 mW helium-neon laser guns. When you kill one of the other participants his light-detector vest will inform the electronic scoreboard. The cost is reported to be S1 per minute.

Zap! Your system's tested.

Now available in Canada from Allan Crawford Associates

Test in "real time" up to 5 megahertz and drastically cut development time and costs.

With the force of the MicroSystem Analyzer, developing diagnostics now can be a snap. Operating in real time at microprocessor speeds up to 5 MHz, the MicroSystem Analyzer speeds total development time, performs hardware/software integration, and gets your prototype into production faster.

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With the MicroSystem Analyzer, you now can control your system with In-Circuit Emulation, and find faults with Signature Analysis, Time and Frequency measurements.

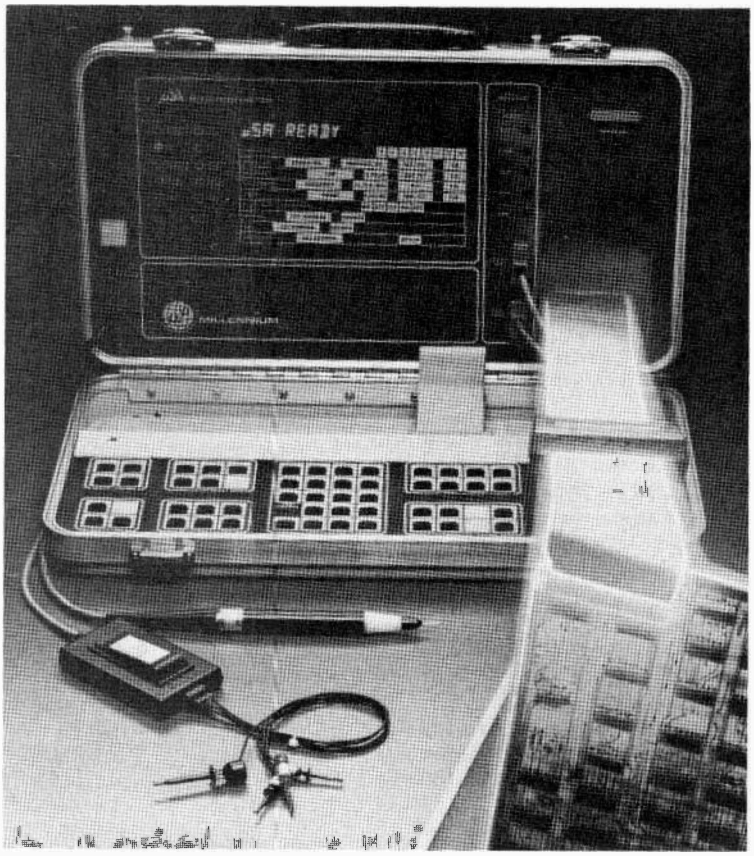
No other system available combines the elements to let you control and test at *all levels*—system, board, and component—in real time. The MicroSystem Analyzer lets you discover intermittent problems over a wide range of temperatures, operate without a built-in test source, and perform fault detection in multiboard systems. Test programs are easier and faster to develop, more complete and more accurate.

Universal—Both Today & Tomorrow

The MicroSystem Analyzer plugs directly into the most common microprocessor sockets —Z80, 8085A, 6800, 8080, with more to come—and uses a series of personality cards and probes to let you thoroughly isolate faults to the subsystem and component level. No matter what major microprocessor you are using in product development or in production test, the MicroSystem Analyzer is the one universal and portable instrument for you.

Get Your Products into Production Faster

The MicroSystem Analyzer eliminates the need for long and expensive test fixture development, so you can move onto the next project sooner. Plus, with the diagnostics developed you have provided total production, depot repair and field test support!



MILLENNIUM

For details on the Millenium Systems, Inc., MicroSystem Analyzer, the most advanced microprocessor test instrument available today, contact the Allan Crawford Associates office nearest you, or use the reader service card.

Allan Crawford Associates Ltd.

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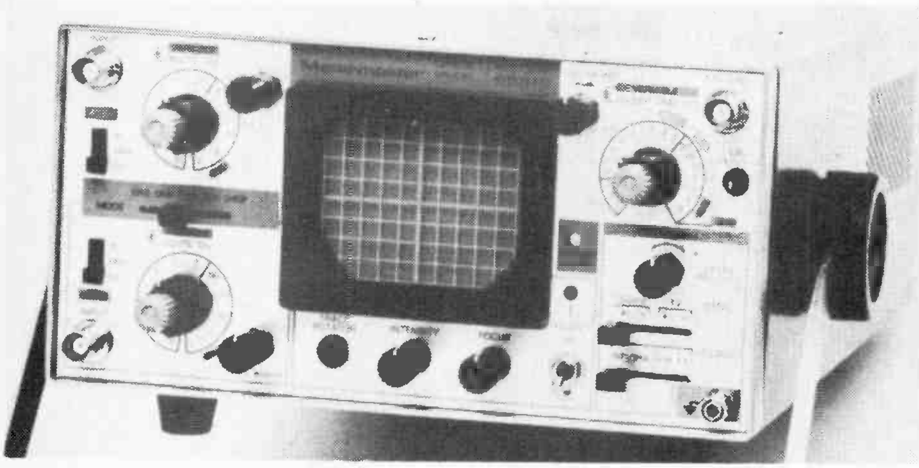


New Scope

Metermaster has introduced a new 15 MHz Portable Oscilloscope. The Model 65310 is a dual-trace scope which may be operated from any one of three power sources: 120V AC, internal rechargeable NiCads, or external 11-30 volts DC. The internal batteries will provide two hours of operation. The scope features 2mV vertical sensitivity per channel, automatic triggering, 100 ns maximum sweep speed, TV sync, and operation in Channel A, B. Dual, Add or Chop modes. Price is $750, weight is 10 lbs.

Walkie-Talkie

This walkie-talkie is available from Fanon Electronics of Canada Limited, 80 Alexdon Road, Downsview, Ontario, M3J 2B4. Phone 416-638-7290.

UK Prestel Extended

Prestel, the British Post Office's consumer computer network (generically named Viewdata), is now being expanded to allow users to connect intelligent terminals or systems. Previously only TV-terminals were connected via the phone-line to a central computer. The expansion is a joint venture with CAP Microsoft. The expansion also helps users with the basic TV-terminal: rather than having to search through blocks of data they now can access more specifically.

450 rpm Discs

RCA will launch "SelectaVision" VideoDiscs in the United States and Canada, Edgar H. Griffiths, President of RCA, announced recently. He said a time schedule for product introduction will be announced later this year.

Two years ago, RCA set three goals to be met before the company would consider a go-ahead on the video disc project. They were:

1. Development of a video disc player that could be sold at retail for $400 (US) or less.
2. Development of an uncoated disc that contained one-hour of programming per side, or a total of two hours per disc.
3. Availability of adequate software, or programming, to support the introduction of a video disc system and sustain it in the market place.

RCA claim to have achieved these with a system using a grooved disc that is played with a diamond stylus. The disc revolves at 450 revolutions per minute and contains one hour of programming per side. The player attaches to any television set. They expect the discs will sell for about $10 to $17 (US).

The disc itself resides in a plastic sleeve, which resembles a record album cover. The sleeve, when inserted into a slot on the front of the machine, deposits the disc on the turntable. The disc is removed from the machine by reinserting the empty sleeve back into the player.

RCA's initial catalogue will contain 250 titles, including feature motion pictures, as well as children's how-to, sports, cultural, educational and musical programs.

Sylvania Catalogue

Three new publications from GTE Sylvania: ECG Semiconductors, Thordarson TV Replacement Parts, and the Set-Up Manual for Chek-A-Color test jigs.

The Sylvania ECG Semiconductors Master Replacement Guide is 290 ETI-sized pages giving equivalents, specs, pinouts and schematics for this range of transistors and ICs. The guide is dated January 1978, so we also received Supplement No 3, published November 1978. We also received a glossy brochure on the ECG line of flameproof resistors.

The Thordarson catalogue is 86 half-ETI-size pages showing Thordarson replacement numbers for parts used by forty-six brands (plus some more exotic ones).

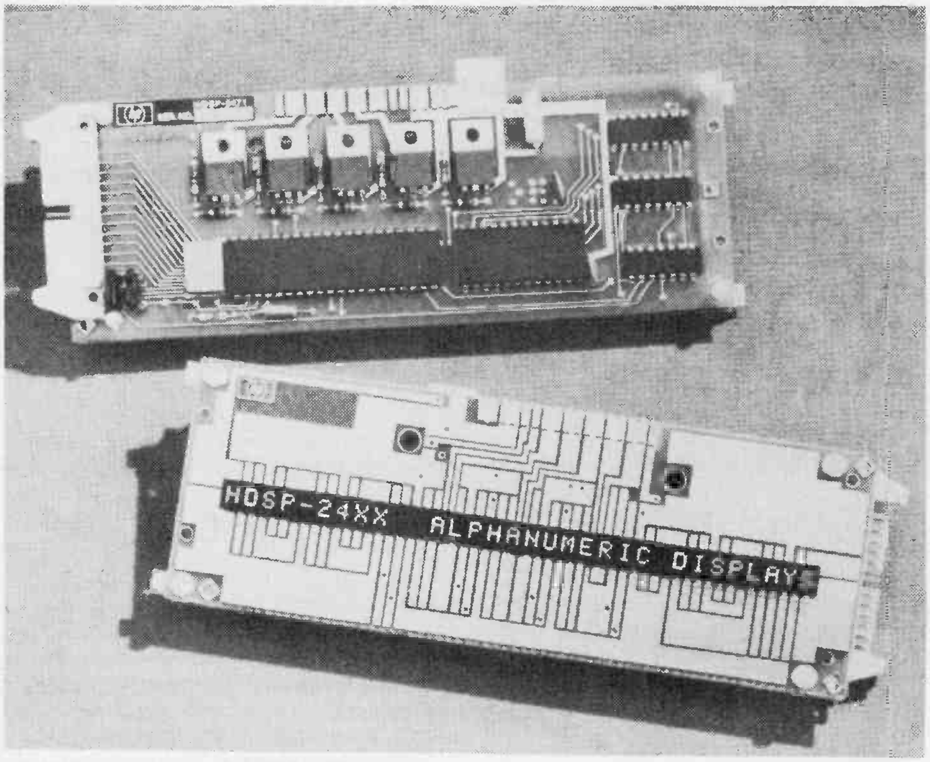
The Set-Up Manual for Chek-A-Color gives set-up numbers for more than 2500 chassis in 61 brands.

The books are available on request (free of charge) from GTE Sylvania Canada Ltd, 8750 Cote De Liesse Rd, Montreal, Quebec, H4T 1H3.

Key Cat

Another catalogue for our files came in from Key Electronics, PO Box 3506, Schenactedy, NY 12303, USA. The five-sheet flier/catalogue has a small listing of the usual resistors, capacitors, diodes, heatsinks, half-a-dozen transistors, plus an ASCII keyboard kit (US $64.95) and the SN76477N complex sound generator from TI (US$2.95).

NEWS DIGEST



Alphanumeric Displays

A new stand-alone dot-matrix alphanumeric display system using a microprocessor controller has been introduced by Hewlett-Packard.

This new system, the HDSP-24XX Series, incorporates pre-programmed routines to accept, decode and display standard ASCII data. Interfacing is made easier by the 5 volt operation, standard LSTTL compatible inputs and four separate display formatting modes. The display series provides optional upper and lower case character fonts, or user-programmed custom character sets. Single line 16, 24, 32, or 40 character display lengths are available.

The price for a 32-character single line display system is $343.17 in 100 piece quantities (taxes extra).

Signal Generator

A new signal generator with a bandwidth of I kHz to 520 MHz has been introduced by Wavetek and is available in Canada exclusively from Allan Crawford Associates Ltd.

The new model 3002 provides 0.001% frequency accuracy and 0.2 ppm/hour stability over the frequency range. Frequency programming is standard, and the unit is compatible with the IEEE 488-1975 general-purpose interface bus when used with Wavetek's model 3911 GPIB converter.

Options available with the signal generator include level programming, external frequency reference, reverse power protection, and low level leakage. The instrument offers CW, AM, and FM operation with internal 400 and 1000 Hz or external modulation capabilities.

Biophysical Monitoring

The new Gould Biophysical Monitoring System, available in Canada from Allan Crawford Associates Ltd, is a versatile system for monitoring multiple biophysical variables.

The heart of the system is a 4-channel nonfade monitoring oscilloscope which displays up to four waveforms with pushbutton "freeze" capability.

A "cascade" mode causes a waveform on any channel to extend over all following channels for a greater viewing interval, and a "programmable trend" mode presents a trend chart of any selected variable. A pushbutton associated with each channel permits recording of delayed scope waveforms. For more information contact: Mr David Green, Allan Crawford Associates Ltd, 6503 Northam Drive, Mississauga, Ontario. Phone 416-678-1500.

The Hansen AT-1 is a mini-sized multimeter 'designed as the subsidiary instrument ' for engineers and technicians. It features protection against magnetic interference, 90 degree mirrored scale, and ABS case. GE diodes give a good frequency response on AC volts ranges.

For more info contact Len Finkler Limited, 25 Toro Rd, Downsview, Ontario, M3J 2A6. Phone 416-630-9103.

ACA Calgary Move

The Calgary office of Allan Crawford Associates Ltd has expanded to larger premises at 14-1935-30th Ave NE, Calgary, Alberta. Phone 403-230-1341.

A major portion of the new premises is devoted to the ACA Electronic Centre where popular models of electronic instruments and equipment may be examined and purchased. Also located at the new address is an expanded service and calibration facility.

Webster Rep Acurex

Webster Instruments Ltd, Mississauga, Ontario, have been appointed exclusive Canadian sales and service representatives for the Autodata division of Acurex.

The Acurex product line includes data loggers, data acquisition systems and wireless data couplers.

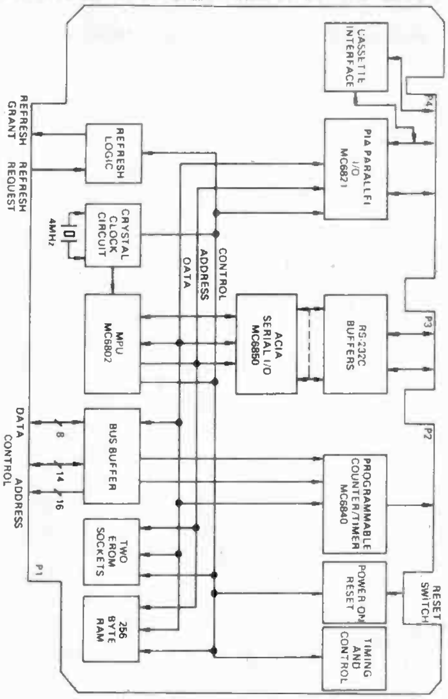
Webster Instruments Ltd, PO Box 427, Port Credit PS, Mississauga, Ontario, L5G 4M1. Phone 416-275-2270.

Motorola Microsystems Monoboard Microcomputer Micromodule Mouthful

Motorola Microsystems has introduced two "monoboard microcomputer micromodules". The M68MM01B and the M68MM01B1A offer programmable timer functions for process controls.

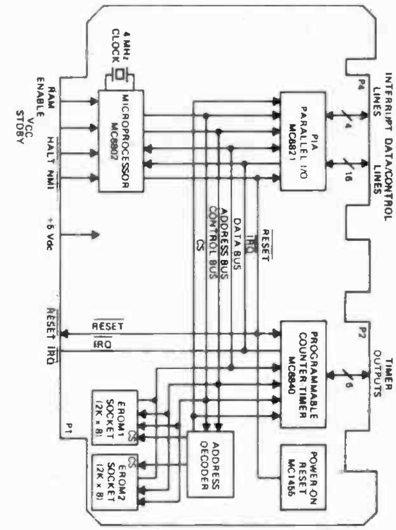
The M68MM01B is a stand-alone microcomputer using an MC6802 MPU with self-contained clock circuit and 128 bytes of static RAM. Additionally, the module contains sockets for up to 4K of EROM or ROM for programming, a peripheral interface adapter (PIA) for parallel data transfers and a programmable timer module (PTM). The PTM module provides for such tasks as frequency measurements, event counting, interval measuring, square wave generation, gated delay signals, single pulses of controlled duration, pulse width modulation and timed system interrupts. The board operates on a single 5 V power supply.

The M68MM01B1A is a more fully-populated version of M68MM01B, with an additional 256 bytes of static RAM,



M68MM01B

provisions for off-board dynamic memory refresh, an asynchronous communications interface adapter



M68MM01B1A

(ACIA) with RS-232C interface circuits, an audio tape cassette interface circuit and bus drivers for the address, data control bus signals.

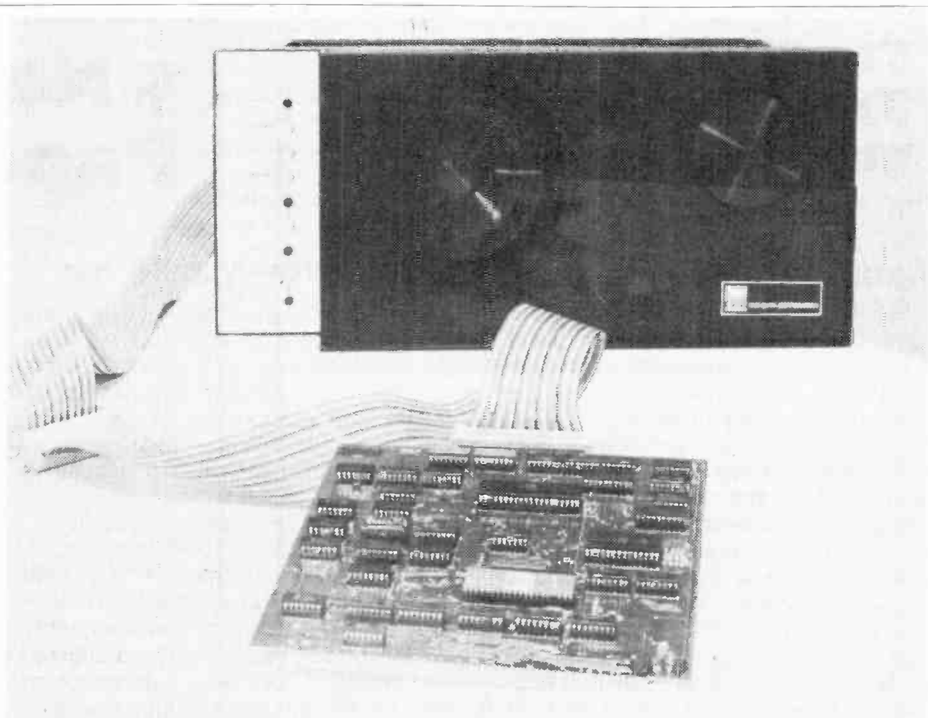
The US unit price of the M68MM01B is $286.00, the M68MM01B1A is $495.00.

ROM For iSBC

Intel Corporation's iSBC 464 is an EPROM/ROM expansion board for the 16-bit iSBC 86/12 single-board computer. The memory board can also accommodate Intel's existing line of 8-bit single board computers. The board accepts 2758, 2716 or 2732 EPROMs, or 2316E ROMs, in four banks of 4, 8 or 16K. US price is $495.

Tape Drives For Micros

Microprocessor-compatible nine-track tape decks are now available from Sonotek Ltd. Model DS11 Controller utilizes Z80 technology and is directly compatible with Zilog Z80-MCB series bus, ZDS-1 and MCZ-1 microcomputer systems. The controller will handle up to four tape drives. It operates on a single 5 V supply from the microcomputer bus, and is capable of controlling most popular makes of formatted tape decks. As depicted, the system utilizes 25 ips tape deck, 800 bpi NRZI recording, and incorporates these features: DMA transfers, dual gap read after write, full IBM-ANSI compatible format with the necessary parity, redundancy check characters,



gaps and file marks. The tape decks are available in the three usual sizes with 7, 8½ or 10" reels. They operate on 115 or 230 VAC or, optionally, on 28 VDC.

For more information contact: Mr. Bob Morgan, Sonotek Limited, 2410-5 Dunwin Drive, Mississauga, Ontario, L5L 1J9. Telephone 416-828-6810.

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64 pages
Published December 1977

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- how to make a zero-beat indicator
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- much more

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Special Offer: Order both the first and the Second Book of Transistor Equivalents and Substitutes and pay only **$4.75** (plus 60¢ postage & handling). The Second Book normally sells for **$3.25.** This offer closes 31st March 1979.
People who bought the Second Book before we had stocks of the First Book can also take advantage of this offer (to get the other book) . . . just send **$1.50,** plus 30¢ postage & handling, and proof that you bought the Second Book (just tell us the transistor named at the top left corner of page 100).

Please use the card to order.

5 New Paperbacks

These five books are advertised here for the first time in ETI. More details will be published in future issues. The books are in stock now. All 7 1/8 X 4 1/4 inches.

Radio Circuits Using ICs by Brian Dance
Published May 1978. 125 pages.
$4.50 + 30¢ postage & handling.

Mobile Discotheque Handbook
by Colin Carson.
Published May 1978. 127 pages.
$4.50 + 30¢ postage & handling.

Popular Electronic Projects by R.A. Penfold
Published July 1978. 135 pages.
$4.80 + 30¢ postage & handling.

IC LM3900 Projects by H. Kybett.
Published August 1978. 119 pages.
$4.50 + 30¢ postage & handling.

Electronic Music and Creative Tape Recording
by M.K. Berry.
Published July 1978. 87 pages.
$4.20 + 30¢ postage & handling.

Please use the card to order.

Audio Today

Developments in audio reviewed by Wally Parsons

BY THE TIME summer rolls around there will be a whole generation of adult audiophiles who can honestly say that stereophonic sound on discs has been around as long as they have. For many of them that is the only kind they know, while for others there may be memories of old "mono" discs in their parents' libraries, just as many a little older remember 78's and some even older recall an attic with stacks of acoustical discs, and maybe a few cylinders.

For them, mono sound is something you get on AM radio or Television, and maybe some portable cassette recorders, but that's about it. It's taken so much for granted that CBC doesn't even operate an FM Network anymore; it's now called, simply, CBC-Stereo. I really don't know what the champagne cocktail set in the Kremlin will do when AM Stereo arrives, but since CBC will probably be the last to hear about it, that problem is a long way off.

QUADRAPHONICS

In the early seventies we "discovered" quadrophonic sound. The idea here is that since we hear real sound in an enclosed space with sources all around us, including sides and rear, it naturally follows that to achieve complete realism in reproduction it is necessary to reproduce sound generate from all directions. This was said to be predominently reverberant information, and since the complete front field was achieved with two channels it is reasonable to assume that a complete field can be achieved with two rear channels. This also produces two side channels on each side, inasmuch as the front and rear of each side constituted a pair of channels.

This was fine as far as it went, but it didn't work out as expected, and this, combined with some rather miserable machinations on the part of uninformed manufacturers anxious to get on the bandwagon and harvest the extra bucks brought about the downfall of the only real advance in sound reproduction since the introduction of the stereo disc and multiplex FM. Now, as far as the Professor is concerned, quadrophonics is not dead, it is merely in a comatose state, sandbagged by the twin villains of corporate greed and irresponsibility, plus technological cretinism.

Someday I'll devote several columns to the subject of quadraphony, but I bring it up here as an introduction to something else.

MATRIXING

All quadraphonic systems, except CD-4 had one characteristic in common: all used a system of matrixing four channels into two. It may come as a surprise to some to learn that this is not a new technique. The earliest example of this technique, to my knowledge, is the telephone companies use of a hybrid coil and amplifier to amplify two signals coming from different directions in a telephone line, making practical the use of a single line to handle both sides of a conversation, and also in the telephone set itself to permit the user to speak into the transmitter and not have his own voice appear in the receiver at excessive levels, and yet allow high level transmission along the lines. I don't know how far back this technique goes, but I find reference to it in Professor Albert's "Electrical Communication", third edition. The first copyright was 1934 and this edition dated April 1950. (Fig. 1)

Fig. 2 shows a Simplex circuit, which allows two channels to be transmitted across a single balanced line. Essentially, E1 is applied to the primary of T1, and appears across the line as a push-pull balanced signal, which is transferred to the secondary of T3 in the usual manner. E2 is applied via T2 to the centre tap on the secondary of T1. For E1 this point is at zero potential, and E2 is impressed as a push-push signal. When it arrives at T3 current travels in opposite directions in each half of the primary, to the centre tap, so no signal appears at the secondary of T3. But since T4 primary is in series with the tap E2 goes through T4 and appears at the secondary. If close balance is maintained on either side of the centre tap, a high level of spearation is possible.

The main disadvantage of this circuit, aside from the cost of suitable transformers, is that the lines are not matched for each channel. E1 has a balanced line, while E3 is really transmitted via two unbalanced lines in parallel.

TWO CHANNEL MATRIX

A stereophonic signal as usually produced consists of two signal channels which are closely related to each other in their characteristics, and very much similar to each other in that each contains basically the same information differing only slightly in specific characteristics. It is only when both are heard simultaneously that the stereo effect occurs.

It is quite possible, then, to combine the two signals, or sum them into one channel which contains all information of the original two channels, which also

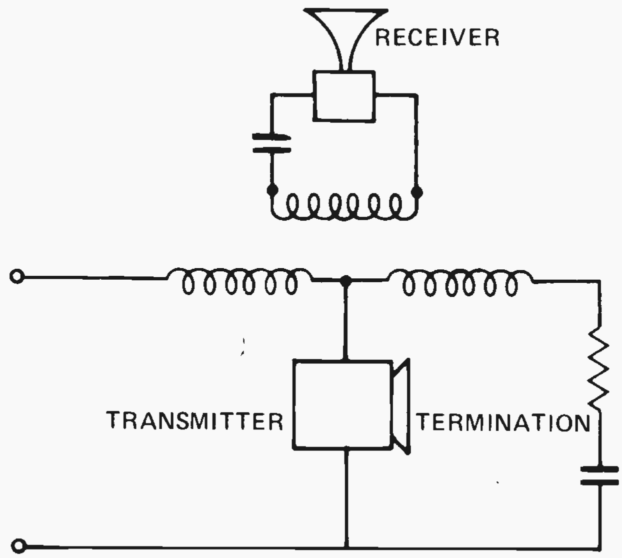


Fig. 1. How a Hybrid coil stops you from talking to yourself.

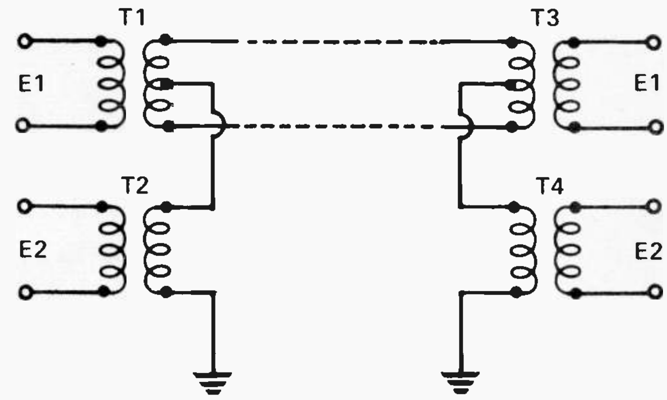


Fig. 2. Basic Simplex circuit, sometimes called "Phantom". Originally used in opera broadcasts.

comes out as monophonic sound. It is also possible to extract from the two channels the one characterisitic which produces stereo — the **difference** between them — and reproduce this difference signal in a single channel. If these are then re-combined in the proper manner the two original channels can be retrieved. Since the sum signal contains all essential information, while the difference signal contains primarily special information, reproduction of the former is usually more stringent. Going back to fig. 2, we can use the sum signal as E1 and the difference signal as E2.

WHY BOTHER?

Before going into the matter of how to produce these signals, perhaps we should give some time to consideration of why we should. The technique was one of the first proposed systems of compatible stereo disc recording, developed in England by Decca, and is still the basis of all their current pick-ups. Their proposal recorded the sum signal laterally, as in mono, while the difference signal was recorded vertically. It had the advantage of mono/stereo compatability, plus lower inherent distortion than the Westrex system which was actually adopted. This was due to the lower inherent distortion in the lateral modulation, while the vertical modulation, by being used for the less stringent difference signal, did not have to be driven to high levels of non-linearity. Since both channels have a vertical component in the Westrex system, reducing distortion has always been one of the major problems in the development of recording techniques.

It was, however, used a few years later in the form of FM Multiplex stereo broadcasting. The sum signal modulates the carrier as in mono FM; the difference signal amplitude modulates a 38 kHz subcarrier. This difference signal is recovered in the multiplex decoder and combined with the sum signal to produce left and right channels.

Reference has been made in earlier columns to the importance of accurate phase balance between channels if stereo imaging is to be preserved. This means precision components in all equalizer circuits, and extremely accurate tracking of controls used in any tone control circuitry, and in level controls. It's not at all unusual for carbon controls to be sufficiently mismatched that a change in level results in a change in balance, and a change in tone control settings produces a shift in stereo imaging. Then, too, not all programme sources possess optimum channel separation, sometimes too much, occasionally not enough.

TRIRIO?

All psycho-acoustic experiments in the past have shown beyond any doubt the impossibility of achieving stereo sound with only two channels in front, the minimum requirement being for three. If speakers are placed far enough apart for a satisfactory stage width, there is a hole in the middle, and if close enough to overcome this, the stage width is inadequate. Modern recording techniques try to compensate for this by providing some centre fill, but it's seldom a satisfactory substitute for a true centre channel, and in any case is never optimized for my particular speaker set-up. Various methods of controlling stage widths have been proposed, but the simplest and most satisfactory is to vary the balance between sum and difference signals.

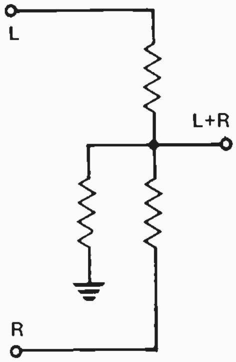
Here's how it works. If L+R, L-R, and it's inversion R-L are combined, their magnitudes add algebraically as follows:

(L+R)+(L-R)= 2L+0R
(L+R)+(R-L)=0L+2R

which is equal to the form in which the information appeared before combining into sum and difference signals. What has happened is that in-phase components, that is, those represented by the same sign, plus, or minus, add together, while out-of-phase components, indicated by different signs, cancel. Now, if we make the sum signal larger than the equivalent difference signal, complete cancellation will not occur with the out-of-phase component, and blending occurs, reducing the sound field. At the extreme, we get mono sound by using only sum and zero difference. At the other extreme zero sum and only difference gives no centre channel, and partway between we can have a super-wide sound field, even to the point of the image disintegrating.

If we have a similar set of tone controls in both sum and difference channels, slight imbalance might affect the image size and possibly the depth slightly, but will not produce sound source wandering and ditheriness which often occur when different phase shifts occur in each discrete channel. This is because the differences operate equally in each channel. That is to say, both right and left are acted upon

(a)



(b)

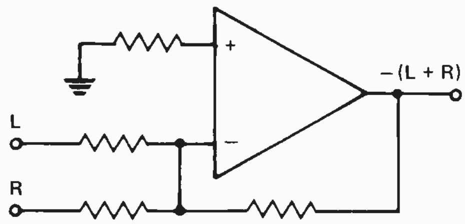


Fig. 3. Summing the channels. (a) Passive Mixer. (b) Active summer.

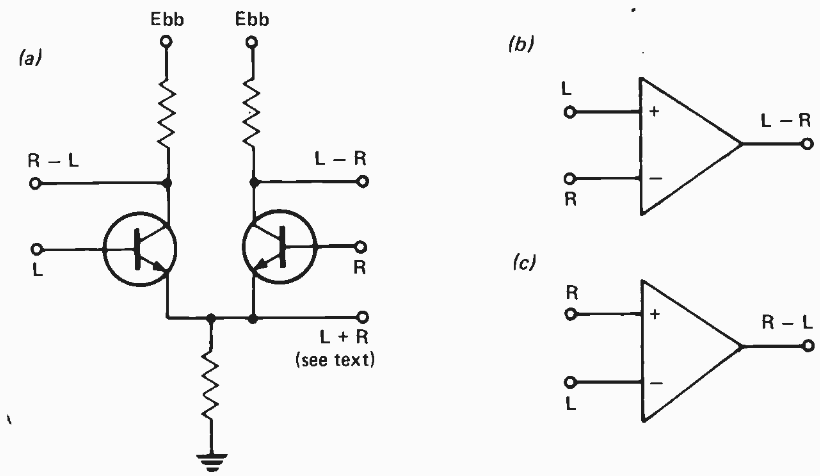


Fig. 4. Extracting Difference Signal. (a) Differential Amp. (b) and (c) Block diagram of differential amps.

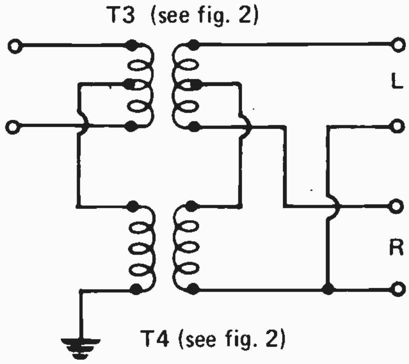


Fig. 5. Recovery of L and R signals in Simplexed sum and difference system.

identically. Similarly with volume controls.

Then, too, if channel separation is not constant at all frequencies, this can be compensated for by changing the response of the difference signal as mentioned earlier. Conversely, noise can be reduced to some extent by reducing separation at high frequencies or any other band where filtering might otherwise be used. The advantage is that bandwidth is not impaired. This is especially useful reducing tape hiss and FM noise.

HOW TO

Getting a sum signal is easy to do: just mix left and right equally using any suitable summing circuit such as in Fig. 3. The easiest way to get a difference signal is either to invert one channel and add, or to use a differential amplifier, or any amplifier with a differential input, such as an operational amplifier, as in Fig. 4. An op amp will require either the use of two circuits, one each for L-R and R-L, or the inversion of one difference signal. A differential circuit will give both just by taking off from the appropriate collector. In the interests of economy, it is sometimes possible to take off a sum signal at the top of the constant current resistor, although this will usually mean using a value so low, in the interest of linear operation, to impair the common mode rejection characteristic, so that some sum signal will appear at the collectors of Q1 and Q2.

Of course, this now gives us three channels, one sum and two difference, but if we only use one of the difference channels, the other can later be recovered by going into one side only of a differential amplifier and grounding the other side. The same signal appears at both collectors, only opposite in phase.

Recovery is easy. Simply sum a L+R and L-R, to get 2L for one channel, and sum a L+R and R-L to get 2R for the other channel. Channel balance adjustments should be accomplished either before encoding or after decoding.

Oh, yes, about that Simplex circuit. To recover the original channel arrangement combine T3 and T4 secondaries as in Fig. 5.

Next month, a more detailed look at some practical applications of this technique.

CONTEST ★★★★★★★★★★

TO CELEBRATE the first anniversary of this column, ETI announces a contest. Just like the big fellas south of the border. Only the contest is not a substitute for content.

In conjunction with this month's Audio Today topic, we thought it would be interesting to see how far readers can take the material discussed in developing their own applications before my suggestions appear next month. All you have to do is take the material and send in your ideas (with schematics — free-hand is OK) on how to use the techniques and/or applications, with explanations of how it works, and why it's useful. Basic ground rules are pretty flexible, and entries will be judge by ETI editorial staff, specifically, Steve, Graham, and me, as to originality, sophistication, novelty, general usefulness. Needless to say, it has to work, and must not require the invention of a new type of device, or a new system of recording or broadcasting.

The deadline is April 30, (by postmark) or May 8 for Western Canada, the Maritimes, and the Territories (it takes a week longer for ETI to get there, and we want everybody to have a chance. After all, British Columbians are Canadians too, no matter what Trudeau thinks). However, just to make things interesting, any entry Postmarked after the May issue goes out, (which is April 15) must not duplicate any application which appears in that issue (Above areas also get an extra week.)

The prize is a year's subscription to ETI, or one year's extension if you already have a subscription. Send entries to: Contest, Audio Today, ETI., Unit 6, 25 Overlea Blvd, Toronto, Ont., M4H 1B1.

Audio Today Products

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

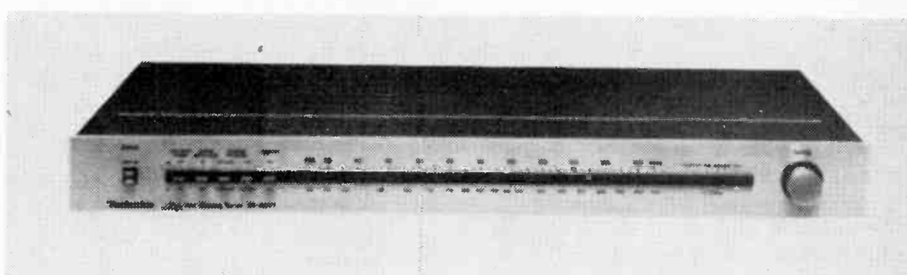
THE TECHNICS LINE

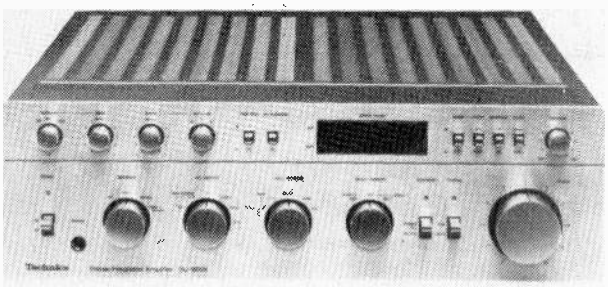
The TECHNICS division of the Panasonic division of Matsushita Electric Co. of Canada Division of Matsushita Electric Co., Ltd., Kadoma Osaka, Japan has unveiled a new line which includes power amplifiers, pre-amps, speakers, tuners, turntables and cassette recorders. On the whole, the line appears to be essentially the result of refinements of circuitry and fabrication with some changes in cosmetics, although special mention should be made of the SE-CO1 Amplifier, SU-CO1 Preamp, and ST-CO1 Tuner. These units are designed and styled to complement each other, and are most notable for their small size, high performance, attractive styling and relative freedom from the clutter of useless and often redundant controls which seem to be the bane of so much of today's equipment. About the only criticism I have in this regard is the presence of power meters (LED) which I have always considered useless and expensive gimmickry when used on a low power (40 W/Ch in this case) amplifier intended for home use, and the "Loudness On/Off" switch, a "feature" which, unfortunately seems to be mandatory on all presently made equipment.

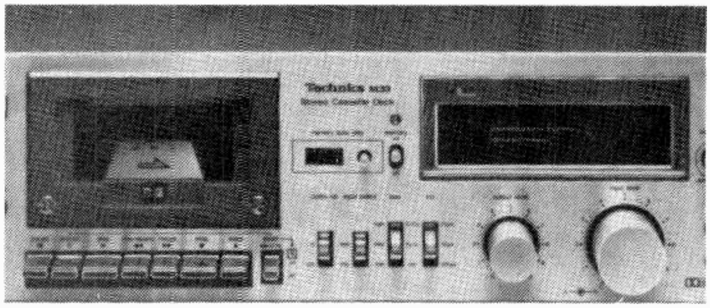
The power supply rectifies line power, converts it to 20 kHz square waves then rectifies it to power the power amplifier. This is said to be mainly responsible for the small size of the power amplifier.

The rest of the power amp line is said to have had distortion measurements made by input/output comparison techniques. This technique has been in use for some years in Britain, and is still the subject of some controversy, with its strongest advocate apparently is Peter Walker, the big force behind QUAD's Current Dumping technique. Whether or not this represents ultimate salvation remains to be seen, but in the meantime it appears to be a useful evaluation tool, and I hope to be able to write something about it before the year is out.

For more information contact: Matsushita Electric of Canada Ltd., 40 Ronson Dr., Rexdale, Ont., M9W 1B5, or phone (416) 248-5551







Audio Today Letters

Want to express your views or report on news? Write to Audio Today, ETI Magazine, Unit Six, 25 Overlea Blvd., Toronto, Ont. M4H 1B1.

SYSTEM EVOLUTION

I am a recent subscriber to ETI and find your section of the magazine of particular interest to me. I am presently building the ETI 50D50 power amp., and am getting started on ETI's CMOS switched pre-amp. Following a logical sequence here, (I think) one of my next projects will have to be a speaker system.

I would like to see your column run a good, comprehensive feature on a three or four-way speaker system. For neophytes like myself this should include cross-over systems and caninet sizes or designs. You might even recommend some speakers by brand name, on the basis of their performance.

W.M. Errington, B.C.

(P.S. I'm sure there must be lots of readers out there who would like to graduate to better speaker systems without having to put out the big bucks for them.)

In the world of logic, one man's logical sequence is often another man's wild flailings, so I don't know how logical yours is. Ordinarily, I would recommend beginning with the speaker, then approaching the amplifier question on the basis of meeting the speaker's drive requirements. This approach presents a problem for the neophyte who is building his own, in that he probably doesn't have enough theoretical knowledge or practical experience to do this effectively. Woe betide the man who builds a 50 Watt amplifier, then decides he should build a bookshelf speaker and wants to hear the Vancouver Symphony at concert hall level playing the Saint Saens Organ Symphony. However, if he starts with the speaker, he has no means of satisfactorily driving it until he builds the amplifier, so it becomes a matter of moving back and forth between the two, modifying and de-bugging each in turn.

However, you have chosen an amplifier and pre-amp which. although by no means state of the art, will give a good account of themselves with most speakers which you're likely to build, so the choice makes a good starting point. If, after a few years you're dissatisfied with the performance you'll probably want to move to a more advanced amplifier design and will have acquired the knowledge and skill to do so.

At this point I would suggest buying or building a simple inexpensive system such as the small Advent (ready made) or one of the small simple Philips designs. It will give you something decent to listen to while planning and executing your major speaker project, and when you have the speakers you really want you'll still have the original ones for use as extensions or whatever other use you might find for them. If you decide on a transmission line, for example, you might then decide to build a higher power amplifier, or bi-amp the system.

A complete speaker system design, or a coherent series on speaker design is beyond the scope of Audio Today, which is intended at various times to provide a general overview of audio, and sometimes to focus closely on individual aspects, all the while examining different philosophical aspects of audio, albeit from a personal point of view.

However, there is the possibility of developing a series of feature articles on the subject, but you must realize that this takes time, as the whole series must be planned in some detail before even the first part can be written. I feel confident that such a series will eventually appear in these pages, either formally or in the form of individual loosely related articles. After all, this is only the first anniversary of this department, and ETI is only into its third year. In perusing back issues, not only on this column, but of the whole magazine, I am surprised at how far we have come. Eventually I hope to see ETI develop as a major authority in one or more areas of electronics, including, naturally, audio.

And as long as we keep getting letters like this, I'm sure we'll get there.

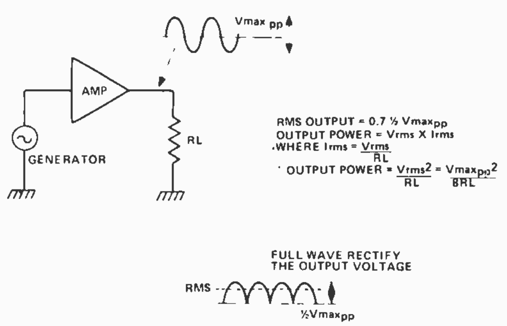
Design Audio Amps

Designing an amplifier is like re-inventing the wheel. There are thousands of published designs and possibly as many as a 100 different types of monolithic amplifiers as well as lots of off the shelf modules to choose from. If you design the amplifier yourself (or use someone else's design) you will probably encounter problems such as heat, noise, instability, distortion, power rating etc, etc. In this article Tim Orr sets out to help you cope.

POWER RATING

The power rating for an amplifier is *generally considered* to be the maximum RMS power that a sine wave can deliver to a load (Fig. 1). The RMS power is given by:

$$P_{(RMS)} = \frac{V_{PP}^2}{8RL}$$



Therefore if RL=8R and Vpp is 1V, $pP_{(RMS)}$ = 15.6mW.

For V_{pp} = 10 V $P_{(RMS)}$ = 1.56 W.
For V_{pp} = 100 V $P_{(RMS)}$ = 156 W.

So the RMS power goes up as a square of the output voltage. However our hearing does not respond linearly to power, and so the difference between a 10 W and 100 W amplifier can be disappointing.

HEAT

Not surprisingly, power amplifiers get hot. When they are delivering power to a load, the amplifier is also dissapating a considerable amount of heat itself. A reasonable rule of thumb is that both the amplifier and the load dissipate the same power, except when there is no output signal. Then the amplifier is the only thing that is getting hot. To get a very low crossover distortion it is usually necessary to run the output transistors in an amplifier in class A or AB. This means that the transistors are biased on (or partly on for AB operation). Thus they consume lots of current and get hot. Therefore designing power amplifiers is a compromise between heat production and distortion. IC power amplifiers, because of their small size, go for low heat generation and hence higher crossover distortion. Discrete component power amplifiers can use large heat sinks sometimes with forced air cooling and thus obtain THD figures from 0.1% to 0.01%.

Some IC power amplifiers get rid of their heat down the IC legs to suitably large areas of copper on the printed circuit board. There are also 'Stick On' heat sinks for DIL packages. Also, when the going gets a bit hot some amplifiers employ a thermal shutdown mechanism. Generally though, high temperature operation means that the device life time is greatly shortened. Thus it is not surprising that the components that fail most regularly are the power transistors in amplifiers and power supplies.

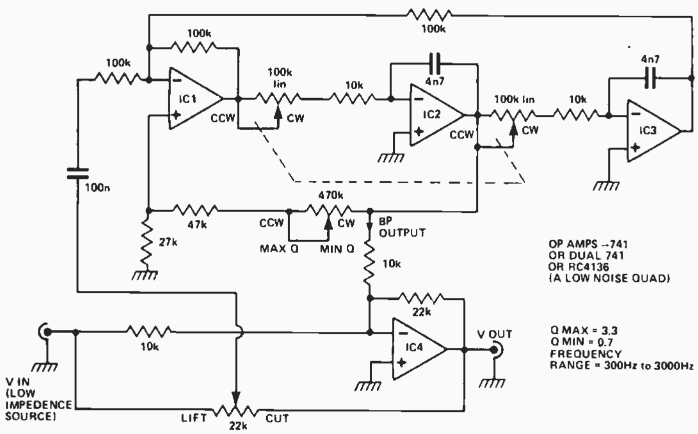
STABILITY

The only difference between amplifiers and oscillators is the phase of the feedback and so it is hardly surprising that a problem exists. When the phase of the feedback becomes positive then oscillation can occur, if the gain of the amplifier is then greater than unity. The gap between a good amplifier and an oscillator is known as the phase margin. When the phase margin is reduced to zero, oscillations will occur.

More feedback when the phase shift is positive will increase the risk of instability. Less feedback when the phase shift is positive will make the amplifier more stable.

However, less negative feedback means more distortion. It is a compromise between stability and distortion. It is possible to increase the phase margin and thus stabilise the amplifier with a suitably placed capacitor. However, in the IC (monolithic) design this is not possible because this capacitor would probably occupy

PARAMETRIC EQUALISER

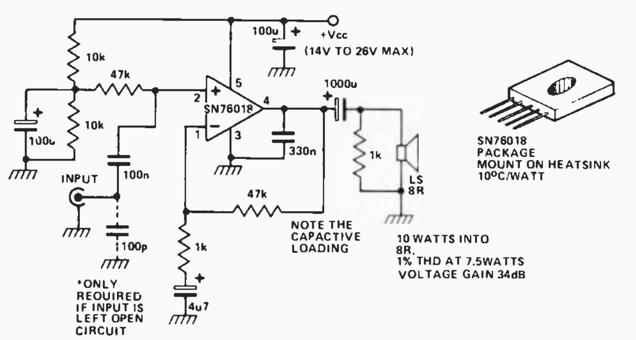


This is possibly the equaliser for the amplifier system that has everything. The parametric equaliser has got three controls. It is a bandpass filter which can have variable cut or lift, so that a particular frequency band can be enhanced or rejected. The resonance can also be controlled so that area of frequency affected can be broad or narrow. Also the centre frequency of the bandpass filter can be varied so that it can be tuned to operate at a particular frequency. The circuit operation is quite simple.

Op amps IC 1, 2, 3 form a state variable filter, the Q and centre frequency of which can be varied. Op amp IC4 is a virtual earth amplifier. When the equaliser is in the lift position, the signal is fed into the state variable filter. It then comes out of the bandpass output and into IC4. In this feed forward position the equaliser has got a peak (lift) in its response. When the equaliser is in its cut position, the bandpass filter is in the feedback loop of IC4 and so there is a notch in the frequency response.

Care must be taken not to cause overloading and clipping when using high Q lifts.

10 WATT POWER AMPLIFIER. (SN6018)



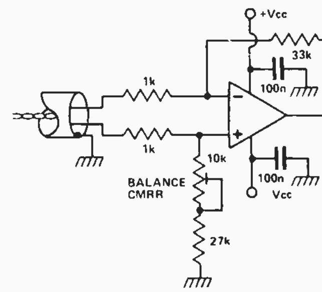
This is a very simple and inexpensive monolithic power amplifier made by Texas Instruments. It comes in a package that looks like a plastic power transistor with five legs.

Thus it can be screwed down to a heat sink without any problems. The THD specifications for this device are:

10 W at 10% THD (R1 = 8 ohm)
7.5 W at 1% THD (R1 = 8ohm)
0.05 W to 6.5 Watt at 0.2% THD (RL = 8ohm)

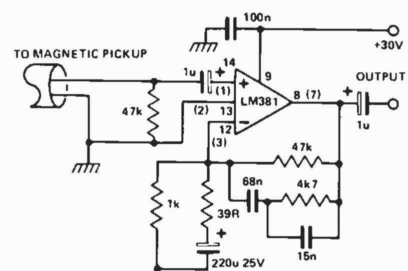
No isolation from the heat sink is required. It should be used in applications where high fidelity is not required. Note that it requires two stabilising capacitors.

ELECTRONIC BALANCED INPUT MICROPHONE AMPLIFIER



It is possible to simulate the balanced performance of a transformer electronically with a differential amplifier. By adjusting the presets the resistor ratio can be balanced so that the best CMRR is obtained. It is possible to get a better CMRR than the one you would obtain from a transformer. Also, a transformer can itself pick up mains hum, it is expensive and heavy. So, electronic balancing can be quite competitive. One problem is obtaining a truly differential low noise amplifier. I would suggest a RC4136 which is a quad low noise op amp.

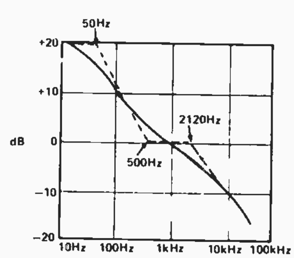
RECORD PLAYER – MAGNETIC PICKUP



THE NUMBERS SHOWN IN BRACKETS ARE THE PINS FOR THE OTHER HALF OF THE IC.

If you were to amplify the signal from a magnetic pickup on a record player and listen to it the sound would be terrible. It would be all treble and no bass. This is because the pickup is magnetic and gives an output voltage which is velocity sensitive. That is the faster the needle wiggles in the record groove, the larger the output voltage, or rather the output voltage (for the same amplitude of excursion) is proportional to frequency. To restore the natural sound, the signal must be equalised with a frequency response as specified by the RIAA.

This play back equalisation gives 20 dB lift at low frequencies and 20 dB attenuation at high frequencies and is 0 dB at 1 kHz. No equalisation is required if you use one of the cheaper ceramic pickups, which have a flat response.



Graph illustrating the non-ideal approximation to the ideal RIAA equalisation curve, the response flows smoothly unlike the 'defined' RIAA response.

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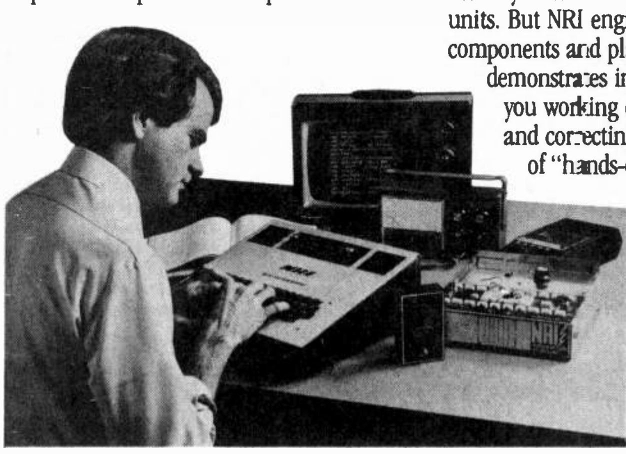

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twice the area as the rest of the integrated circuit. So, the designers of IC power amplifiers usually make this stabilising capacitor small and set the amplifier gain high (less negative feedback).

You end up with a power amplifier that is only stable with high values of gain and which has a relatively high distortion. Even so, most monolithic designs need additional capacitors on their inputs and their outputs to maintain stable operation. Other stability problems are:

1) Amplifier gain and phase margin depend on power supply voltages. Thus, an amplifier may not be stable under varying conditions of supply voltage. During the power up, the amplifier may emit a squeak or a whoosh, due to high frequency instability.

2) Amplifier gain and phase margin depend on temperature. Thus as the amplifier warms up it may then become unstable, oscillate, the output transistors get very hot and the amplifier burn out.

Alternatively, the amplifier may be unstable only when cold. So you switch on and it squeaks (oscillates), warms up, stops oscillating, cools down, oscillates (squeaks), warms up, etc. etc. (Breaks the ice at parties!).

3) The load put on an amplifier will affect the phase margin. Designing an amplifier that will drive any load is difficult. Often a power amplifier will have a capacitor resistor network from its output to ground. This network is used to increase the phase margin.

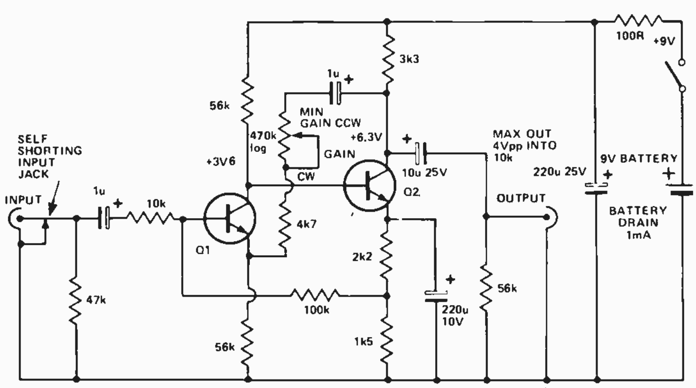
DISTORTION

If you put a pure sinewave into an amplifier and you get out of it the same sinewave plus some harmonics, then you have got distortion. Any other spurious signals are not distortion products and are not included in the THD calculations.

Crossover distortion is usually generated by the output transistor pair (Fig. 2). This is caused by one of the transistors switching off before the other one can switch on. The result is a 'lump' in the output waveform which gives the sound a 'buzzy' quality. The distortion can be reduced by turning the output transistors on a bit more, by biasing their bases further apart. This increases the quiescent current and thus more power is dissipated: Also, overall negative feedback can be used to iron out the kinks, but this will increase the chance of instability.

Another type of distortion is harmonic distortion. An amplifier, used in open loop is usually fairly non linear. This non-linearity will cause any signal passing through the amplifier to be distorted. Negative feedback is used to iron out the non-linearities and so reduce this source of harmonic distortion.

It is interesting to note that the hi-fi market wants low THD figures of 0.1% to 0.01% but the music market actually prefers (in some cases) higher figures of about 2%.



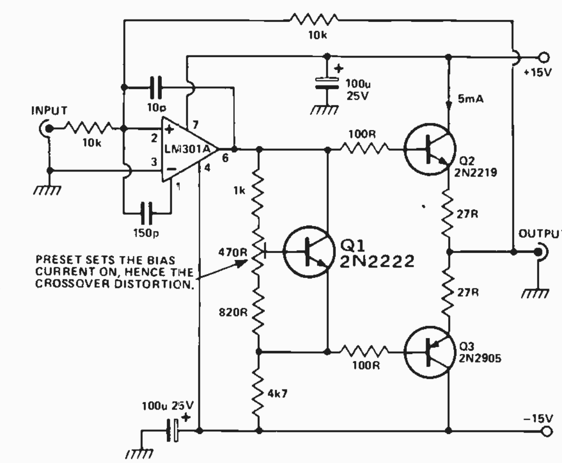
Q1 and Q2 are MPS6515

Mains hum is easily picked up with high impedance microphones, particularly if the microphone cable is long. Also, a treble cut occurs when using long cables. The output impedance of the microphone and the capacitance of the cable produces a low pass filter which cuts off the high frequencies, so that a high impedance microphone should only be used on a short cable.

For low impedance types, a low-noise high gain amplifier is needed, as output is much lower, and the circuit above is such an amplifier. The noise generated by transistors is a function of collector current. The current through Q1 has been optimised to give low noise operation.

The amplifier has an open loop gain of more than 60 dB. Negative feedback is applied, via a variable 470k pot, so that the closed loop gain is controllable from 6 dB to 35 dB. This allows the gain to be tailored to suit different types of microphone and hence get the best overload and S/N ratio conditions. A maximum signal output of 4 V into a 10k load is obtained and the current drain is 1 mA making it possible to run the amplifier from a 9 V battery.

UNBALANCED LINE DRIVER



The high open loop gain of an op amp is combined with the power handling capabilities of descrete transistors to produce a line driver amplifier. The output driver stage (Q1, 2, 3) is included in the overall feedback, and acts as a power booster on the output of the op amp. Transistor Q1 is used as a V_{BE} multiplier. That is, it sets up a voltage of about 1V5 between its collector and emitter. The actual voltage can be set by the preset connected to its base. Thus the bases of Q2 and Q3 can be biased apart by a set amount, just sufficient to make them work in class B operation.

If there are any ambient temperature changes, Q1 automatically adjusts the bias voltages to Q2,3 to maintain a constant bias current. There is overall negative feedback from the output, providing a voltage gain of 0 dB (x1). The output is partly short circuit protected by the 27 ohm emitter resistors. This amplifier can deliver high level, low distortion signals into low impedance loads. It could be used as an output driver in an unbalanced audio mixer.

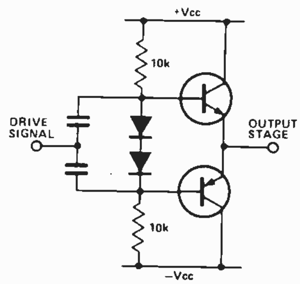
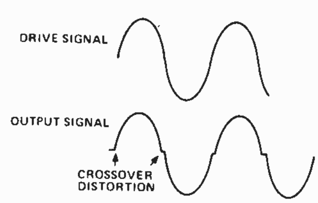


Fig 1 (above) is the classical output pair that produces the equally classical crossover distortion illustrated below. Careful biasing of the output pair can reduce the effect but it is usually present in most amplifiers of this type.



NOISE

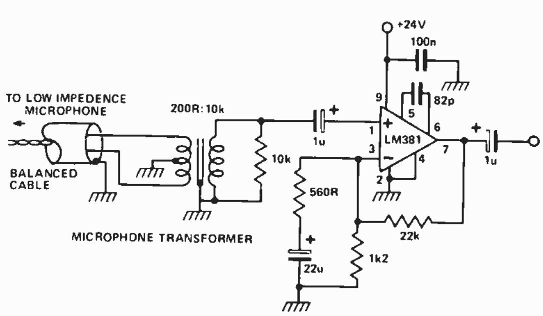
Noise is generally not a problem in power amplifiers but it is in the pre-amplifier stages of an audio system. An overall system signal to noise ratio of 70 dB (3 000 to 1), is quite good and not very difficult to achieve. Better than this is studio or professional quality. When amplifiers are used to reproduce stored signals, such as from a disc, radio or tape recorder, then an overall S/N ratio of 70dB is quite adequate. This is because the S/N ratio for these storage or transistor systems is quite low.

For example the best disc technology will only give us a 60 dB S/N ratio. The best studio quality tape recorder (unprocessed), will give 65 dB. Radio transmissions are about 50 dB on FM, and cheap cassette players only clock up 30 dB's.

As tapes and discs are used then their S/N ratio deteriorates. Also, most listening environments have a high background noise level (air conditioning, street noise, jets etc.).

The most demanding situations where the noise of a preamplifier will be important are in amplifying the signals from low impedance microphones, magnetic cartridges for record players and tape recorder pickup heads. In the following sections there are several examples of low noise pre-amplifier designs.

BALANCED MICROPHONE PREAMPLIFIER

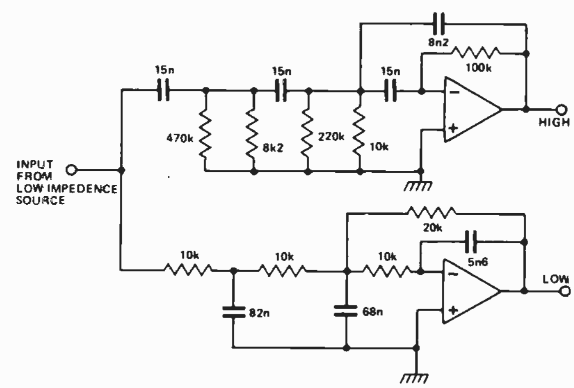


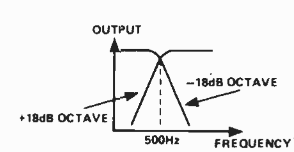
Professional audio equipment generally uses balanced inputs and outputs. This means that the inputs and outputs are differential, which is usually obtained by having balancing input and output transformers.

The advantage of using a balanced system is that any unit can be connected to any other unit without any ground loop problems. A balanced system eliminates these problems. Also, mains hum pick up is reduced. A balanced audio cable has an outer screen and a twisted pair of wires in the centre. Any mains hum (or other signal) which is picked up on the twisted pair will have the same amplitude on each of these central wires. This is a common mode signal. The microphone signal applied to these two wires is a differential signal. Thus, when the microphone signal plus mains hum is connected to the transformer, the differential signal appears at the output windings and the common mode signal is rejected. Thus the mains hum is suppressed.

The transformer also provides a voltage gain, and the LM 381 provides a low noise amplification of about 32 dB (x40).

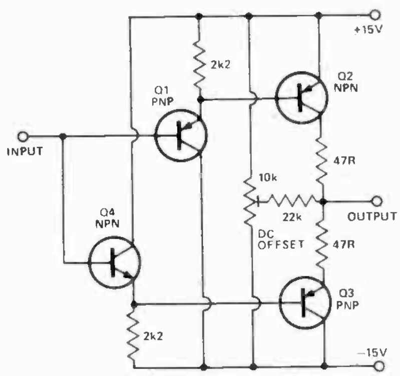
ACTIVE CROSSOVER UNIT





The circuit shown is for a two speaker system having a crossover frequency of 500 Hz. The filter structures are third order Butterworth multiple feedback, low pass and high pass. (Third order implies that roll off slopes of ±18 dB/octave are obtained.)

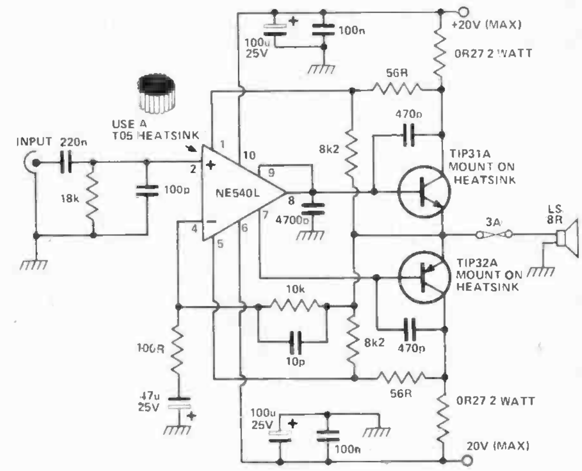
50 OHM DRIVER



When you want to buffer a test generator to the outside world it is often very difficult to get an amplifier with sufficient bandwidth and power handling to do the job. The circuit is a very simple unity gain buffer. It has a fairly high input impedance, a 50 ohm output impedance, a wide bandwidth and high slew rate.

The circuit is simply two pairs of emitter followers. The base emitter voltages of Q1 and Q2 cancel out, and so do those of Q3 and Q4. The preset is used to zero out any small DC offsets due to mismatching in the transistors.

20 WATT AMPLIFIER



An audio power amplifier can be constructed from a power driver op amp plus a pair of transistors. The power driver is a NE540 made by Signetics. It generates quite a bit of internal heat and so a TO5 heat sink is required. Note that this design uses five stabilising capacitors.

The amplifier works quite well once any stability problems have been sorted out and the power output is quite adequate for a domestic amplifier system.

What Quad Terms REALLY Mean(t?)

A light-hearted glossary by Michael Gerzon and Hugh Ford.

THERE HAS been considerable confusion and misunderstanding as to what various technical terms used in connection with quadraphonic sound actually *mean*. The following glossary is an attempt to define the meanings normally given to various commonly-used words and phrases in this field.

AMBIENCE. A sort of muddiness added to sounds to make them less clear.

COINCIDENT MICROPHONES. An arrangement of directional microphones which are spaced apart by more than five wavelengths of the highest audio frequency.

COMPATIBILITY. A property of quadraphonic systems that ensures centre-back sounds are not reproduced in mono and that stereo reproduction gives either narrow or lopsided images.

CONCERT-HALL RECORDINGS. A type of recording in which all sounds appear to be in the middle of an echo chamber

CONSUMER. The technical term for an animal used for laboratory experiments in quadraphonics.

DISCREET SYSTEM. The same as a discrete system.

DISCRETE SYSTEM. (1) Any four channel system that uses four channels. (2) A system that uses four mutually related and interdependent channels. (3) The opposite of a discreet system.

FOUR-CHANNEL SOUND. A recording containing only one dimension (a circle) of sound.

4. (1) A symbol meaning two.
(2) The Japanese word for death.

LOGIC. A method of doing the impossible in an unsystematic manner.

MATRIX. Any system that achieves full discreteness by cheating. Also known as a four-channel system.

MONO. A system of recording sounds from all directions, capable of producing an illusion of spaciousness and depth.

PHASE MATRIX. A system of reproduction using four loudspeakers in which sound positions are determined entirely by the amplitudes of the sounds from the four loudspeakers.

QUAD. Any modern sound reproduction equipment not made by the Acoustical Manufacturing Company Ltd.

QUAD POT. A method of not positioning sounds very well.

QUADRAPHONY, QUADRASONICS, QUADROPHONY. Any system of recording originating on eight or 16 tracks, transmitted through two disc channels, and reproduced through 12 loudspeakers (including woofers, midrange units and tweeters). Note the curious use of Quadri or Quadru roots.

QUADRAPHONIC HEADPHONES. Stereo headphones that cost twice as much.

QUADRAPHONIC SEAT. The only position in a room from which it is not domestically practical to listen.

READY FOR QUADRAPHONICS. Ready for stereo.

SEPARATION. The meaning of this term depends on the laws of logic, which vary from moment to moment.

SHIBATA STYLUS. A method of determining how much dust has collected at the bottom of your records' grooves.

SIDE SOUND POSITIONS. This term has no meaning.

SQUARE SPEAKER LAYOUT. A type of speaker layout that does not fit into domestic listening rooms.

STEREO. An obsolescent term meaning a hi-fi system in which two speakers are missing.

SUBCARRIER MODULATION. (1) A spluttering sound on discs audible to your wife and children. (2) A method once proposed to prevent anyone from taping discs.

SURROUND RECORDINGS. A type of recording in which all sounds seem to be in the middle of your head.

TETRAHEDRAL REPRODUCTION. A system in which one of the loudspeakers is positioned so as to endanger the listener's life.

ULTIMATE IN SOUND RECORDING. Any system not yet including any height information.

VARIABLE MATRIX. A method of making matrix recordings discrete, which uses the fact that you can't tell that a sound is coming from a given direction if it is coming from the opposite direction.

VIDEODISC. A method of obtaining hexadecaphony on gramophone records.

ALL SOLID STATE. Seized controls and cross threaded screws included.

CONSTRUCTED WITH MILITARY GRADE COMPONENTS. Made in 1936.

DESIGNED TO MEET STANDARD 1234. We would like to meet standard 1234 and it's half the price of the competition who succeed.

DISTORTION IS ELIMINATED BY . . . You'll be lucky if you can find the fundamental.

ELECTRONIC OVERLOAD PROTECTION. I^2R smell. Specification: Copywriter's imagination.

IT WILL RECEIVE MORE STATIONS THAN BRAND X. Image rejection and selectivity are zero.

LOW DISTORTION AT EVERY SAGE (SIC) Wireless World P48 (Dec 1937). The dictionary says: distortion, a twisting or writhing motion. Sage, a wise man. The mind boggles.

NOTE THE SMOOTH LOUDSPEAKER RESPONSE CURVE. They took at least a week fiddling the pen speed for this one.

SIGNAL-TO-NOISE RATIO OF 156 dB. It only measured 50 dB unweighted but using a 3 Hz bandpass filter this figure can sometimes be met.

SOLID STATE CIRCUITRY. High distortion.

THIS EQUIPMENT USES AN INTEGRATED CIRCUIT TOO EXPENSIVE FOR OTHER MANUFACTURERS TO USE . . . NASA lost a bundle putting them on the government surplus market at 3c each.

USING THE LATEST COMPUTER TECHNIQUES FOR ADVANCED DESIGN. A mathematical muddle.

WITH VU METERS FOR ACCURATE LEVEL CONTROL. We thought we'd put VU on the scale when we printed our trade mark.

Sun Rays Keep Falling On My Roof

. . . so, might as well use them. ETI provides some background info on what you can do to get in on this fascinating field — a hobby that saves you money, and may save the world.

AND IT CAME TO PASS, when men began to multiply on the face of the earth, they all bought houses or lived in apartment buildings. And they used much power to heat their homes, and bathtubs (not even to mention run their cars) and the use of energy was extravagant among them.

And God saw that the consumption of fossil fuels was great on the earth, and that every imagination of man's thoughts was upon how to use up more faster. And it repented the Lord that He had allowed man such easy comforts. . .

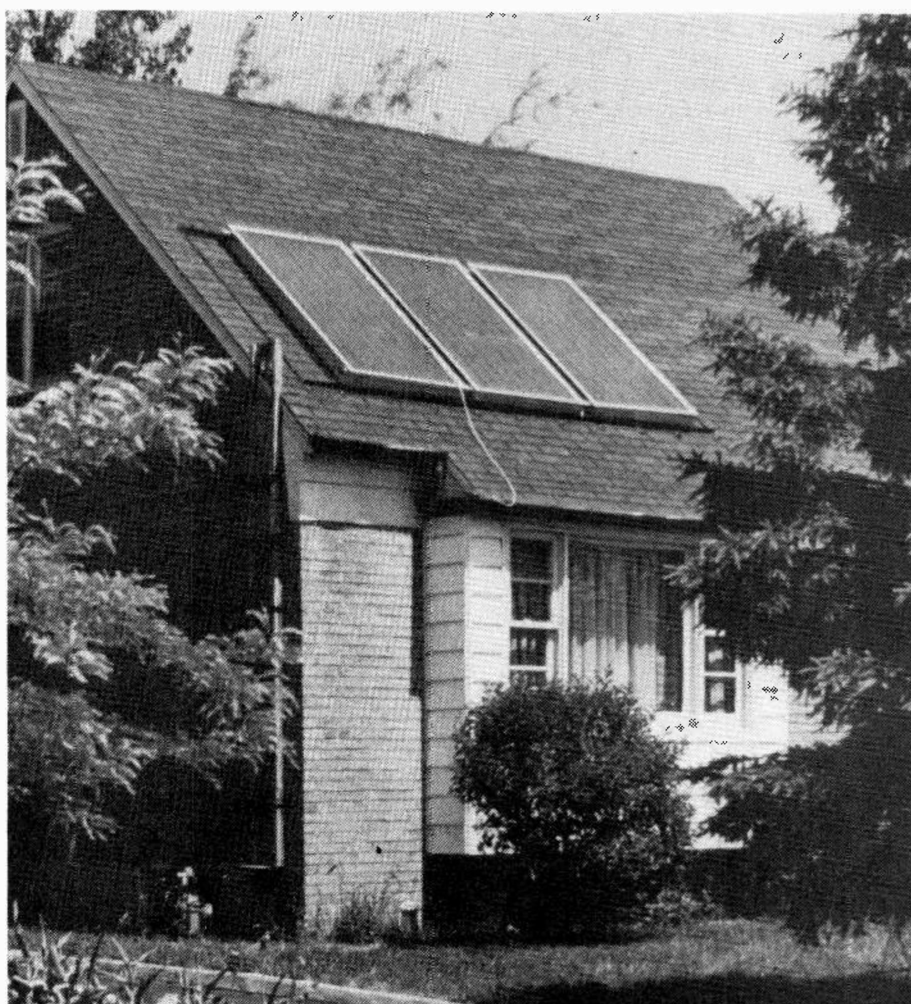
But Noah thought the world should use more natural power sources, wind, water and sun, and so found grace in the eyes of the Lord.

And God said unto Noah, Build thee a house, with large windows, and a solar collector and water storage system. Use of electricity only that kind which comes from the breath of the wind, the tides and temperatures of the sea, the damming of the rivers, or the shining of the sun. Cast out of thine hands that which is non-renewable.

And so, Noah laboured day and night, with his wife and his sons and daughters (for he was an equal opportunity father) and soon a well insulated, large windowed house took shape, with a handsome solar collector system attached.

And while his neighbours scoffed and watched .TV, and generally cruised about in their big American V8 powered cars, he and his family continued to put on the finishing touches.

And when Noah was ready there was political trouble in Iran, and for forty weeks and forty weekends there was no oil and no gasoline. And while Noah and his family sat comfortably in their new



Four Ontario Housing Corporation houses are saving money through the use of roof mounted solar collectors which supply partially heated water to the existing water heaters. The systems cost under $3000, in this case financed by the Ontario Ministry of Energy, who also supplied this photo.

Senior citizens at this Aylmer residence are kept warm 100% by their rooftop solar collectors. In this system a 200,000 gallon insulated storage tank is the secret to night-time heating for the 29 residence building owned by OHC, partially funded by the National Research Council, and CMHC. Photo: OME.

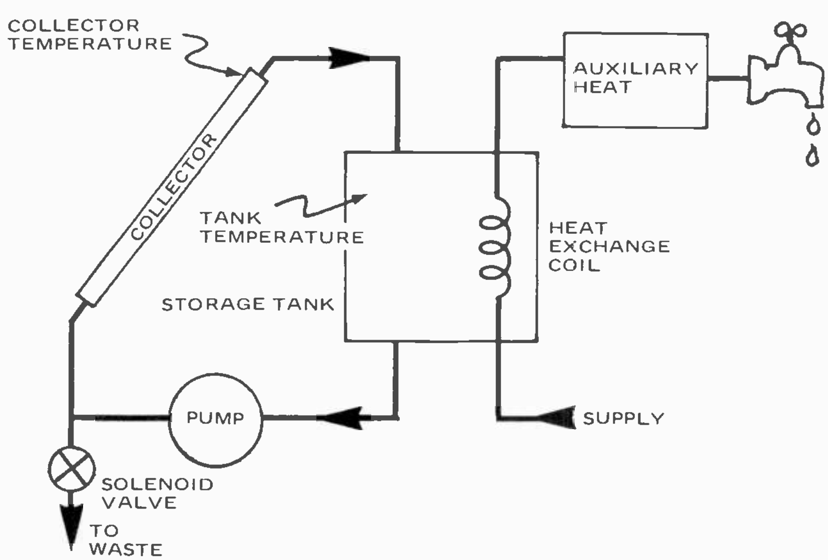


Fig. 1. Hot water heating. This diagram shows one way of hooking up a collector for heating your hot water. Since the water from the the tap must be "potable", that is fit for human consumption, it must be kept separate from the liquid in the collector. Thus a heat exchanger tank is used. Solar heated liquid flows out of the top of the collector and into the top of the tank. The cold supply water flows through a coil of pipe within the tank (some systems have a tank-within-a-tank) and is heated. It then flows through an auxiliary conventional heater to bring the temperature up when the solar heater is not providing enough heat.

home, all his neighbours complained bitterly, sold their cars, and went bankrupt.

So it was that the neighbours came to see the wisdom of Noah's ways, and soon their homes looked like Noah's, windmills were built, and tidal and river power was harnessed, so that all could watch their TV sets again.

And the Lord looked down upon the earth and said, I wonder what Johnny Carson's got that I haven't got?

A GREAT DEAL of activity is now underway in the effort to put the sun's energy to more good use, as a replacement in many applications for what we are now aware are ever depleting fossil fuels. In addition, opponents to various atomic power schemes see solar and other natural energy sources as a positive and hence more persuasive argument to forward their causes. What is fascinating about solar power is the equal contributions from both large companies and the individual to the overall knowledge of this field. It's one of those delightful fields where the private experimenter can achieve as satisfactory a result as the big research lab. It's just like the early days of electricity, radio, and automobiles. What we describe here are but the first few rewarding steps in getting into solar power.

WHAT'S HAPPENING

A wide range of different approaches are being investigated in the use of the sun's rays, so first an overview, then down to those most amenable to the individual builder.

BASIC PRINCIPLES

The problems of solar power can be broken down into 3 main areas of concern. These are: form of energy source, energy storage system, and finally the end use form of energy. Fossil fuels which we presently use afford probably the greatest convenience as a form of solar power (photosynthesis in trees followed by petrification over thousands of years, storage of energy in the compact form of gasoline or fuel oil, and quick easy conversion to heat, electricity or mechanical movement when needed.). Unfortunately, this process is not producing fuel fast enough, essentially no petrification of trees is taking place so we regard this form of fuel as non renewable.

So far as present users are concerned, and restricting the discussion to stationary (non-vehicle) energy consumption, there is a definite preference for energy to arrive at our homes or businesses as electricity, or at least in a compact form such as (natural) gas, or not quite so desirably in a form that requires storage on the premises, such as fuel oil.

SOLAR ELECTRIC POWER

A look at current (ho ho) systems shows that electricity from the sun is probably farthest from service for a variety of reasons. First problem, common to all solar collectors, is that the intensity of sun power is quite diffuse, averaging 16 W/sq ft (over a year, and over the earth's surface), with a daily peak of at best 110 W/sq ft, and nightly minimum of zero. So energy must be collected from a large area to be useful. Various ways have been tried to concentrate the sunlight, such as a field full of mirrors reflecting sunlight at a central tower whereon photovoltaic cells are mounted. There still remains the problem of orienting the mirrors, and perhaps moving them as the "sun moves".

Further problems exist because photo-electric cells are not very efficient yet. Finally, as with most solar collection schemes, the energy input cannot be varied in response to the load, you have to catch it while you can, and store it until needed. Unfortunately, electrical energy is one of the more difficult forms to store.

Other approaches to using the sun's energy to produce electricity are in development, such as a scheme to exploit temperature differences in the oceans.

ENVIRONMENT AND WATER

Some of the major uses of energy are in home and industrial building heating ("space heating") and heating water for washing. These happen to be items relatively easy to accomplish by sun power, and mean substantial savings of the more portable fuels and more versatile electrical energy. A widespread acceptance of solar heating might free enough of the other fuels to tide us over until for example our cars do not require non-renewable fuel.

Building and water heating are conceptually easy to understand, and what works for a house can just be scaled up for a big industrial or office building.

The simplest form of solar heating involves having larger windows and better insulation, which allows the the sun's energy to shine in and stay in. That's it, but it's surprising both how effective this is, and how few buildings take advantage of it, even to the lengths of having almost no windows!

The pump does not cycle the water around continuously. A controller (like the project in this issue) monitors the temperature at the top of the collector (the hottest point) and in the exchanger tank, deciding when to circulate, and when not. It is generally found that for this type of system it is not worth switching the pump on until the temperature differential is 4 to 16 degrees C depending on the flow rate and collector size and shape. Once on the pump usually should stay running until the difference is less than two degrees, then turn off until the temperature rises again. A system with different turn-on and turn-off points is said to have "hysteresis". If the turn-on and turn-off points were the same, the pump would simply be turned on and off rapidly at the borderline temperature, not a very useful or wear reducing state of affairs.

Note that the auxiliary heater can have its own thermostat within to switch it on.

It can be seen that the exchanger tank not only serves to exchange heat, but to store it for periods when the sun is not providing. Thus the larger it is the better, up to the point where it can store all the heat needed in the worst 24 hour period. Similarly, the collector is more useful the larger it gets, except that it must not be allowed to boil. Thus it is a question of having enough storage to take any heat the collector can supply, and making both collector and storage as large as possible, versus size and cost.

The problem of boiling must not be overlooked. If collector water turns to steam it can blow the pipe joints, or plate glass off a flat plate collector. A way to protect against this is for the controller to have a limit detector scheme to activate a solenoid valve, draining the liquid out in case it approaches boiling. One must be particularly wary of filling an already hot collector. One person tried this unaware that the copper pipes of his collector were already over 100 degrees. The water entered the pipes, pockets of rapidly expanding steam developed, propelling water around the pipes at bullet speed knocking out joints at several places!

The other hazard is freezing. Depending on your system and climate, the solution might be anti-freeze in the water, circulating internally warmed water through the collector (a waste of energy) or again a limit detector to dump the water out at near freezing temperatures.

When the snow melts off this collector system it will provide 75% of the space and water heat to the school that's built underneath it. That's Applewood Public School in St Catharines Ontario. The Ontario Ministries of Education and Energy put out $150,000 for the system. Photo: OME (Energy).

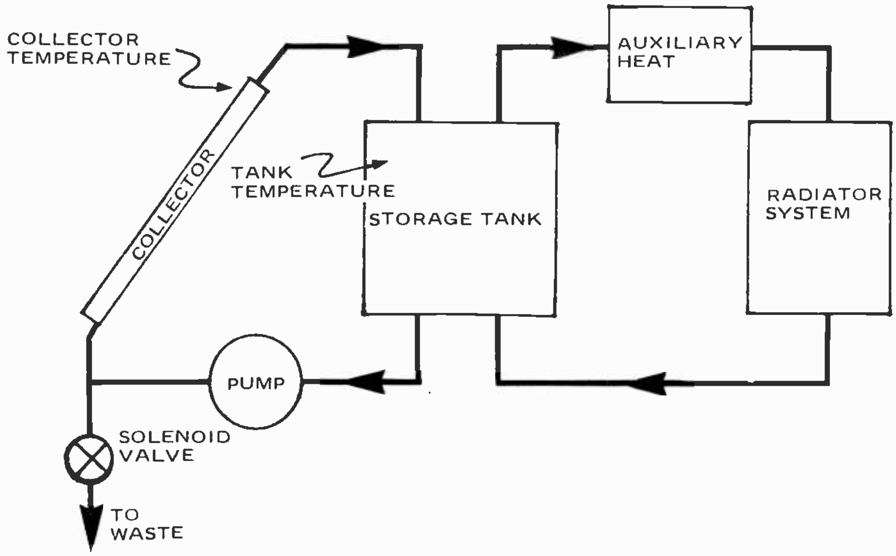


Fig. 2. Space Heating. A radiator system is shown here. This is essentially similar to the water heating system shown in Fig. 1.. However, it is not necessary to keep the two liquids apart. Thus, as long as your collector liquid is compatible with your rads, the tank can simply be a common storage tank for both circuits. The control system is similar to that of Fig. 1. as are the commonly used turn-on and turn-off differential figures.

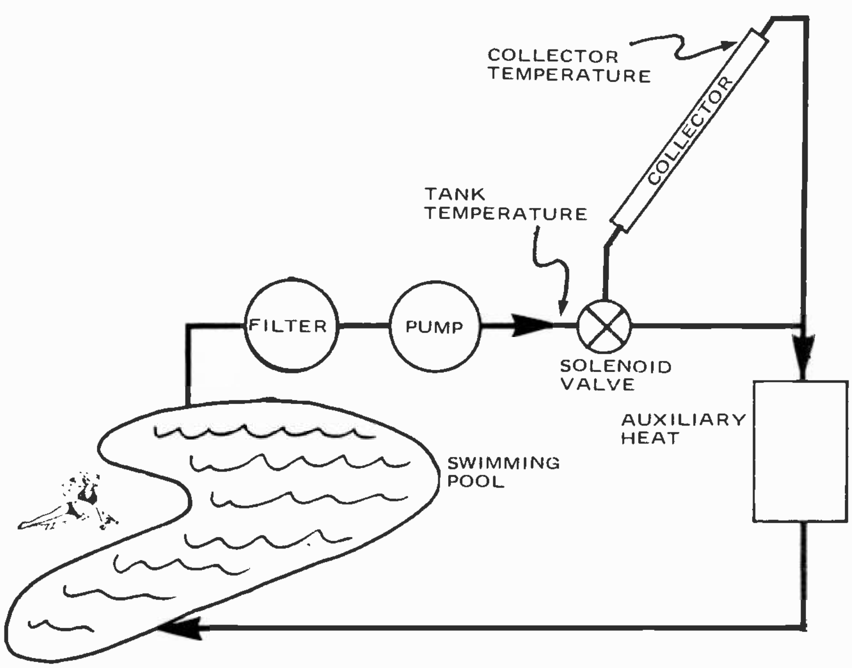


Fig. 3.Pool Heating. This system is popular with both public and especially private pool owners, since it rids them of guilt feelings over the use of energy for luxury purposes. In other words, there are a lot of expensive pools out there not being used to the maximum enjoyment because their owners don't feel right about using up natural gas or electricity for pleasure.

It's also a rather efficient and effective way to use solar energy for several reasons. Only one liquid needs to be involved, heat is desired during the day when the sun is around, and the pool provides its own storage for heat. In addition, there's already a pump in the system. So all that's required is the collector and plumbing, a solenoid valve, and a controller.

This basic system of course has the major disadvantage that it doesn't work at night, nor for that matter at any time the sun is not shining your way. So, storage is needed. Here's where we split into two separate classifications, those systems not using liquid, and those which do.

Suppose the above large windowed house has a block wall, or pile of rocks behind the window. These will absorb the heat during the day, and release heat at night. To be most effective, this kind of system employs a sophisticated circulation system, with blowers and controllers to determine when the occupied rooms need warming and so on. Because such a collector and ventilation system is quite large, this type of heating is really only applicable to designing into new homes or buildings.

Other storage media are being researched, such as solids which melt when heated by the sun. These would be useful because a large amount of energy is stored in a material's "Heat of Melting" without a high temperature, this reducing the amount of heat lost from the storage unit while it's just sitting. Water for example "stores" 80 cal/g in melting, but of course this characteristic is in the wrong temperature range.

LIQUID SYSTEMS

Probably the most popular solar energy systems involve heating up a liquid of some kind, usually water. All these systems have a collector through which the liquid flows to absorb heat. Thus most collectors are oriented either to causing a thin layer of water to flow over a large surface, or to easy construction using lengths of pipe exposed to the sun.

The three major applications areas for this kind of collector are space heating via radiators, hot water for washing and swimming pool heating. These are discussed in Figs 1, 2, and 3.

COLLECTORS

As mentioned above, solar systems afford great leeway for experimentation, especially the collector arrangement.

Most collectors are based on the principle of getting the pipes or back plate (usually metal), or whatever very hot, which then heats up the liquid it carries. To this end the pipes or plate are painted matte black for maximum absorption. Meanwhile, heat loss must be minimized, so for example, a flat plate collector might have a second layer of glass on top to reduce the amount of heat carried away by the wind etc.

Sun Rays Keep Falling On My Roof

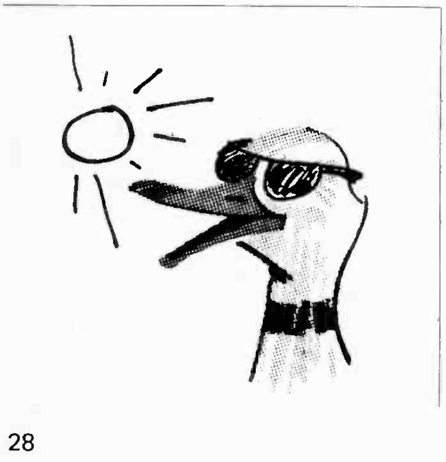
Experimentation with different liquids is also fruitful. Liquids other than, or mixed with, water may afford lower freezing point, higher boiling point and so on. But additionally, heat can be absorbed directly by the liquid if it is not transparent like water. Markko Construction for example has been experimenting with suspensions of black particles in water, which catch the sun's energy, heating the water from within. This affords somewhat higher efficiency.

CONCLUSIONS

It is not the intention here to go into great detail on the mechanical construction of collectors and tanks, but rather to provide a background for the understanding of how such systems work in general. If you have the same view as us, it's a real turn-on to find an area where you and I can be just as much at the forefront of today's knowledge, and where your research is just as valid and important as that of industry.

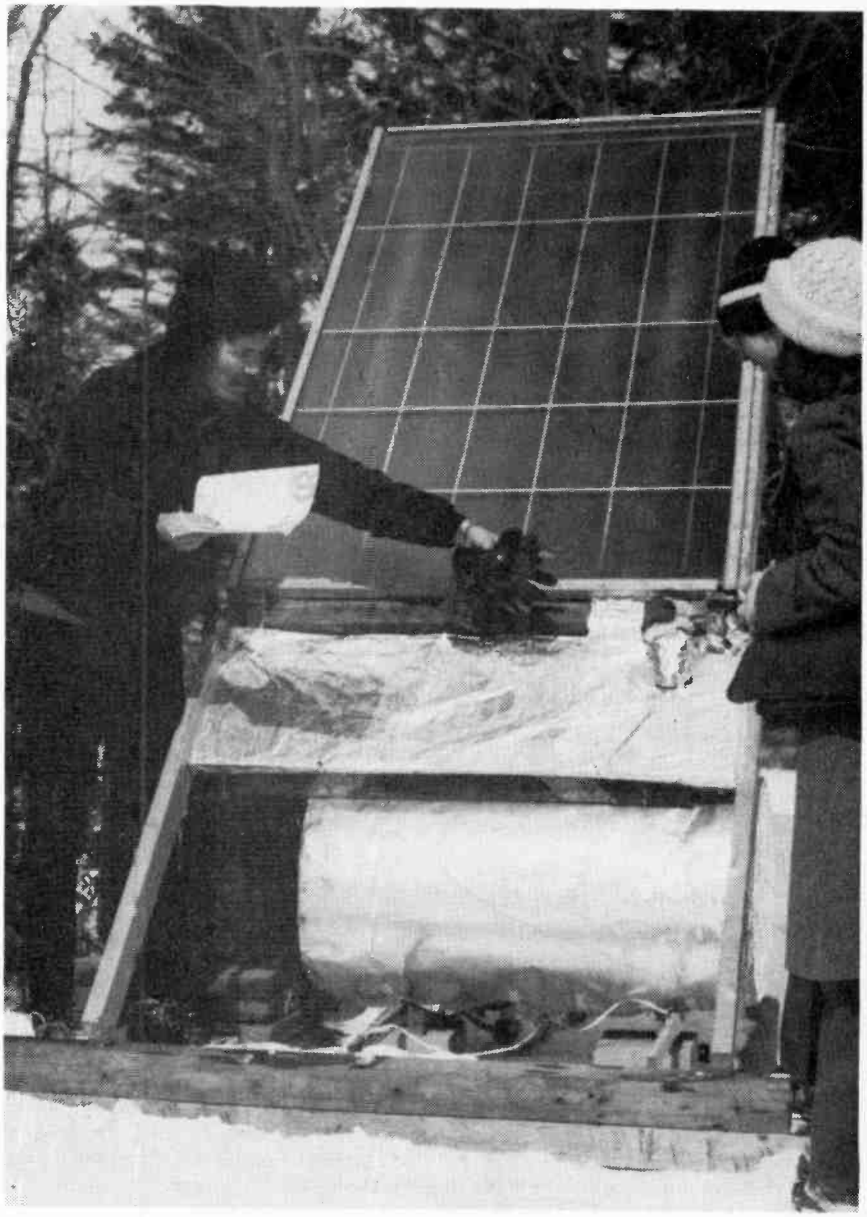
So, do some reading on the subject, and get building! Lots of books are now appearing on the field, mostly written by "Noahs" around the continent, with construction plans, and details on commercial and experimental units. One that we would particularly recommend is "Solar Energy, A Biased Guide" by William I Ewers, published by Coles Publishing Company, 90 Ronson Drive, Rexdale Ontario M9W 1C1, or at your local plaza. It covers very neatly most of the things you need to know in order to build a solar system in a friendly manner, and contains an extensive bibliography.

A list of sources is also included, but these seem all to be in the sunny states. Any Canadian solar system or component sources are invited to write to ETI and we'll mention them in News Digest. One such company we know of is: Solerco Ltd/ltee, Solar Energy Division, P.O. Box 211, Under Bunker Rd, Ayer's Cliff, Que J0B 1C0, 819-838-5935. Ask for their catalogue.

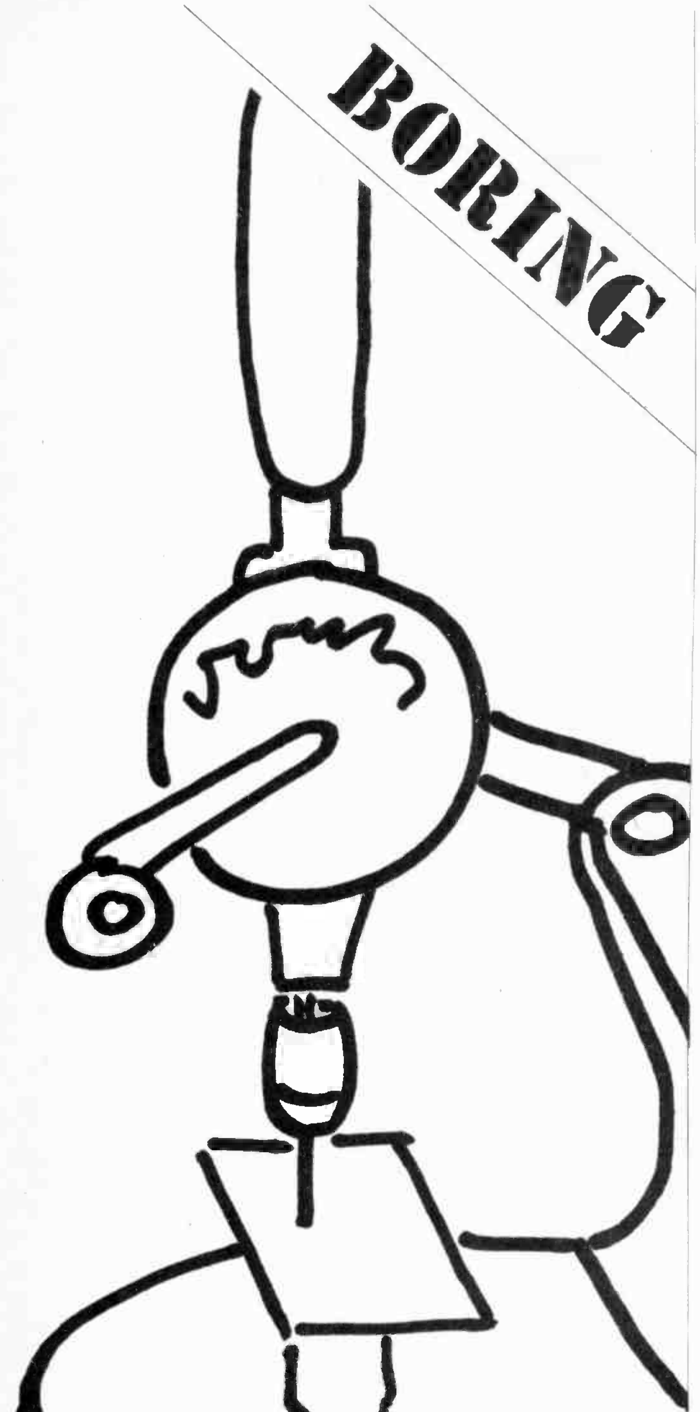


Here's another factor: The human body is very sensitive to "hot" and "cold" at temperatures near that at which pools tend to sit just below. In other words, if your body thinks 20 degrees is cold, but 22 is warm and 26 is hot, then your pool will be invariably at 19 degrees, except during the hot spell when you're on vacation enjoying the rain in Nova Scotia.

Thus, even a small heat increase can make a big difference to your pleasure. In this case it's worth feeding the water through the collector when ever the collector is hotter than the pool, even by a small amount, especially since in most pools the pump runs continuously for the benefit of the filter. This occurs when the collector is absorbing more heat than it loses to the air, fairly early in the day. For this reason pool controllers should turn on the solenoid valve to the collector at a relatively low differential, say 2 to 4 degrees, and off at zero. No boiling protection scheme is shown, but you probably should do something if bubbles start forming in the deep end.



Mark Cairenius of Markko Construction points out the details of the special low energy requiring circulation system in their solar collector design. Although this prototype is a fairly typical flat plate design, the use of black particles suspended in the liquid have resulted in very efficient heating.



NEXT MONTH . . .

There's an article on how to build a very simple, but extremely convenient drill press for making holes in printed circuit boards. We have as well projects for a light show controller, a log-periodic antenna design for TV and FM, and more. Next month's features include a look at how hospitals can see inside the body without X rays, using ultrasonic means, a method that is both safer and can yield more information.

See you next month!

A LETTER FROM BEBE

Subscriptions Department,
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Unit Six,
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My Dear Readers,

Hi, many of you know me already — I'm the sexy voice you talk to about subscriptions, books, and back issues.

I'd like to say thank-you to all those who have sent me nice letters.

In this letter I would like to talk to my subscribers. About letting me know when you move house and about when to renew your subscription.

Many readers forget to tell me their new address when they move — all I hear is that the Post Office haven't delivered the magazine. If you are planning to move please let me know 8 to 6 weeks beforehand.

And when you renew your subscription, please do this by the last month of your old subscription or you may miss an issue.

Bye for now, keep in touch.

Love,

Bebe

Bebe Lall

Solar Controller

Build this unit to control your solar collection system. Developed jointly by the staffs of ETI and Markko Construction, this differential temperature controller is suitable for space, water or swimming pool heating control.

FOR THOSE PEOPLE who really are going to get into the sun, we present the ETI Differential Temperature Controller. Its main function is to monitor the temperatures of collector panel and storage tank, and turn on or off the pump which circulates the fluid.

Turn-on differential is switch selectable from 4 degrees C to 16 degrees C and turn off differential is preset to 2 degrees C.

Additionally the unit incorporates two limit circuits to detect when the system is above or below safe temperatures, activating the pump or separate valves for protection. Alternatively, one of the limit detectors may be used tp switch other conventional heating systems in or out of action.

Conventional relay outputs (2.5A) and also solid state triac switch outputs (5A) are outlined. Heavier loads could be cattered to with external relay(s).

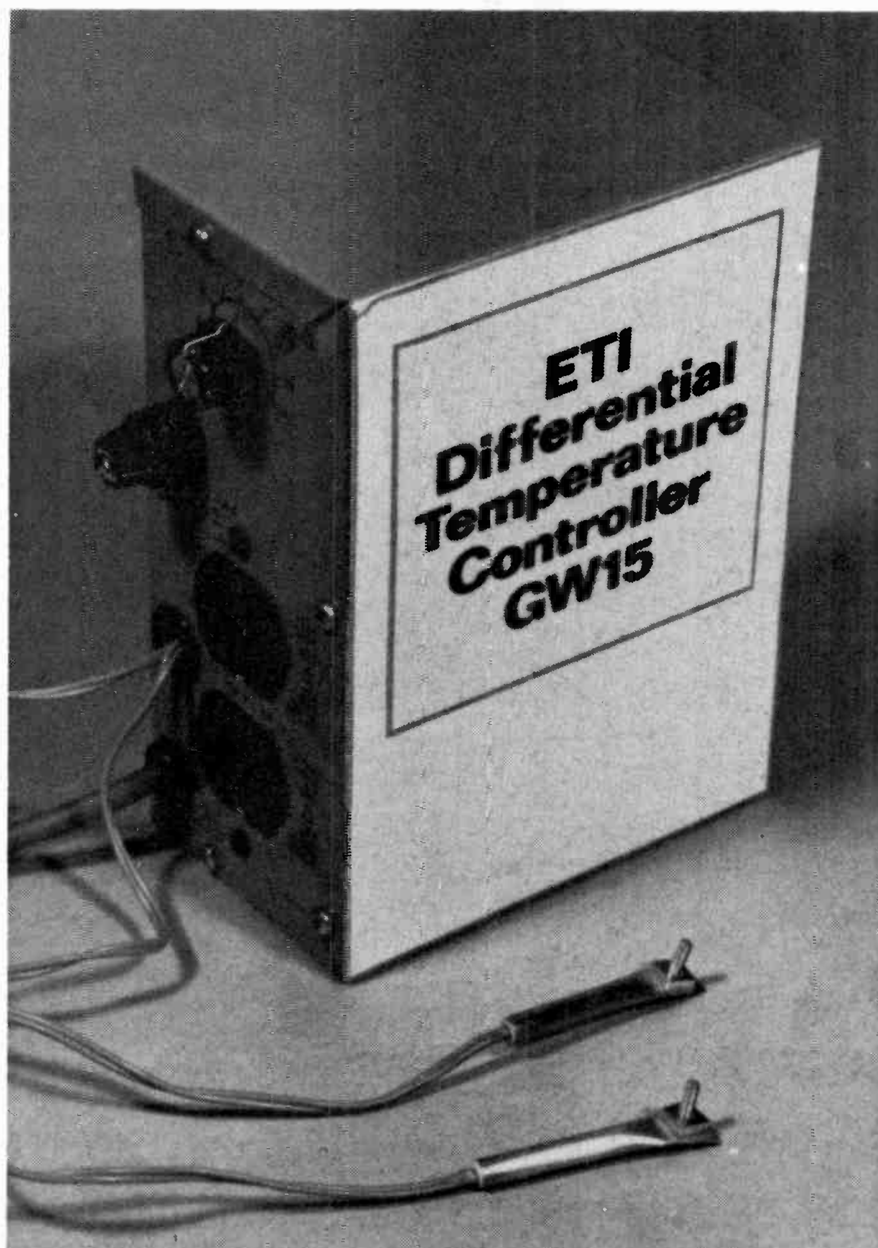
DECIDE ON YOUR MODEL

A variety of different options is possible; what kind of outputs to use, what limits to detect and so on, see the separate box titled "Options". In addition, we have provided a switched selection of turn-on differentials, a variety which may not be neccesary in your application. Swimming pool heater builders will also want to read how to build the unit with lower on and off differentials, see "How It Works" and "Calibration" for details of selecting R8 and R9.

CONSTRUCTION AND TESTING

Once the options have been decided upon, construction is quite straightforward. The mechanical details of the box should be settled first, all holes drilled etc., paying particular attention to the holes for mounting the board assembly, and the triac (more below). The board will be mounted in the box

text continues on page 34 . . .



Solar Controller

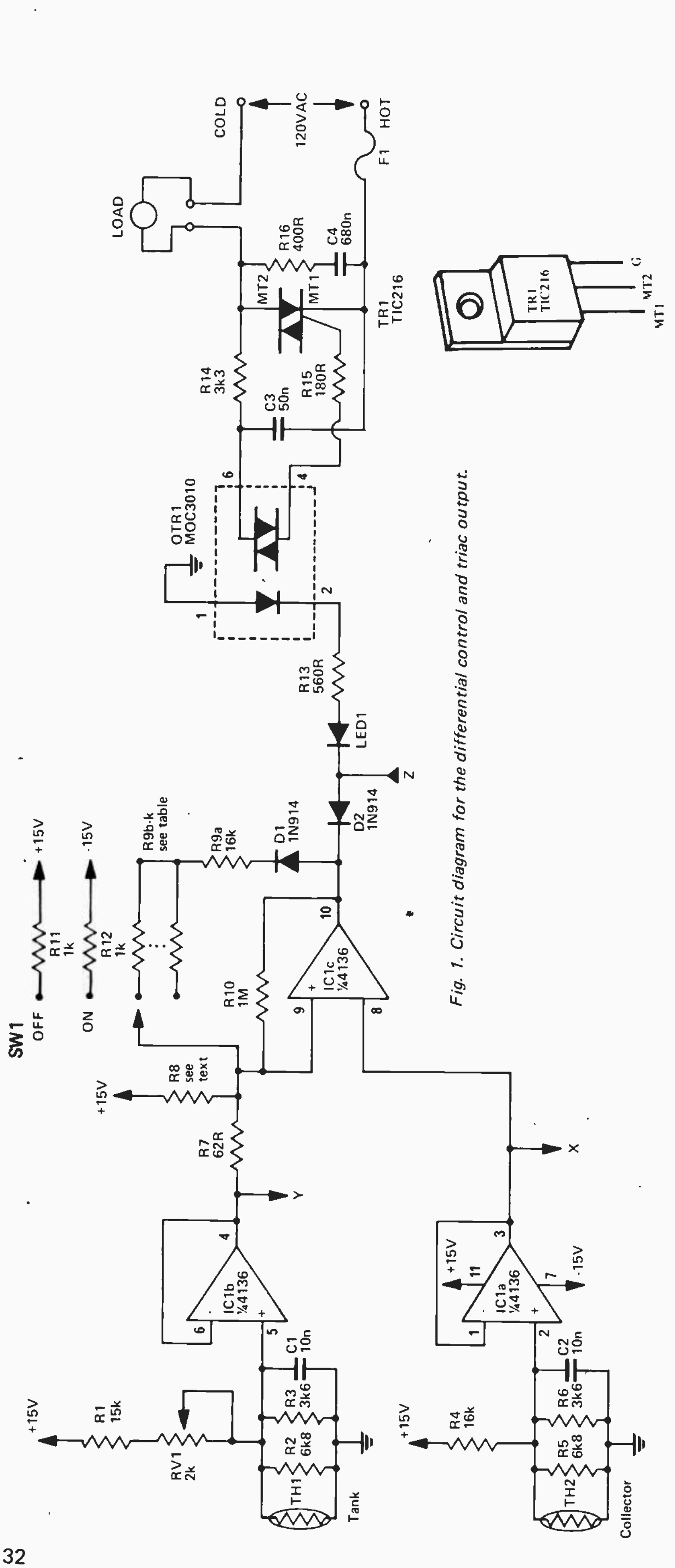


Fig. 1. Circuit diagram for the differential control and triac output.

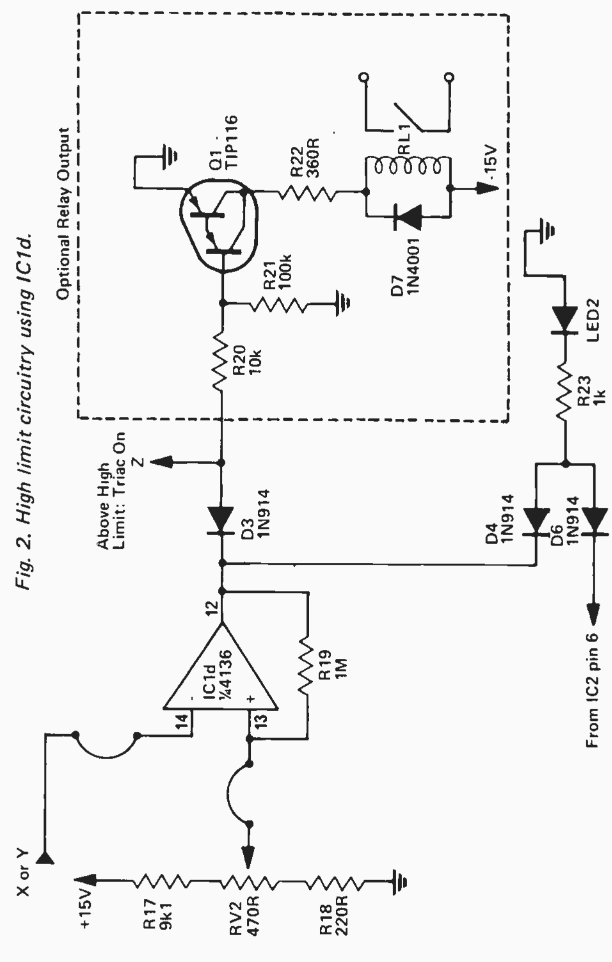


Fig. 2. High limit circuitry using IC1d.

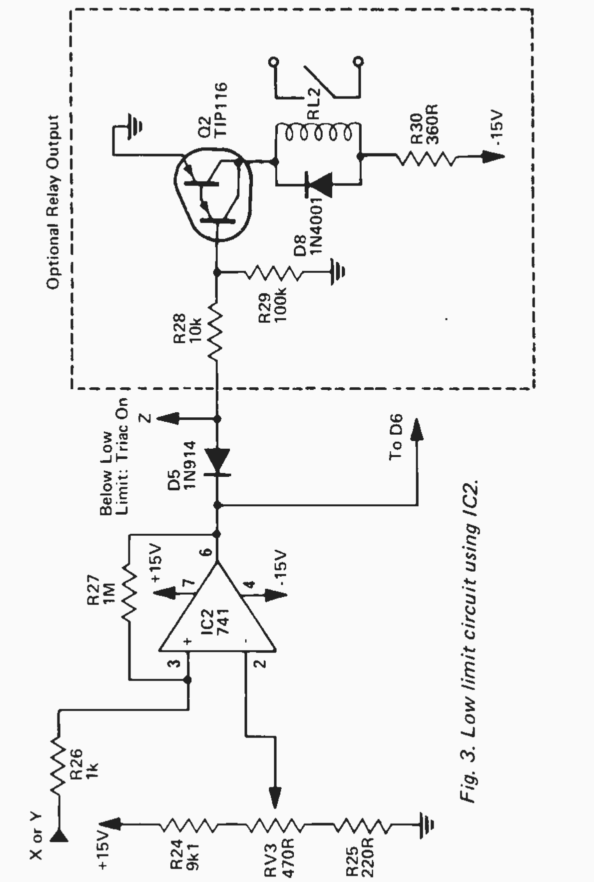


Fig. 3. Low limit circuit using IC2.

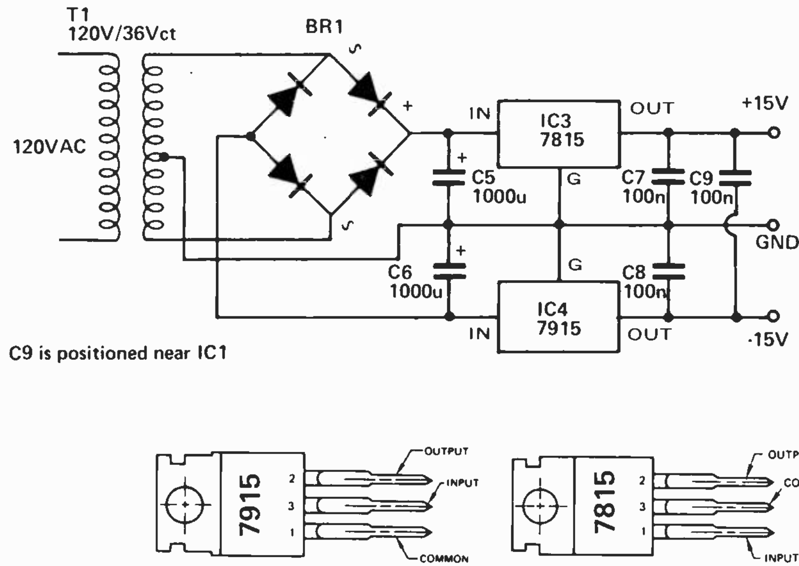


Fig. 5. Circuit diagram of the power supply.

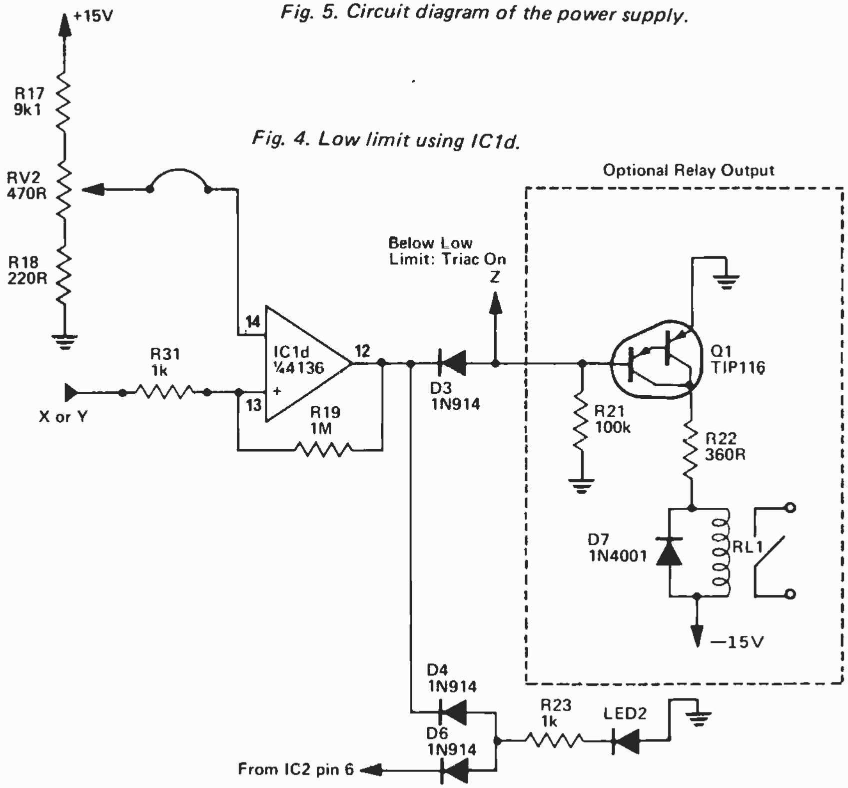


Fig. 4. Low limit using IC1d.

HOW IT WORKS

A straightforward approach to understanding this circuit is to see how each part of the circuit forms a part of the overall system. For this purpose let us break down the system into "input" (thermistors and IC1a and b) "information processing" (IC1c, d and IC2) and "output drivers" (OTR1, TR1, and the sections marked "Optional Relay Output"). In this way the constructor can see how the various sections fit together, and also extract portions to use in other situations.

INPUT

TH1 is a Texas Instruments TSP102, a sensor whose resistance varies as its temperature increases. When placed in parallel with a 2370 ohm resistor the combined resistance versus temperature curve is very linear. In fact it is approximately 614.3 ohms at 0 degrees (all temperatures in Celsius), rising by 3.578 ohms per degree. Over the range 0 to 100 degrees the deviation of an actual device is less than ½ degree. This linearity is important as we shall see.

The temperature sensing circuits consist of voltage dividers, in one case R1, RV1 and TH1 with R2 and 3 for the storage tank, and for the collector R4 with TH2, R5 and R6. Since the thermistors with parallel resistors are going to be in the range 600R to 1k, the voltages at IC1 pins 5 and 2 are going to be near .7V all the time. Thus R1 and RV1, or R4, may be regarded as supplying a constant current of 14.3V/16k (.894mA) to their respective thermistor circuits. This in turn simplifies the calculations because now the input voltages to IC1a and b are .614 x .894 = 594mV plus T(degrees C) x 3.578 x .894 (or 3.2mV per degree). If you're wondering why we chose these odd numbers, it's just to get convenient resistor sizes.

Manufacturing differences between thermistors are such as to multiply the whole value by some constant, so that a thermistor with a value say 5% below the specified value would measure 583 + 3.4 x T ohms. Adjustment of RV1 varies the current to one of the thermistors to compensate for this kind of error.

The rest of the input circuit is IC1a and b, connected as voltage followers, that is the output of each equals its input voltage. This is done so that the these voltages which carry the temperature information are not affected by later stages of the circuit.

INFORMATION PROCESSING

The main information processing is done by IC1c and resistors R7 to 9. The idea is to compare the two input temperatures, and under certain conditions turn the power output (to pump) on or off. In this circuit, if IC1c output is "low" (−12V) the pump is turned on, if high (+12V) then it is off.

Let us start with the solar collector panel much hotter than the storage tank. The voltage at IC1 pin 9 will be lower than at pin 8 (initially imagine that R8 is not there). Thus the output of IC1c will be low – pump on. Gradually the heat is transfered to the tank, the tank warms while the collector cools. Voltage at pin 9 increases, and at pin 8 decreases.

If R7 and R8 had no effect then as pin 9 increased past pin 8 then the output of IC1c would switch from down to up, turning off the pump. However we wish this to occur not at the same temperature but when the collector is still 2 degrees hotter than the tank, so R7 and R8 are incorporated to "add" 2 degrees to the tank temperature signal, before the comparison is made. If R8 is 140k, about 0.1mA is supplied through R7, causing the required offset of about 6.4mV. R8 with R7 are also used to compensate for non-ideal op amps IC1a,b and c as outlined under "calibration".

supported on one edge by being soldered to a special barrier strip which has protruding tags, and on the other side by a bolt and spacer in the hole (between D7 and IC4). Thus either drill the holes in the box after soldering on the barrier strip, or vice versa paying extra attention to the position of the strip when attaching it to the board.

Next install the components in the board, using sockets for the IC1 and IC2. Before inserting IC1 and R8 read the section on calibration.

Note which components are not on the board, R9b-k and R11 and R12 are mounted on the switch, while LED1 and LED2 are later to be epoxied onto the box. Do not wire up the 120V AC connections yet (screw terminals 1-6). At this stage (board still out of box) you can hook up the transformer and check the operation of the power supply and most of the circuitry with a voltmeter. The relays can be seen and heard operating, and LED2 seen while twiddling RV1 and RV2, while LED1 will operate if the sensors are individually heated or cooled.

TRIAC MOUNTING

To dissipate the heat from the triac it is mounted on the back of the box under the board. (see photo) When you are ready to test this circuitry, try out the positioning of the triac by inserting it into the board (do not solder), and gently bend it back and position the board in the box. Locate and drill the hole for the triac mounting screw. Again check the position of all pieces. You can now solder the triac and test the board out of the box. The triac will not need the heat sinking of the metal box unless driving a heavy load.

To actually test the operation of the triac wire up a load, say a 100W light bulb, plus fuse, and AC supply (120V!) as detailed in the component positioning diagram (Fig 7.) The bulb should operate as the sensors are heated and cooled appropriately.

If all is well proceed to the actual installation of the board into the box,

HOW IT WORKS . . .continued.

OK, continuing with the story, the collector temperature had sunk to the point where the pump turned off, IC1c output high. Now we don't want the pump to turn on again until the collector reaches a significantly higher temperature than the tank, perhaps 4 to 16 degrees. This is accomplished by R9a to k. When IC1c output is high, D1 conducts, feeding extra current through R9a and one of R9b - k selected by the switch SW1, finally through R7, again "adding" to the temperature signal from the tank. If the added temperature is called Ta, then the appropriate feedback loop resistor value is R9 = 232/Ta in kohms. Note that this includes R9a, and does not take into account the 2 degrees from R8. So for example, for a turn-on differential of 4 degrees, Ta = 2 degrees, the required value of R9 is 116k, thus R9b is 100k. See table 2.

It can now be seen that using linear sensors results in the capability to easily add on a desired amount of temperature to a particular signal.

If the selector switch is in the ON (or OFF) position, a relatively large current is provided to R7 via R12 (or R11) from −15V (+15V). This subtracts (or adds) a large voltage representing a large temperature, making the tank seem to IC1c very cold (or hot) thereby forcing the pump on (or off). R10 is incorporated to provide some small amount of hysteresis around IC1c to make sure that the transitions from high to low, or low to high, are sharp with no indecision when the two input voltages are very close.

LIMITS

The other intelligence section or decision making is done by IC1d and IC2. Each compares an input voltage, one of the temperature signals, to a reference preset on trim pots RV2 or RV3. In the case of IC1d used as a high limit (temperature too hot), IC1d's output is caused to go low ("on" in our application) if say the signal at X (collector) exceeds a certain value, corresponding perhaps to near boiling.

Similarly, functioning as a low limit the collector temperature might be monitored (point X) and below a certain point near freezing the pump may be switched on to warm the collector up. Or set at a higher level, the low limit circuit may be used to sense point Y, tank temperature, to bring an electric heater into action if the solar system is not providing adequate heat. See discussion of options to find out how these connections are made.

Again the function of R19 and R27 is to provide hysteresis for IC1d and IC2 to ensure clean turn-on or off for these stages.

OUTPUT STAGES

Two different sorts of output are used, both a triac "switch" and a relay style output.

As shown in the circuit diagram and pc board overlay, the main circuit output IC1c connects to the triac output, while the high or low limits may each be connected either to the same output (via point Z) or to their own separate relays ("Optional Relay Output"). Note that both styles of output are "on" when the input to them is low. Diodes D2, D3 and D5 are arranged so that if all are connected at Z, point Z will be pulled low if any of IC1c, d or IC2 outputs are low. This would be the case if these were all to activate the triac, and no relays were used for example. If three independent outputs were required then simply do not connect D2, 3 and 5 at Z, and each functions separately.

TRIAC OUTPUT

The triac output operates if the cathode of the led (the "bar" end) is pulled low. This causes the led within optical triac isolator OTR1 to glow, (the led, LED1, will glow too, indicating output on.) turning on OTR1's output triac. This in turn feeds current to the gate of TR1 switching it on. Components R14 with C3 and R16 with C4 are to allow OTR1 and TR1 to operate with inductive loads, and are known as snubber networks.

If these are omitted and an inductive load (such as a pump) is connected, TR1 will be unable to turn off, even though no current may be arriving at the gate via R15. This is because the point of the AC cycle when TR1 is trying to turn off is when zero current is passing through, which with an inductive load will be a time when there is still voltage across the triac. In attempting to turn off, the voltage across TR1 suddenly rises. Due essentially to capacitive effects within the triac between MT2 and the gate, some current appears to flow at the gate keeping the triac on. This of course continues to occur and the triac never turns off. The solution is the snubber network to slow the rate of rise of voltage across MT1 − MT2. This is a compromise however, since now even with the triac off some current flows through the circuit via R16 and C4, and R14 and C3, but this is negligible in most applications. It is enough though to turn on very small loads, and thus if a noninductive load is to be attached these components may be omitted. (Just leave out C3, C4 and R16 replacing R14 by a wire.) Also the snubber components were chosen for worst case situations, and values allowing less "leakage" may be used with smaller inductive loads.

RELAY OUTPUT

Both relay outputs are essentially identical. If the input to R20 is low, Q1 will turn on, feeding current through R22 and RL1 which of course turns RL1 on. D7 is placed across the relay coil to conduct when Q1 turns off and RL1 discharges its stored magnetic energy as a negative pulse, which could otherwise damage Q1.

D4 and D6 combine the signals from the high and low limits, turning on LED2 if either limit is passed.

POWER SUPPLY

A very simple design, T1 feeds a full wave rectifier bridge, whose output is about plus and minus 24V. This is smoothed by C5 and C6, and regulated to plus and minus 15V by IC3 and IC4.

the triac onto the back, switch and leds onto the side and finally the wiring of the AC connections.

To mount the triac, insert and epoxy a nylon bolt to the triac so that the threaded end will poke through the hole in the box. Install a mica insulator, and coat with silicone heat sink compound between the triac and the box when finally installing board and triac into the box. Last, affix the nut on the other end of the nylon screw. NOTE: THE TRIAC MUST BE INSTALLED WITH THE MICA INSULATOR AND NYLON SCREW SINCE THE METAL BACK OF THE TRIAC WILL BE LIVE, AND MUST NOT TOUCH THE METAL BOX.

Also note that the connections to RL1's output are not made on the foil pattern to allow your own choice of hook-up, which should be done before installation in the box.

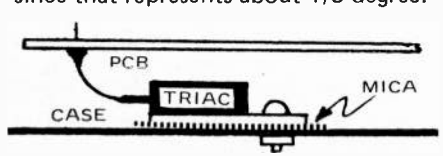
Next step . . . calibration.

CALIBRATION

Three calibration operations are required. The first is a test on IC1, and must be done before the circuit is assembled.

CHECKING IC1: On a breadboard, or by other quick means, assemble the "Test Circuit" of Fig. 6., omitting Radd.

Ensure that no oscillation can occur by putting 100n capacitors from pins 7 and 11 to ground, close to the IC. (This can be checked on a scope if desired.) This circuit simulates the operation of IC1 in the controller, and is used to determine the overall effect of the offset voltages of each op-amp. The offset voltage is the amount by which the op-amp's input stage is off when it thinks that the two input voltages are the same, typically less than 5mV. We will worry about anything greater than say 1mV, since that represents about 1/3 degree.



Now, using a sensitive voltmeter, measure the voltage Vadd. Look at table 1, in the "2 degree" column and select the appropriate resistor for use as R8. If you put this in the test circuit as Radd the output to the meter should now read 6.4mV corresponding to the 2 degree offset for turn off (see How It Works). If zero differential is desired select R8 from the other column of table 1.

ADJUSTMENT OF RV1: This adjustment compensates for variations between TH1 and TH2 and associated circuitry. Bolt or attach the two sensors together and allow them to reach the same temperature, say 20 degrees C. Now adjust RV1 until the voltage between the two thermistors (screws 7 and 9, or IC1 pins 2 and 5) is less than 1mV.

ADJUSTMENT OF RV2 AND RV3: Two methods may be employed. Heat up the appropriate sensor to the desired limit temperature, then adjust RV2 or 3 to the point where the relay concerned just turns on. Or figure out the voltage which represents your desired temperature, and set the wiper of the trimmer to that voltage. This second method will not be as accurate as the first.

OPTIONS

A number of sets of choices must be decided upon. First, how many, and what kind of limits are desired? Secondly, which output circuit is each signal (differential output, and one or two limit outputs) to be connected to? It would be a good idea to check off one from each group of:

a) First Limit

– IC1d as low limit – as shown on overlay Fig. 7.

OR IC1d as high limit. Remove R31 and jumper from RV2 to IC1 pin 14. Replace these with a jumper from RV2 to IC1 pin 13, and a jumper from pin 14 to X.

(b) Tank or Collector for above?

– IC1d monitors collector (point X) as shown in Fig. 7.

OR IC1d monitors tank, connect R31 (or jumper in the case of high limit) to Y instead of X.

(c) Second Limit

– Additional limit not required, omit all components of Fig 3 (IC2 etc).

OR: IC2 as low limit: as shown on overlay Fig. 7.

OR: IC2 as high limit: This is possible only by cutting the pc tracks to IC2 pins 2 and 3, and changing over the connections, ie: RV3 to pin 3, R26 (may be replaced by jumper as in Fig. 2 in this case) to pin 2. R27 still goes to pin 3.

(d) Tank or Collector for above?

– IC2 monitors collector, as shown on overlay Fig. 7.

OR IC2 monitors tank, connect R26 (or jumper, high limit) to Y instead of X.

(e) Output Connections

Differential circuit drives triac, while each limit drives relay, as shown on Fig. 7. "To point Z" location on each limit is not connected to point Z of Fig. 1.

Other Output Configurations:

(i) Triac driven by IC1c plus:

IC1d: install jumper from D3/R20 to Z.

OR IC2: install jumper A (Fig. 8) from D5/R28 to Z.

OR both: install both.

(ii) RL1 driven by:

IC1d plus:

IC2: connect jumper from anode of D5 to anode of D3 (no connection to Z) (B on Fig. 8.).

(iii) RL2 driven by IC2 plus IC1d, install jumper from anode of D5 to anode of D3, (no connection to Z) (B on Fig. 8.)

(iv) If it is desired to have IC1c drive a relay instead of, or as well as the triac, connect the anode of D2 to the input end of R20, or R28, as appropriate. This may be independent of (or in addition to) operation of that relay by IC1d or IC2 according to whether D3 or D5 are disconnected (or connected) to the same point.

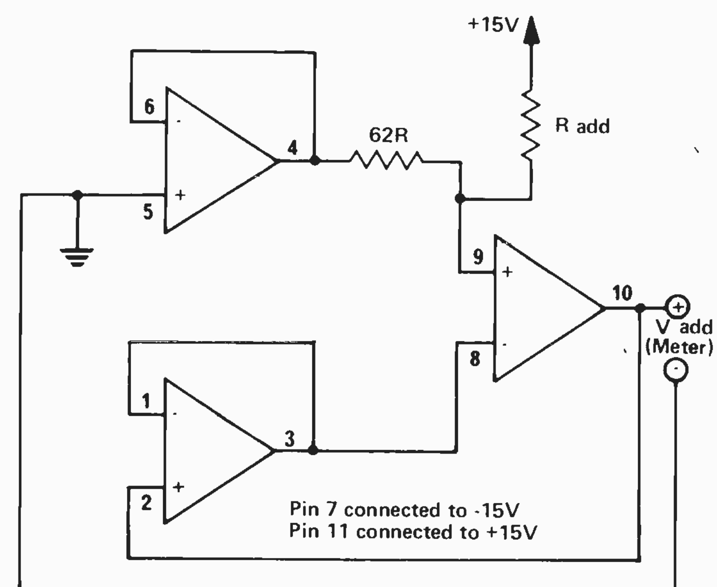


Fig. 6. Circuit used to select R8 according to IC1.

NOTE: It was intended that the limit circuits would operate the triac OR a relay. If however the two limit circuits are connected to Z, AND relays are installed, all output stages will of course turn on and off together. To make operation separate, (for example IC2 works as a limit to turn on triac plus relay, but IC1c only turns on triac) install D5 from IC2 to relay circuit as shown, and a separate diode from IC2 to point Z (anode to Z). Similarly for IC1d.

Table 1. Determination of R8.

Vadd	2 degree turn-off	0 degree turn-off
+8mV	62k	110k
7	66k	126k
6	72k	147k
5	78k	180k
4	85k	220k
3	94k	300k
2	106k	440k
1	120k	890k
0	140k	–
–1	165k	970k*
–2	200k	490k*
–3	260k	320k*
–4	370k	240k*
–5	640k	200k*
–6	2.2M	160k*
–7	1.6M*	140k*
–8	600k*	120k*

* indicates R8 should be connected to –15V supply instead of +15V.

Table 2. Selection of R9.

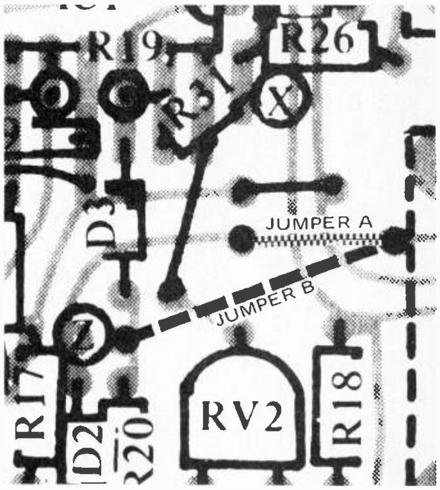
T add	Turn-On Diff.	R9b-k (select)
1 deg.C	3	216k
2	4	100k
3	5	61k
4	6	42k
5	7	30k
6	8	22k
7	9	16k
8	10	12k
9	11	9k
10	12	6.5k
11	13	4.4k
12	14	2.6k
13	15	1.1k
14	16	0

Note: Turn-on differential includes 2 degrees from R8. Also, total R9 is the series combination of R9b-k with R9a, a 16k resistor. Thus for Tadd = 2, R9 = 116k.

SENSORS

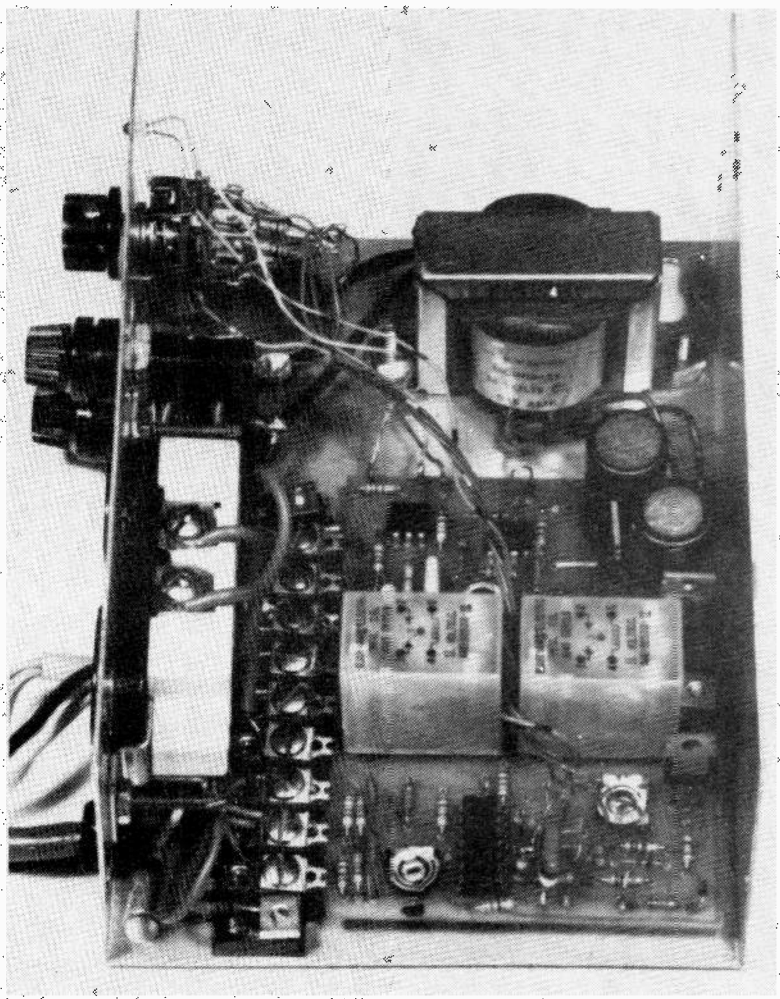
The temperature sensors are Texas Instruments TSP102s, and these are mounted in a special casing. Obtain some ¼ inch (outside diameter) brass tubing from a hobby shop and cut off a 2 inch length for each sensor. Carefully flatten about ½ inch at one end, and drill a hole ready for bolting the completed unit to the collector or tank. The flat part should be at an angle so that the round part of the tube will not interfere with the ability to mount the unit to a flat surface (see photo). Now take a thermistor and solder on the long leads (a 6 inch length of teflon coated wire may be used for the collector sensor which will get hot). Insulate the bare wire with tape or "spaghetti". Fill the prepared brass tube casing with epoxy and push the thermistor into it as far as possible, wiping away the excess epoxy. This completes the sensor unit ready for mounting.

Fig. 8. Exploded view of overlay showing detail of jumpers.



POSTSCIPT

Preliminary application has been made to CSA to have the production model of this unit approved. Markko Construction thus hopes to fill in for the present absence of Canadian made solar electronic products.



PARTS LIST

RESISTORS all ¼W unless otherwise stated.

R1	15k	R16	390R ½W
R2	6k8	R17	9k1
R3	3k6	R18	220R
R4	16k	R19	1M
R5	6k8	R20	10k
R6	3k6	R21	100k
R7	62R	R22	360R
R8	see text	R23	1k
R9a	16k	R24	9k1
R9b-k	see text	R25	220R
R10	1M	R26	1k
R11	1k	R27	1M
R12	1k	R28	10k
R13	560R	R29	100k
R14	3k3	R30	360R
R15	180R	R31	1k

VARIABLE RESISTORS

RV1	2k
RV2	470R
RV3	470R

CAPACITORS

C1	10n
C2	10n
C3	50n
C4	680n
C5	1000u 25V
C6	1000u 25V
C7	100n
C8	100n
C9	100n

DIODES

D1—7	1N914 or sim.
D8,9	1N4001
BR1	50V 1A or more
LED1, 2	Any red 10mA

TRANSISTORS

Q1, Q2	TIP116

INTEGRATED CIRCUITS

IC1	4136
IC2	741
IC3	7815
IC4	7915

TRIAC AND DRIVER

TR1	TIC216
OTR1	MOC3010

TRANSFORMER

T1	120V—36Vct 150mA

SENSORS

TH1, 2	Texas Instr. TSP102

RELAYS

GUARDIAN 1345-1C-12D

FUSE

F1	6¼A

SWITCH

SW1	Rotary, multi position to suit.

HARDWARE

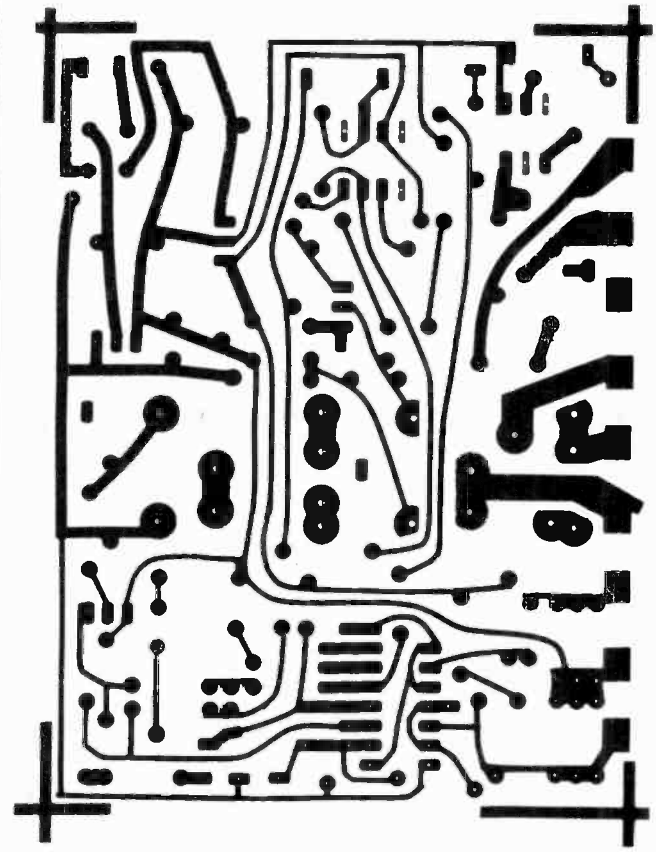
Barrier Strip CINCH JONES 9-140-¾-W
Appropriate sockets, fuses and holders, wire, nuts, bolts, case, pcb, line cord, etc.

THE Differential Controller is available in several forms from Markko Construction, 195 Kennedy Rd South, Suite 309, Brampton Ontario, L6W 3H2.

Differential Controller kit including drilled and punched case, complete hardware, pcb and components, two sensors and IC1 tested for R8 value: $70.
Same as above plus first additional limit including relay $82.
As above with first and second additional limits including relays: $94

Add $5 for mailing and handling, Ont res add 7% PST.

The printed circuit board is also available at $6 plus (7% PST for Ont res) plus $1 mail and handling.



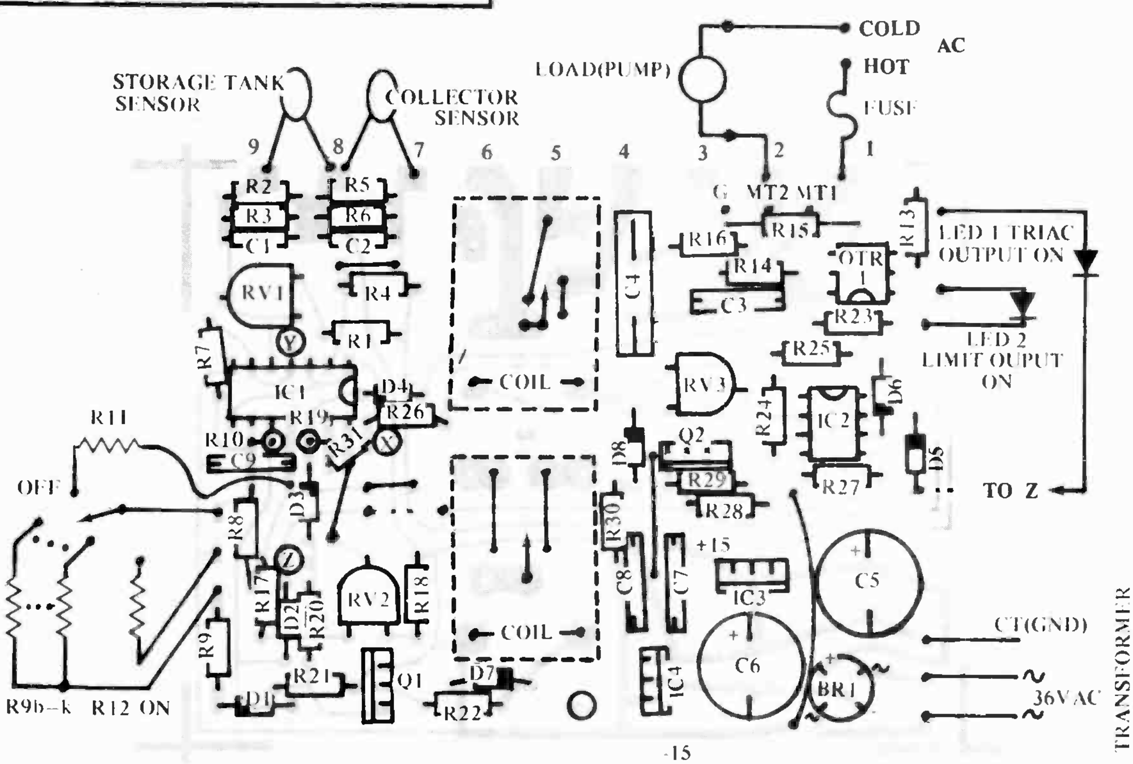


Figure 7. Component positioning diagram showing IC1d as a low limit AND IC2 as a low limit. Each limit is independently connected to its own relay output. Connections inside relay outlines indicate the internal operation. The lower relay is not connected to the edge screws, so that it can be wired as the builder desires. If there is any ambiguity: X is IC1 pin 1, Y is IC1 pin 4 and Z is the anode of D2.

All in ETI's 741 Cookbook:

Differential voltage comparator
Open-loop inverting DC amplifier
Closed-loop inverting DC amplifier
Non-inverting DC amplifier
Unity-gain DC voltage follower
X100 inverting DC amplifier
Variable gain inverting DC amplifier
High impedance x100 inverting DC amplifier
X100 inverting AC amplifier
Non-inverting x100 DC amplifier
Non-inverting variable-gain DC amplifier
High input impedance, non-inv, x100 AC amplifier
Non-inverting x100 AC amplifier
DC voltage follower
AC voltage follower
Very high input impedance voltage follower
Unidirectional DC v-follower, boosted output
Bidirectional DC v-follower, boosted output
Unity-gain inverting DC adder (audio mixer)
Unity-gain balanced DC phase splitter
Unity-gain differential DC amplifier (subtractor)
Semi-log AC voltage amplifier
Constant-volume amplifier
1kHz tuned amplifier (twin-T, acceptor)
1kHz notch filter
Variable low-pass filter
Variable high-pass filter
Variable-voltage supply
Stabilised power supply
Stabilised power supply with overload protection
Precision half-wave rectifier
Precision half-wave AC/DC convertor
DC voltmeter converter
DC voltage or current meter
Precision DC millivoltmeter
Precision AC millivoltmeter
Linear-scale ohmmeter
Audio Wien-bridge oscillator
Square-wave generator
Precision temperature switch

Available from ETI for $2 (includes postage). Just order our May 1977 issue from ETI Back Issues Dept, Unit Six, 25 Overlea Blvd, Toronto, M4H 1B1.

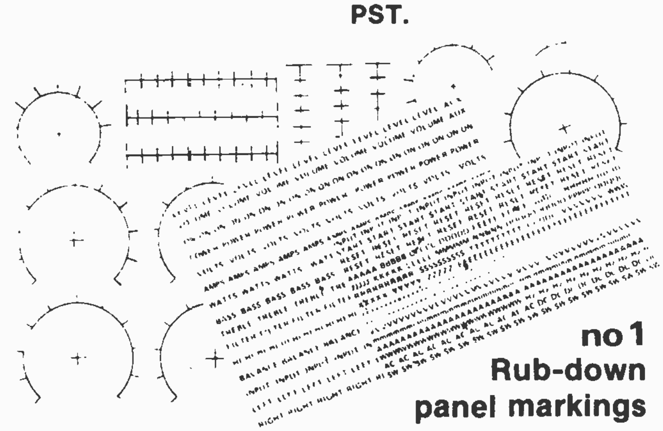
eti PANEL TRANSFERS

A really high quality system for finishing off your projects. The sheets include a mass of lettering and control scales for both rotary and linear pots.

The lettering is transferred simply by laying on to the panel and rubbing down — it's strong and permanent.

The markings are on two sheets (a full-sized one cut in half for easy postage) and contain sufficient lettering for dozens of projects.

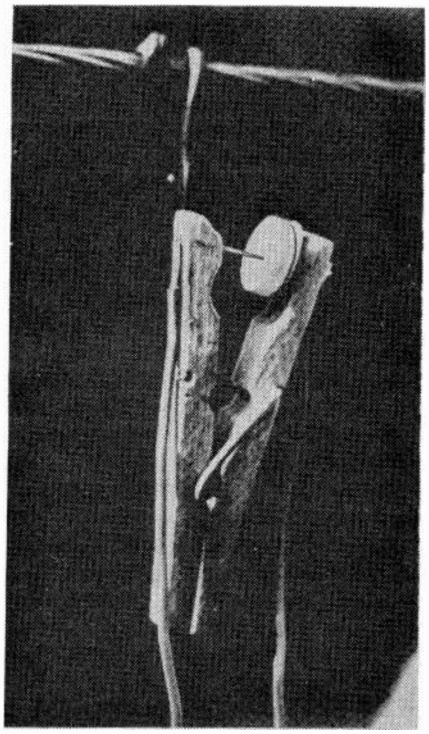
Send $3.50 (including postage) to ETI PANEL TRANSFERS. Unit Six, 25 Overlea Blvd., Toronto, Ontario, M4H 1B1. Ontario Residents add PST.



no 1
Rub-down
panel markings

10¢ Moisture Alarm

An engineer has been defined as someone who can do for ten cents what others can do for ten dollars. By this standard, our hitherto unknown contributor must be regarded as at the pinnacle of her profession — for she has done just that. By Ursula Simpler.



Vertically suspended hygroscopic transducer features disposable actuating element.

YOU MAY THINK WE ARE KIDDING — AND SO WE ARE. BUT THIS DEVICE REALLY WORKS.

COMBINING a career as a carpet designer with that of a housewife with seven enuretic children is in itself difficult.

When these are combined with a neurosis about whiteness, you can imagine my state of tension on washdays.

Always, continuously overshadowing the anticipation of that one perfect wash, was my — perhaps neurotic — fear of rain.

Is it — could it be — raining? . . . Every few minutes I would rush outside, despite a cloudless sky, just to calm my fears.

No wonder I took ten aspirins every washday.

Then one day, whilst munching my ninth aspirin, the thought struck me, in all its blinding simplicity:

"Aspirins dissolve!"

Surely here was a principle that could be further exploited. Here was the basis for a simple rain detector.

Aspirins dissolve! So simple if it worked.

First I checked a number of aspirins from different batches, to establish that their solubility time was reasonably uniform.

The result was even better than I had hoped.

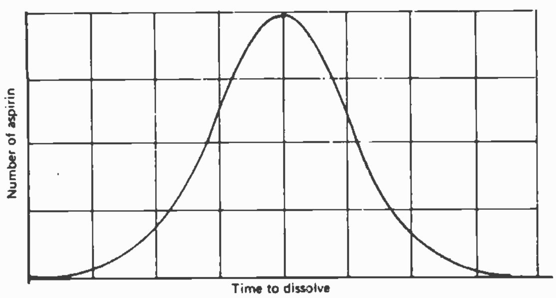
A perfect Gaussian distribution! (Fig.1). The standard deviation (SD = $\sqrt{\frac{\Sigma d^2}{N}}$) was less than 5%.

I next clamped an aspirin tablet between two spring-loaded contacts and checked the dry resistance. This I found to exceed several thousand ohms.

Then I placed the assembly outside in the rain. To my delight the effect was even better than I had hoped.

Not only did the tablet dissolve, thus allowing the contacts to close, but the hygroscopic inertia of the aspirin performed an integrating function. $\Delta t/\Delta p$, as the most enuretic of my boys put it (he never did understand calculus).

There was just one problem — the response time of a standard aspirin was a little too slow. A colleague, however, pointed out that some makes of aspirin dissolve 2¼ times faster, and this provided the exact reponse time I required.

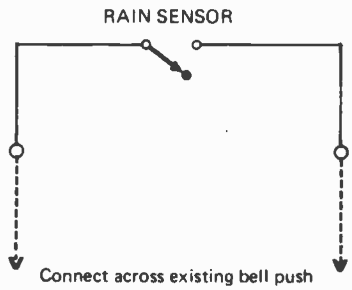


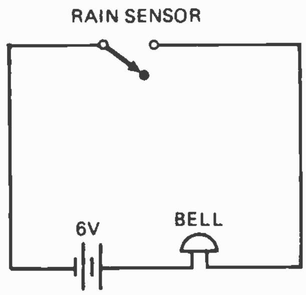
Normal probability curve (Gaussian Distribution) of 1000 aspirins

I now had a simple moisture transducer — open circuit when dry, closed circuit when wet.

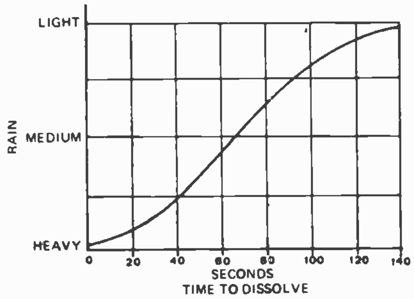
Next I connected the unit across my front doorbell. It worked perfectly. Admittedly, it was difficult to tell whether it was raining, or one had an unusually persistent caller (or both), but the saving in cost compensated for the occasional ambiguity.

The unit is still in use. Reliability is excellent, running costs depend upon how often it rains but seldom exceed 2 cents per week. How little to pay for peace of mind!





Alternative self contained alarm.



10¢ Moisture Alarm

SPECIFICATION

Input voltage	2 - 12 volts ac/dc
Response time	~30 seconds
Consumption	
(electrical)	<1mA
(pharmaceutical)	1 aspirin per alarm
Dimensions	2¾" x ¾" x 5/8"

PARTS LIST

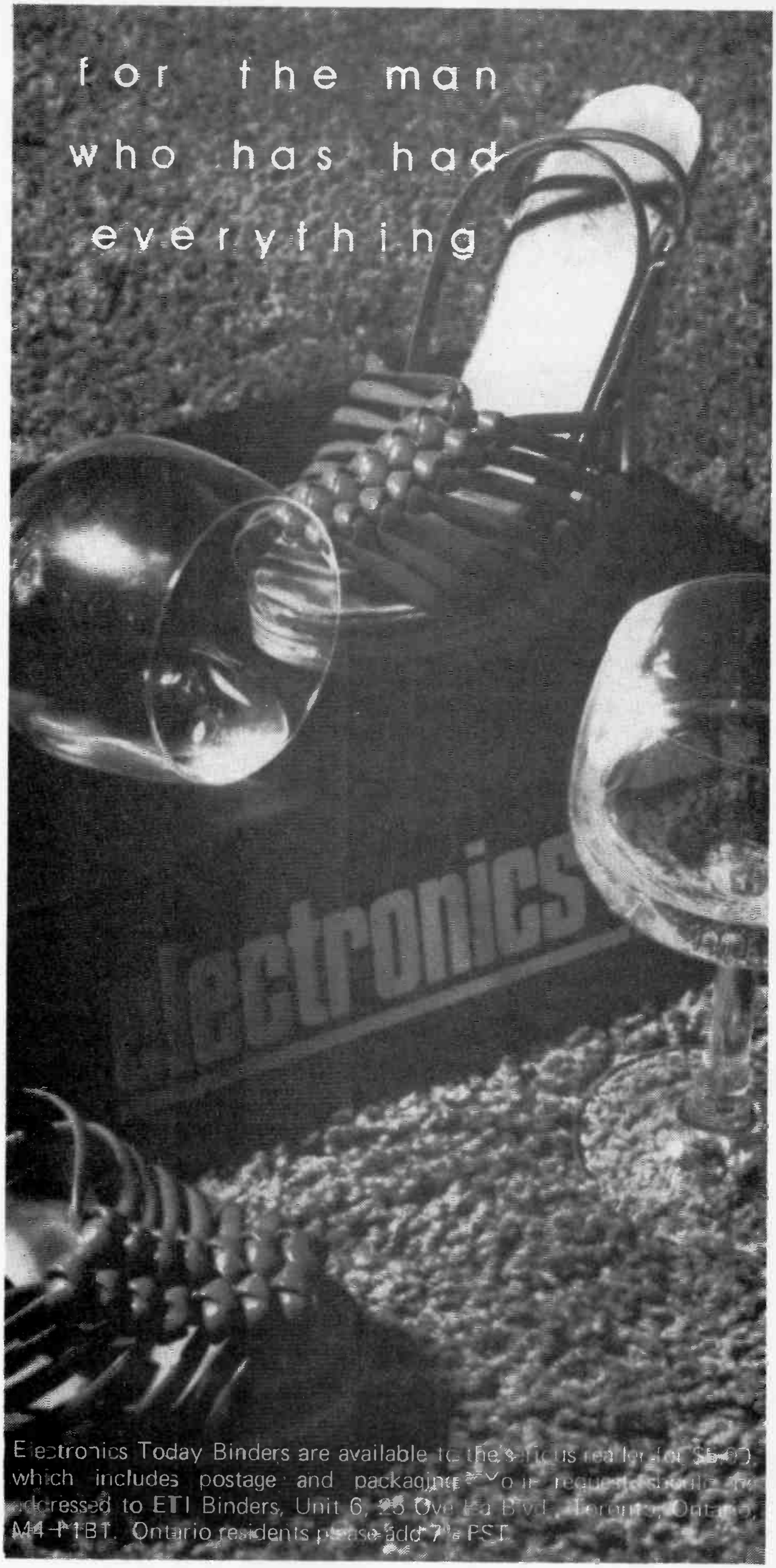
1 clothes peg
2 drawing pins
2 thumb tacks
1 bottle of aspirins

★★★★★★★★★★★★★★

CONTEST

Readers — we're still searching for the quickest dissolving, or crumbling clothes peg jaw opener — please write to us with your experience and times. Contributor with the fastest pills reported to us before May 31st wins a complete set of genuine wooden clothes pegs autographed by ETI staff. Please enclose a couple of sample tablets with your entry, and details of your test method. Prescription pills do not qualify.

★★★★★★★★★★★★★★



Audio Compressor

Increase your talk power with this circuit.

THE HUMAN VOICE, being expressive at its best, varies considerably in level, even when one is speaking in a normal conversational voice. The peaks are considerably higher than the lower levels, which can give rise to problems when the speech waveform is being modulated onto a carrier by a transmitter. For example, if the mic gain control is set so that the peaks are just giving 100% modulation, then soft sounds can barely be heard whereas if the gain is turned up to give a higher level on vowel sounds, etc., then plosives (p-sounds) will give overmodulation and consequent splattering and poor speech quality.

A higher ratio of average power to peak voltage can be achieved by several methods, including compression or clipping of the audio signal and compression or clipping of the radio frequency signal. Radio frequency compression or ALC (automatic level control) is often used in the final stages of SSB transmitters.

Radio frequency clipping is the most effective method of increasing the average power; however it requires complex circuitry, since it is necessary to generate an SSB signal, clip, and then insert this signal into the transmitter IF chain.

Almost as effective as RF clipping is a combination of audio compression, clipping and filtering, which is relatively simple and can realise an improvement in signal to noise ratio of up to 5 dB on weak signals.

COMPRESSION

When speaking into a microphone it is desirable to keep the voice level as constant as possible. This can be quite difficult as any change in the distance to the microphone will cause a drastic change in its output. To overcome this a variable gain amplifier can be used which senses the average speech level and adjusts its gain accordingly for a constant output voltage. The compressor operates with a fast attack (gain reduction) and a slow decay (gain increase), to quickly respond to the voice while remaining at this level to prevent amplification of background noise during speech pauses.

CLIPPING

The average power contained in a speech waveform is quite low compared to the peak voltage, and much less than the average power of a sine wave of the same amplitude. If the low energy high voltage peaks are cut off at a preset level the remaining signal can be increased without overdriving the transmitter. The average power is therefore increased. Clipping will slightly change the sound of the voice but will increase the intelligibility of a weak signal, as well as preventing the transmitter from being overdriven by limiting the maximum signal voltage.

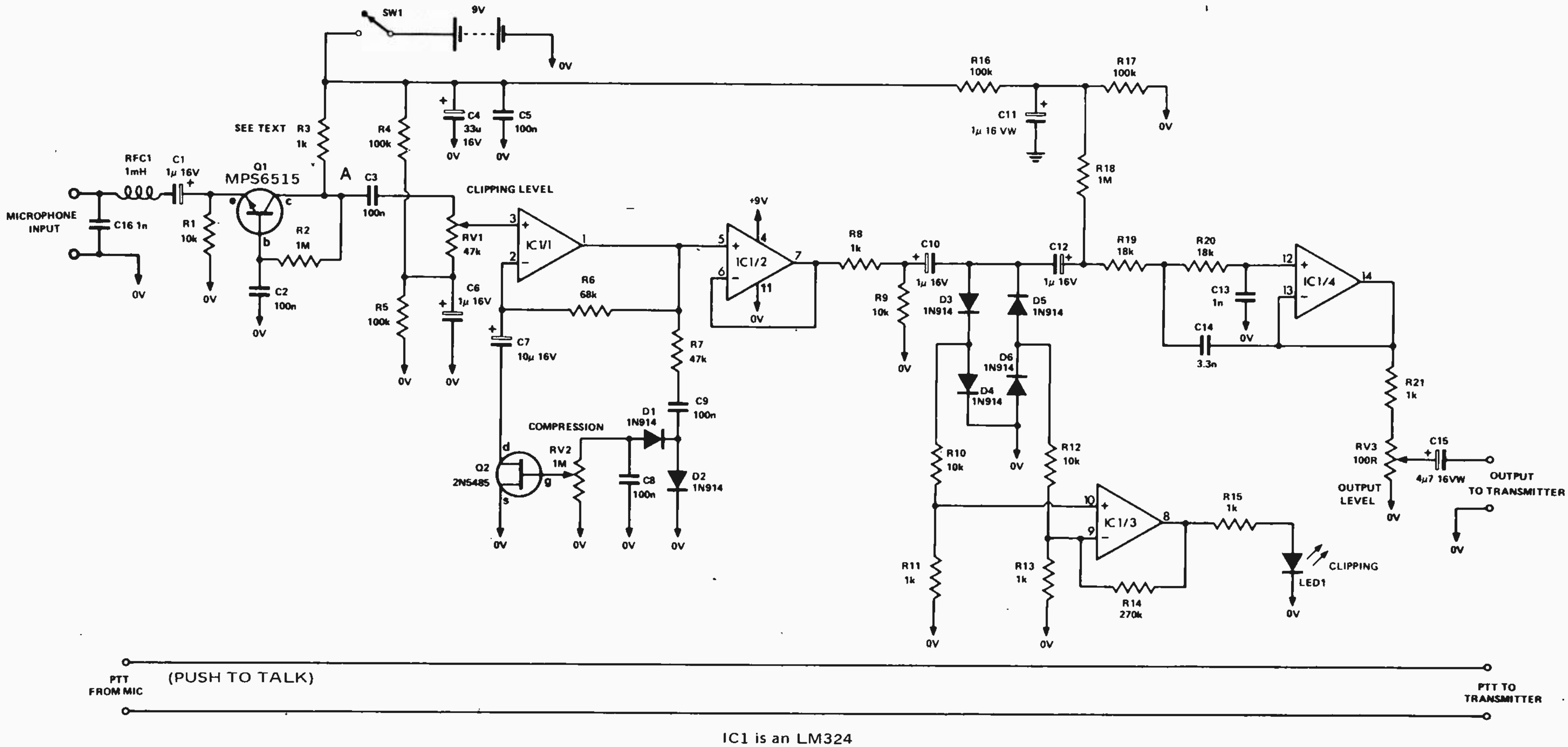


Fig. 1. Circuit of the Audio Processor.

HOW IT WORKS

The input is fed to a common base amplifier (Q1) and then to the gain control, RV1. The signal is then further amplified by IC1/1. Some of the output from IC1/1 is rectified and negatively charges C8. This voltage is then fed to Q2, a depletion mode N – channel FET. As the output of IC1/1 increases the voltage on the gate increases negatively and the impedance of Q2 increases. This increases the ratio of the feed back signal applied to the negative input of IC1/1 and the overall gain is reduced. The attack time is set by the time constant of R7 and C8, while the decay time is set by RV2 and C8.

IC1/1 is a buffer to isolate the peak limiter from the compressor input. R8 limits the output current of IC1/2 on peaks while R9 provides output bias current to prevent crossover distortion in the LM324 when driving capacitive loads. The diodes D3-D6 form the peak limiter by shorting any signal over about 1.5 V. When clipping occurs the voltage across D4 and D6 rises to 0.7 V. This voltage is used to turn on IC1/3 to give an indication of clipping by lighting LED 1.

The active low pass filter, IC1/4, removes the unwanted harmonics produced by clipping. RV3 sets the output level. The low frequency response is limited by the value of the coupling capacitors and C2.

FILTERING

When a waveform is clipped, high order harmonics are produced which, if allowed to reach the transmitter, would cause splatter and interference to neighbouring stations. A filter must be used after the clipper to rapidly attenuate all frequencies above 3 kHz, which are unnecessary for intelligibility. This is achieved by using an active filter with 12 dB/octave attenuation above 2.5 kHz.

CONSTRUCTION

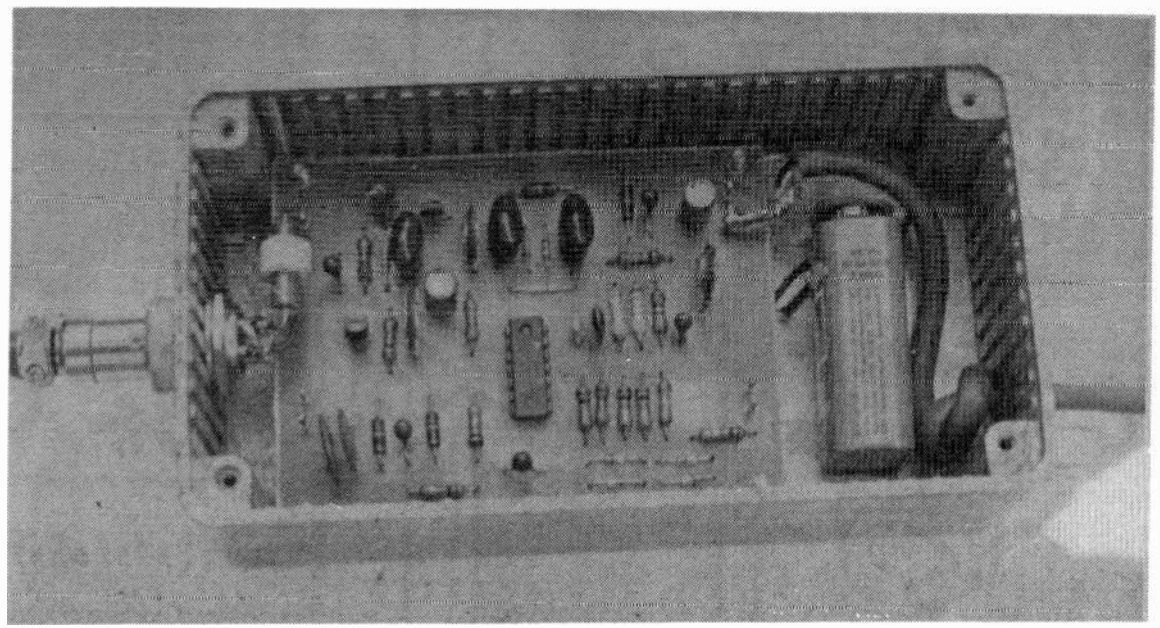
The speech processor is mounted in a diecast aluminium box to guard against feedback which can be caused by strong RF fields. Our box measured 150 mm x 80 mm x 50 mm deep. Either an internal 9V battery or the 12V transceiver supply can be used. The processor is designed to be used in the line from the microphone to the transmitter without any modification to either. A matching socket to the mic plug is used for the input and the output taken via a lead with a matching plug. The connections for the plug and socket vary between makes of transceivers and will have to be taken from the circuit diagram of the transceiver. The clipping indicator (LED 2) and the power switch are mounted on the front panel.

SETTING UP

Turn the compressor control to maximum and speak into the microphone at the greatest distance you are likely to use, (say 30 cm). Increase the gain control until the clipping LED flashes. If this point cannot be reached decrease the compression control and try again. The setting of these two controls is best determined by on-air tests. The output level control should be set so the RF indicator on the transmitter reaches the same peak as with only the microphone plugged in.

For high output, high impedance microphones, such as crystal types, Q1 can be omitted, RV1 replaced with a 1M trimpot and the input fed to point A on the circuit.

The gain of Q1 is proportional to the value of R3. Increasing its value increases the gain. To guard against feedback the lowest value possible should be used.



Inside view of the Processor. *The RF choke should be mounted as close as possible to the input socket.*

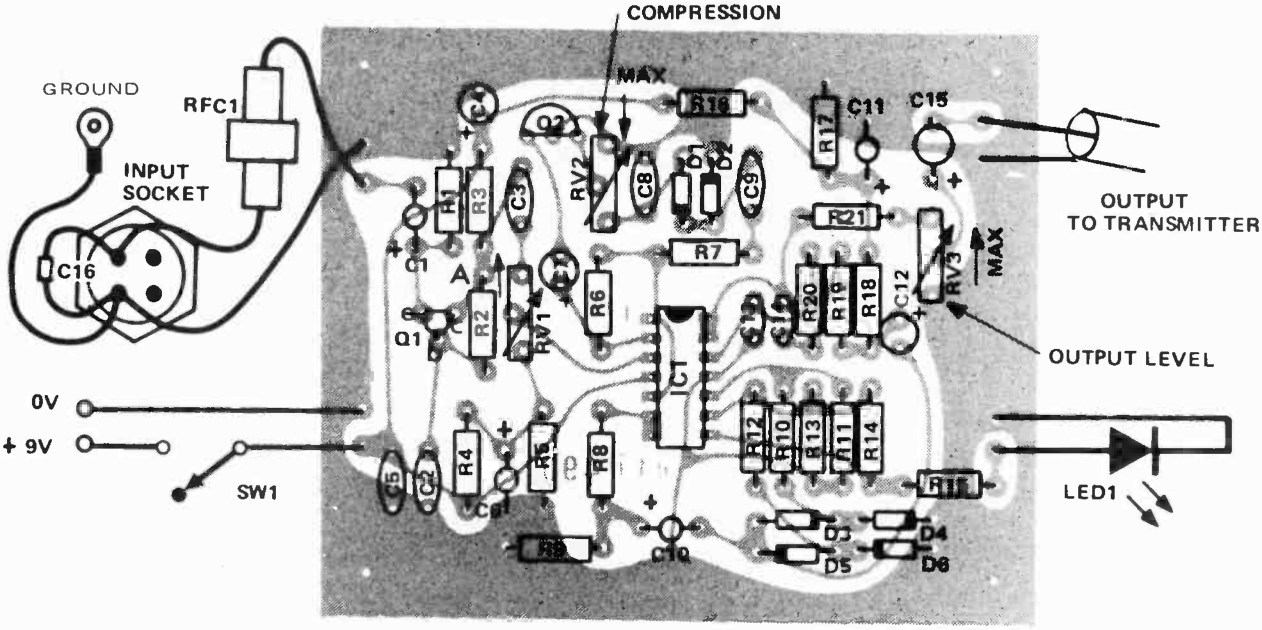


Fig. 2. Component overlay of the Audio Processor. Note the RF choke and capacitor mounted between the PCB and input socket.

PARTS LIST

RESISTORS all ¼W, 5%

R1	10k	R12	10k
R2	1M	R13	1k
R3	1k	R14	270k
R4, 5	100k	R15	1k
R6	68k	R16, 17	100k
R7	47k	R18	1M
R8	1k	R19, 20	18k
R9, 10	10k	R21	1k
R11	1k		

POTENTIOMETERS

RV1 . . . . 47k lin mini trimpot
RV2 . . . . 1M lin mini trimpot
RV3 . . . . 100Ω lin mini trimpot

CAPACITORS

C1. . . . . . 1μ 16 V electro
C2, 3 . . . . 100n
C4. . . . . . 33μ 16 V electro
C5. . . . . . 100n
C6. . . . . . 1μ 16 V electro
C7. . . . . . 10μ 16 V electro
C8, 9 . . . .100n
C10–C12 . 1μ 16 V electro
C13 . . . . . 1n
C14 . . . . . 3.3n
C15 . . . . . 4μ7 16 V electro
C16 . . . . . 1n

SEMICONDUCTORS

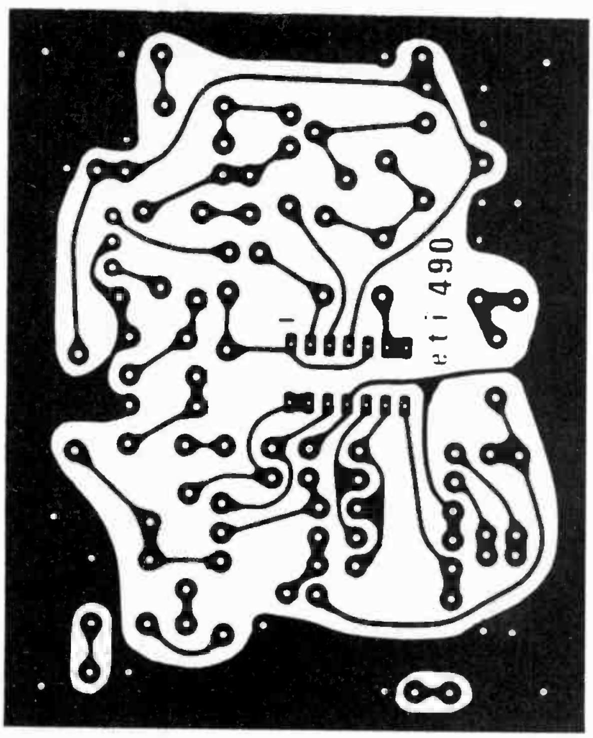
Q1 . . . . . MPS6515
Q2 . . . . . 2N5485 FET
IC1 . . . . . LM324

D1–D6. . . 1N914 or sim
LED1. . . . Red LED

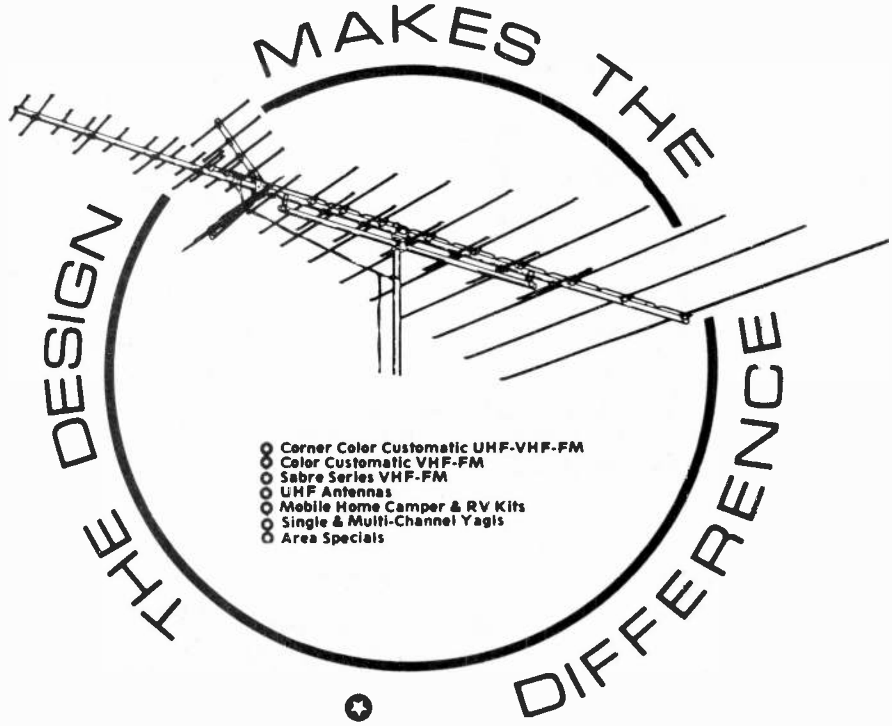
MISCELLANEOUS

RFC1. . . .1mH or higher Radio Frequency Choke
SW1. . . . . SPST miniature toggle
Metal box to suit, 9V battery and holder, microphone plug and socket to suit, length multi wire shielded cable.

Two source are available for the pcb for this project: B & R Electronics, P.O. Box 632F, Hamilton, Ont. L9C 6L9. Also Spectrum Electronics, 38 Audubon St. S. Hamilton Ont L8J 1J7.



UHF-VHF-FM ANTENNAS



BUILT TO LAST

The antennas sold by GTE Sylvania Canada Limited are backed by twenty years of expertise in the engineering, design, development and production of quality home television receiving antennas, from single channel yagis to all channel UHF-VHF-FM models. Over the years, more than 1600 engineering drawings of standard and "area specials" have been accumulated.

The plant where GTE Sylvania antennas are designed and produced is highly vertically integrated.

Antennas are designed in modern laboratory facilities by a well qualified engineering staff and constructed from materials fabricated from within the plant.

Aluminum is rolled, punched, cut and tabbed from tools and dies made on the premises. High quality products are thus ensured by maintaining all operations "in-house".

Remember, GTE Sylvania antennas are built with "quality" in mind.

Your requests are invited for any of your antenna needs.

THE DESIGN MAKES THE DIFFERENCE

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GTE Sylvania Canada Limited
8750 COTE DE LIESSE ROAD
MONTREAL, QUEBEC H4T 1H3.
(514) 735-4201

Wheel of Fortune

Round and round and round she goes, where she stops, nobody . . . .

ELECTRONIC BLACKJACK machines, pinball tables with an MPU at their centre – the world of electronics has a lot to answer for. Is nothing sacred?

The answer to that last question as far as we at ETI are concerned is not a lot. We've taken the liberty of implementing that traditional fairground attraction, the Wheel Of Fortune, in our own electronic fashion. The game usually features a large wooden wheel and ratchet arrangement, the stall either accepting bets on which of the ten numbers will be under the pointer when the wheel stops, or perhaps, suggesting that a message under the pointer will give an indication of what the future holds in store for you – you will meet a tall dark stranger, you will marry young and 2.4 mortgages, etc.

CROSS MY PALM

Our game accurately mimics the real thing, the circle of LEDs similating the spin of the Wheel getting under way as a pair of touch contacts are crossed with your palm (or more likely finger). The movement of the LEDs will then slow down to what seems an excrutiatingly slow speed until it finally stops. All this visual activity is at the same time accompanied by a clicking sound that simulates the ratchet sound of the real game.

It's easy to become a trifle blase about electrical games, particularly in the face of the never ending stream of things that we see in the shops at present, but even the most hardened people, and we've got some fairly hardened people here at ETI, found the Wheel of Fortune to be fun. If you start thinking about building it now it might just get finished for Christmas.

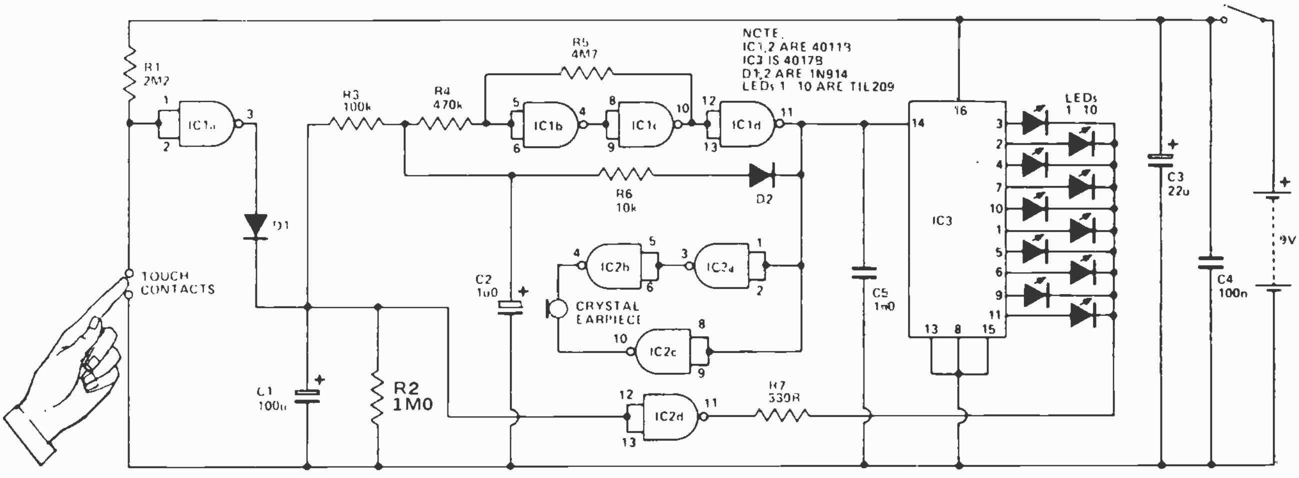


Fig. 1. Circuit diagram of the Wheel of Fortune.

HOW IT WORKS

THE Wheel of Fortune circuit can be broken down into a number of distinct sections; the display circuitry, an audio stage, a VCO, and a touch senstiive/monostable configuration.

In the "off" state R1 holds the input of IC1a high and hence the output of this gate, wired as an inverter, is low and C1 is discharged. Bridging the touch contacts causes the gate's output to go high and C1 to be charged up via D1, When the finger is removed from the touch contacts and the output of IC1a returns low, C1 is prevented from discharging into this gate as D1 is now reverse biased, instead C1 discharges slowly via R2.

The VCO is formed by the components associated with IC1b, c and d. The circuit in fact generates a series of constant duration negative going pulses separated by "spaces" whose duration can be varied by the control voltage.

When the control voltage (the voltage on C1) is below a threshold level that is equal to half supply voltage the circuit will not oscillate. If we now assume that the voltage on C1 rises to supply, as would be the case when the touch contacts are bridged, C2 will start to charge up. The voltage across C2 is applied, via R4, to the schmitt trigger formed by IC1a and b. As the voltage applied to the schmitt crosses its upper switching threshold the output of IC1d, which inverts and buffers the schmitt's output, will go low. This will cause C2 to be rapidly discharged via the relatively low impedance path offered by R6 and D2. As the voltage on C2 crosses the lower threshold of the schmitt the output of IC1d returns high and C2 once more begins to charge. The time taken for the voltage on C2 to reach the schmitt's trigger point is dependent on the voltage across C1. Thus when the voltage on C1 is large, C2 quickly reaches the trigger point and the VCO produces a high frequency, this frequency reducing as the voltage of C1 falls.

The output from the VCO is fed both to IC3 to drive the ring of LEDs and to IC2a, b and c to produce the audio output.

The crystal earpiece that provides the "clicking" is driven from a bridge circuit. This effectively doubles the voltage applied to the transducer and hence, from $P = V^2/R$, quadruples the audio output.

The LEDs driven by IC3 have their cathodes connected via R7, to the output of IC2d. The output of this gate will normally be high, going low when the voltage on C1 is above half supply. As IC3 outputs are active high the display is thus enabled for a period of time that is slightly longer than the duration of the VCO's oscillation.

C3 and C4 are included to decouple the supply while C5 is needed to prevent any RF interference affecting the circuit's operation.

None of the components used in the Wheel of Fortune game should prove hard to find as most will be stock items in many component shops. A tantalum capacitor would be best for C1 and C2, as low leakage is needed.

CONSTRUCTION

Start by mounting all the components on the PCB with the exception of the LEDs. Pay attention to the orientation of the polarity sensitive devices and, preferably, mount the ICs in sockets.

The touch contacts formed by two thumb tacks are glued to the front panel. When the case has been prepared, place, but do not solder, the LEDs into the PCB and offer them up to the case. Solder one lead of each LED. At this stage make sure that all the devices are properly seated, then solder the second lead.

That about completes the construction, just connect up to a battery and place your bets.

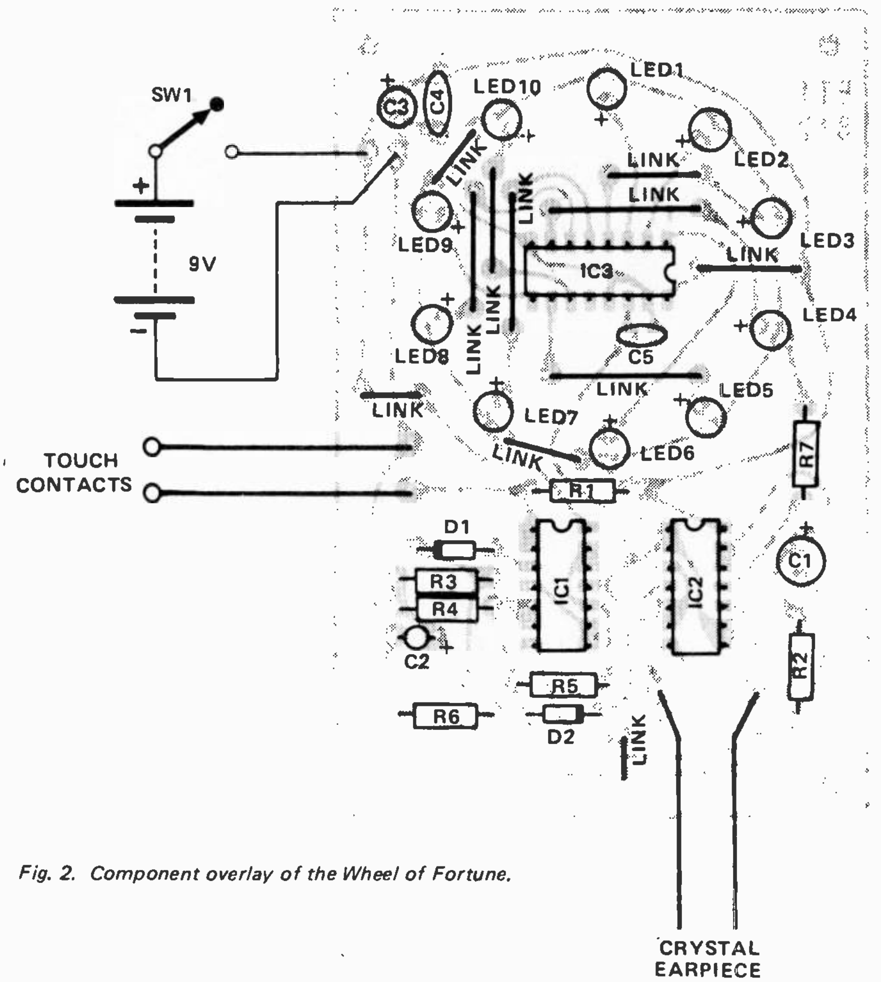


Fig. 2. Component overlay of the Wheel of Fortune.

PARTS LIST

RESISTORS all ¼W 5%

R1	2M2
R2	1M
R3	100k
R4	470k
R5	4M7
R6	10k
R7	330R

CAPACITORS

C1	100µ 16 V
C2	1µ 16 V
C3	22µ 16 V
C4	100n Ceramic
C5	1n Ceramic

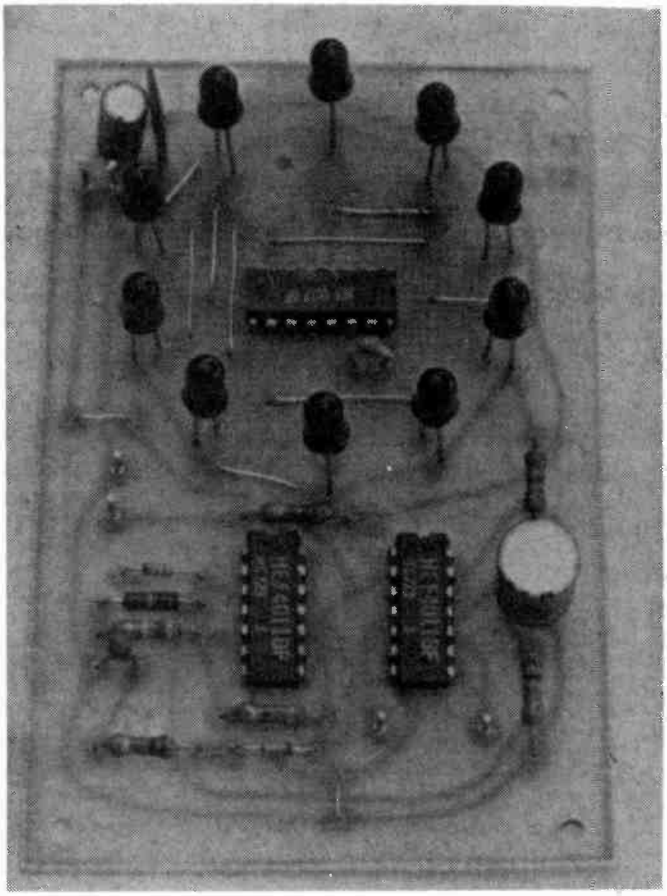
SEMICONDUCTORS

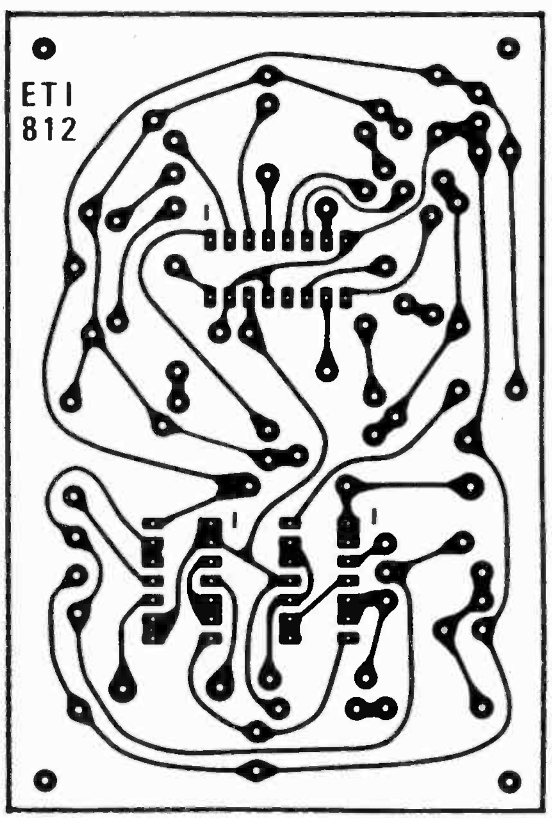
IC1, 2	4011B
IC3	4017B
D1, 2	IN914 or similar
LED1-LED 10	TIL 209 or similar

MISCELLANEOUS

9V battery and clip, crystal earpiece, miniature jack socket, box to suit, pcb.

PCB from Spectrum or B & R. Complete kit from Spectrum or parts only kit (no pcb) from Supreme. Addresses are: Spectrum Electronics 38 Audubon St S, Hamilton Ont L8J 1J7; B & R Electronics P. O. Box 632F Hamilton Ont L9C 6L9; Supreme Electronics Inc. P.O. Box 58276 Postal Stn L Vancouver B.C. V6P 6E3




ETI
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RF Chokes

Roger Harrison takes a close look at what's in the different styles of RF choke now available.

RADIO FREQUENCY chokes are used to prevent the passage of radio energy (hence the term 'choke') while allowing direct current or lower-frequency signals (eg, audio) to pass. This sort of application is principally one of decoupling; that is, isolating the RF–carrying portions of a circuit by providing a high RF impedance between two portions of the circuit. The principle also applies in RF interference suppression applications. For example, in reducing RF 'hash' from SCR or Triac motor speed controllers, light dimmers, etc.

RF chokes are also used widely in a variety of filter applications, eg, low-pass and high-pass filters. They are also used in pulse-forming networks and as frequency compensation components in wideband amplifiers (eg, video amplifiers).

RF chokes are also referred to as 'minichokes', 'microchokes' and 'video peaking chokes', etc.

CONSTRUCTION

The general range of construction styles employed are illustrated in Figure 1. The different winding styles have particular advantages and characteristics on which I will elaborate shortly. RF chokes are generally made in values according to the preferred series, in tolerances of 5%, 10% and 20%.

Regardless of the form of the winding or the encapsulation, RF chokes are wound on bobbins consisting either of a phenolic or plastic material (non-magnetic), powdered iron or ferrite material. The last two materials, because of their high permeability increase the inductance of the winding effecting a decrease in the number of turns required as well as influencing the other characteristics of the choke – which I will discuss shortly.

The bobbin generally has integral pigtail leads moulded into the material to which the winding is terminated. Axial leads are the most common form although radial-lead RF chokes are obtainable – principally intended for printed-circuit mounting.

A form of construction that reduces the external magnetic field of the choke to negligible proportions is illustrated in Figure 2. This form of construction completely encloses the winding with the result that it has a very weak stray field, reducing 'crosstalk', or coupling, between the choke and adjacent components. In fact, two chokes can be mounted so that they touch each other over the full length of the bobbin – and crosstalk attenuation is quoted as 60 dB.

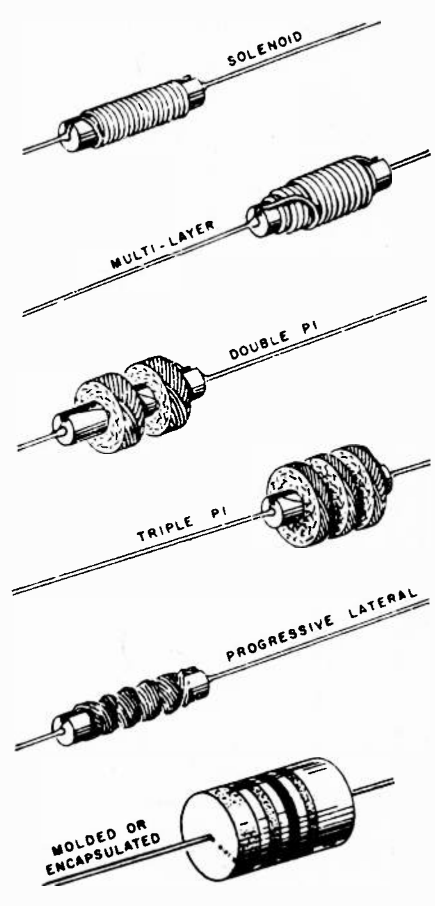


Fig. 1. General range of constructor styles of RF chokes. The particular style employed depends on the required or allowable component. Size, the inductance, the application and the required characteristics.

Low inductance RF chokes are usually 'solenoid' wound, whereby a single layer of wire is closewound on the bobbin. Chokes in the range 0.1 μH to 200 μH are generally solenoid-wound. The very low inductance types below 10 μH are generally wound on a non-magnetic bobbin. Powdered iron bobbins are generally used for chokes between about 5 μH and 100 μH, ferrite for the higher inductances to 200 μH or so.

Higher inductance chokes are obtained by overlapping several closewound layers on the bobbin. There is a limitation to this as the self-capacitance of the winding increases, decreasing the frequency range over which the choke is effective. This is discussed later. Chokes in the range 20 μH to 10 mH are often multilayer wound, generally on powdered iron or ferrite bobbins.

The Philips series of 'micro-chokes' cover the inductance range from 0.1 μH to 100 mH and employ solenoid or multilayer windings on the en-

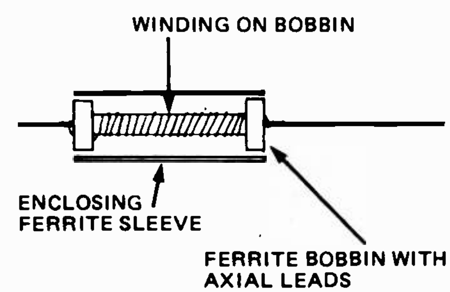


Fig. 2. Construction of fully-enclosed style of RF choke. Philips' make this style.

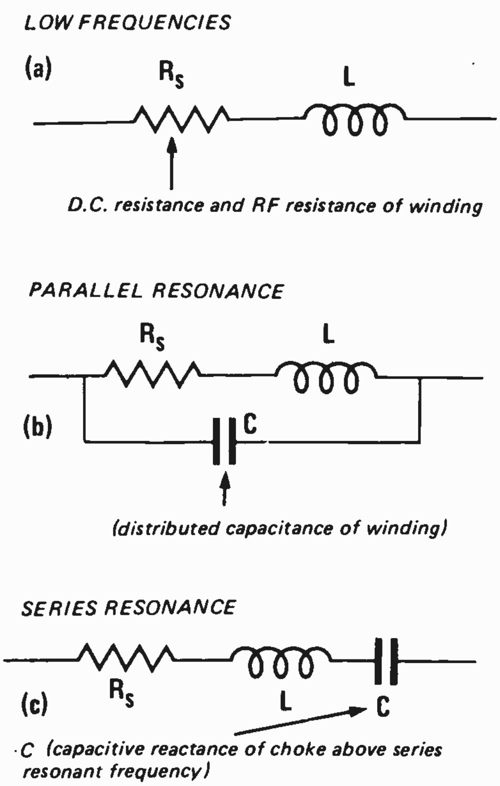


Fig. 3. Equivalent circuits of an RF choke over a wide frequency range.

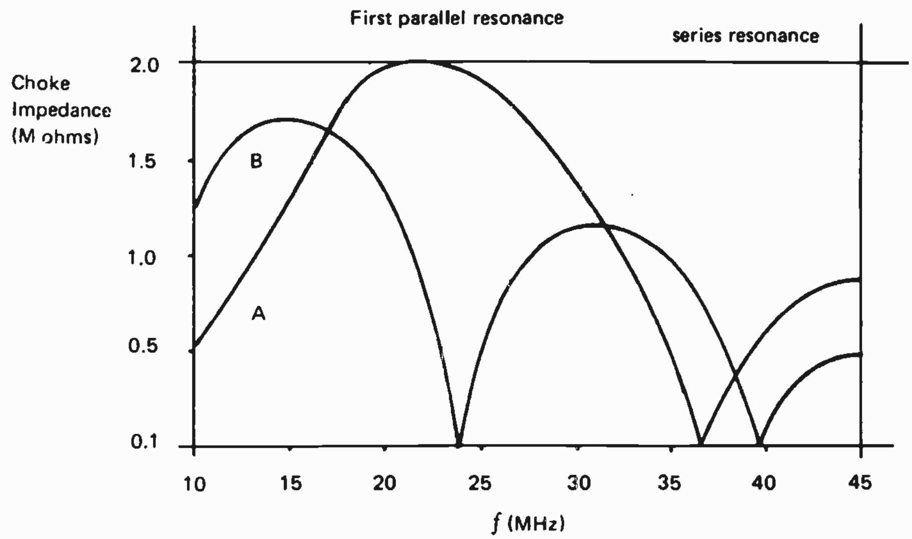


Fig. 4. Typical behavior of two RF chokes (A = around 10 µH, B = around 40 µH) over a range of frequencies.

L	Q @ F(MHz)		SELF-RESONANT FREQUENCY	DC RESISTANCE (Ω)	MAX. DC CURRENT	CONSTRUCTION & SIZE
0.1 µH	45	25	≈450 MHz	0.7	2.9 A	
0.15	45	25	≈400 MHz	0.12	2.8A	4 mm dia
0.22	45	25	≈350 MHz	0.14	2.7 A	by
0.33	45	25	≈300 MHz	0.17	2.6 A	10 mm long
0.47	45	25	≈270 MHz	0.21	1.7 A	* wound on
0.68	45	25	≈220 MHz	0.25	1.6 A	ferrite bobbin
1.0 µH	45	25	≈200 MHz	0.31	1.5 A	with ferrite
1.5	40	8	≈110 MHz	0.38	1.2 A	sleeve and
2.2	40	8	80	0.45	1.1 A	encapsulated.
3.3	40	8	60	0.53	900 mA	
4.7	40	8	55	0.63	650 mA	
6.8	40	8	45	1.0	500 mA	
10 µH	40	8	38	1.7	300 mA	
15	40	2	30	0.55	250 mA	
22	40	2	26	0.7	150 mA	
33	40	2	25	0.9	120 mA	
47	40	2	19	1.35	110 mA	
68	40	2	15	1.6	100 mA	
100µH	40	2	12	1.9	60 mA	
150	45	0.8	10	3.5	60 mA	
220	45	0.8	7.5	6.5	50 mA	
330	45	0.8	6.5	11	40 mA	
470	50	0.8	6.0	20	35 mA	
680	50	0.8	5.0	41	35 mA	
1 mH	50	0.8	4.0	48	25 mA	
1.5	50	0.25	3.1	25	100 mA	6.5 mm dia
2.2	50	0.25	2.9	30	100 mA	by
3.3	45	0.25	2.6	50	70 mA	10 mm long
4.7	45	0.25	2.4	60	60 mA	* same
6.8	40	0.25	2.3	75	50 mA	construction
10 mH	40	0.1	2.0	90	40 mA	as above.
15	40	0.1	1.4	110	20 mA	
22	40	0.1	1.3	130	15 mA	
33	35	0.1	1.3	130	15 mA	
33	35	0.1	1.3	275	12 mA	
47	35	0.1	1.2	400	10 mA	
68	30	0.1	1.1	470	9 mA	
100 mH	25	0.1	1	720	8 mA	
0.1						

TABLE 1 Typical characteristics of encapsulated microchokes wound on ferrite bobbins as made by Philips.

closed ferrite bobbins as illustrated in Figure 2.

RF chokes from around 47 µH through to 100 mH are often 'pie-wound'. This is a form of winding where the wire is zig-zagged around the circumference of the bobbin and built up in many layers. The individual turns are not colinear — lying alongside the adjacent turns — but the wires cross at an angle due to the zig-zag winding, thus reducing the total self-capacitance of the coil. A multilayer winding wound in this way is termed a 'pie', the method of winding is also referred to as 'universal' winding.

Pie-wound RF chokes may have 1, 2, 3 or as many as 5 or 6, pies making up the inductance. Generally the pies are of the same width, diameter and number of turns but some types for special applications, or where special characteristics are required, are wound with a number of pies, each having a smaller diameter but a greater width than the preceding pie. This achieves a more uniform impedance characteristic over the desired frequency range.

A variation on the pie winding is the 'progressive lateral' type where the zig-zag winding is progressively moved along the bobbin rather than building a high, multilayer pie. This technique reduces the inherent self-capacitance of the winding and provides a more uniform impedance characteristic across the required frequency range.

Encapsulated chokes are generally of solenoid or multilayer construction, and are encapsulated in an epoxy or other suitable material. Pie-wound chokes are sometimes encapsulated although they are more usually wax-impregnated. Heat-shrink tubing is also used to enclose and protect RF chokes.

CHARACTERISTICS

RF chokes are an inductance that is required to have a high value of impedance over a wide range of frequencies.

In practice, an RF choke has inductance, distributed capacitance, and resistance. At low frequencies, the distributed capacitance has negligible effect and the electrical equivalent of the choke will be as shown in Figure 3(a). With increasing frequency the effect of the distributed capacitance becomes more evident until at some particular frequency it becomes a parallel resonant circuit. The equivalent circuit at and around this frequency is illustrated in Figure 3(b). At frequencies beyond this the overall reactance of the choke becomes capacitive and eventually the choke becomes a series resonant circuit, as shown in Figure 3(c).

The cycles of parallel resonance-reactance, series resonance, etc, repeat with increasing frequency, the overall impedance of the choke rapidly becoming lower past the initial cycles. This sort of characteristic is illustrated in Figure 4.

L	Q @ F(MHz)		SELF-RESONANT FREQUENCY	DC RESISTANCE (Ω)	MAX. DC CURRENT	CONSTRUCTION & SIZE
0.1 µH	50	25	500 MHz	0.027	3.5 A	4 mm dia. by 9 mm long * solenoid wound on phenolic bobbin
0.15	50	25	510	0.03	3.0 A	
0.22	50	25	415	0.035	2.6A	
0.33	50	25	350	0.065	2.0 A	
0.47	50	25	300	0.085	1.7 A	
0.68	45	25	250	0.15	1.3 A	
1.0 µH	40	25	200	0.29	930 mA	
1.5	30	8	170	0.485	700 mA	
2.2	30	8	140	0.97	505 mA	
3.3	30	8	70	0.14	1.35 A	4 mm dia. by 9 mm long * wound on powdered iron bobbin
4.7	30	8	60	0.21	1.1 A	
6.8	25	8	50	0.375	810 mA	
10 µH	30	8	42	0.605	640 mA	
15	55	2.5	30	1.2	460 mA	
22	60	2.5	24	2.2	335 mA	4 mm dia by 9 mm long * wound on ferrite bobbin.
33	60	2.5	23	1.6	360 mA	
47	60	2.5	20	2.1	340 mA	
68	60	2.5	16	2.7	320 mA	
100 µH	55	2.5	10.5	3.3	275 mA	
150	60	0.8	7.2	4.1	230 mA	
220	65	0.8	6.2	5.0	200 mA	
330	70	0.8	5.4	7.0	170 mA	
470	70	0.8	4.7	9.55	145 mA	
680	65	0.8	3.6	13.8	115 mA	
1 mH	65	0.8	2.8	18.5	70 mA	6.5 mm dia by 12 mm long * wound on ferrite bobbin.
1.5	75	0.25	2.9	10	140 mA	
2.2	70	0.25	2.2	17.5	120 rnA	
3.3	70	0.25	2.2	20.5	100 mA	
4.7	65	0.25	1.9	27.5	80 mA	
6.8	55	0.25	1.5	41.5	70 mA	
10 mH	50	0.25	1.5	51 5	50 mA	

TABLE 2 *Typical characteristics of various encapsulated RF chokes, representative of those made by a variety of manufacturers.*

TABLE 3 *Typical characteristics of a variety of pie-wound RF chokes, representative of a number of manufacturers.*

L	Q af (MHz)		SELF RESOANAT FREQUENCY	DC RESISTANCE (Ω)	MAX. DC CURRENT (mA0	NUMBER OF PIES	CONSTRUCTION DETAILS	
47 µH	55	2.5	12 MHz	3	250	1	6 mm	9 mm
100	50	2.5	9.8	5.1	190	1	7.5 mm	9 mm
120	60	0.8	9	5.7	180	1	8 mm	9 mm
150	60	0.8	8	6.3	170	1	8.5 mm	9 mm
220	60	0.8	6	7.8	160	1	9 mm	9 mm
270 µH	60	0.8	5.2	9	180	2	7.5 mm	9 mm
330	60	0.8	4.5	10	170	2	8 mm	9 mm
470	60	0.8	3.5	12.4	170	2	8.5 mm	9 mm
560	60	0.8	3	14	160	2	9 mm	9 mm
470 µH	60	0.8	6.5	14	160	3	7 mm	12 mm
560	60	0.8	5.5	15 5	160	3	7.5 mm	12 mm
680	60	0.8	4.5	17.2	150	3	8 mm	12 mm
820	60	0.8	4	19	140	3	8.5 mm	12 mm
1 mH	60	0.8	3.5	21	130	3	9 mm	12 mm
1.2 mH	60	0.25	3.1	23	130	3	9.5 mm	12 mm
820 µH	60	0.8	3.2	13	190	2	9 mm	13 mm
1 mH	60	0.8	3.2	16	170	2	9.5 mm	13 mm
1.2	60	0.25	3.1	19	160	2	10 mm	13 mm
1.5	65	0.25	3	22	150	2	10.5 mm	13 mm
2.2	65	0.25	2.5	28	130	2	11 mm	13 mm
2.5 mH	65	0.25	2	30	120	2	12 mm	13 mm
2.0 mH	60	0.25	1.8	26	150	2	11.5 mm	16 mm
2.2	60	0.25	1.7	28	140	2	12 mm	16 mm
2.5	60	0.25	1.5	30	140	2	12.5 mm	16 mm
2.7	60	0.25	1.45	32	130	2	13 mm	16 mm
3.0 mH	55	0.25	1.4	34	140	3	11 mm	16 mm
3.3 mH	55	0.25	1.3	36	130	3	11.5 mm	16 mm
4.7 mH	55	0.25	1.1	45	120	3	12 mm	16 mm
5.6 mH	55	0.25	1	50	110	3	12.5 mm	16 mm
6.8 mH	55	0.25	0.95	56	110	3	13 mm	16 mm
8.2 mH	55	0.25	0.9	63	100	3	13.5 mm	16 mm
10 mH	55	0.25	0.85	71	90	3	14 mm	16 mm

RF chokes should not be used within about ± 20 –30% of the series resonant frequency, nor more than about 1.5 times the series resonant frequency. Obviously, from Figure 4, they exhibit their greatest impedance around their parallel resonant frequency.

Tables, 1, 2 and 3 list data on typical RF chokes of several varieties and sizes – they should only be taken as a guide, consult the manufacturers' literature if the characteristics of a particular choke are required.

The lower the self capacitance of a particular style of winding, the higher will be the series resonant frequency (also referred to as the self-resonant frequency), thus allowing the choke to operate over a wide frequency range. Special windings, such as the progressive lateral, have extremely low distributed capacitance as well as less variation in impedance across the frequency range, compared to other styles. The variation in self resonant frequency versus choke inductance for three different bobbins and winding styles is illustrated in Figure 5.

The equivalent series resistance of a choke is made up of the actual dc resistance of the winding plus the RF resistance of the wire used due to 'skin effect'. The actual dc resistance of the choke may need to be taken into account in a circuit, particularly in high current circuits or with high inductance chokes. The latter may have dc resistances up to 500 or 600 ohms.

The equivalent series resistance (also called the 'apparent resistance') varies with frequency, reaching a peak before decreasing due to the shunting effect of the distributed capacitance of the winding. The variation of R_S with frequency for a range of inductances is illustrated in Figure 6.

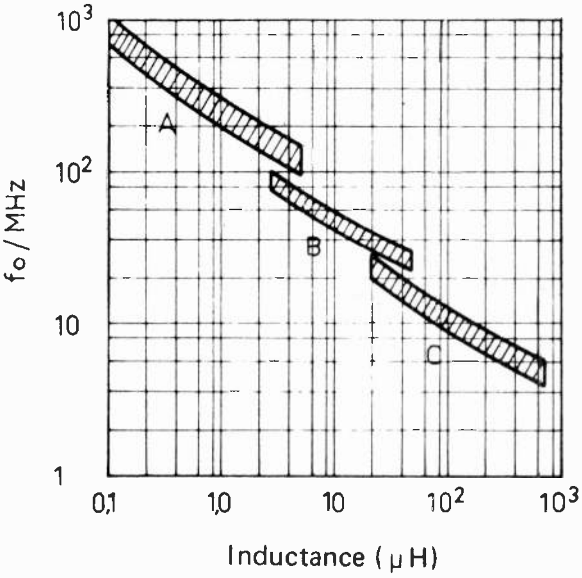


Fig. 5. Typical variation of self-resonant (or series-resonant) frequency against choke inductance for three different styles of choke construction.
A = non-magnetic bobbin
B = solenoid wound (single layer) chokes on powdered iron and ferrite bobbins
C = Multilayer chokes on powdered iron and ferrite bobbins.

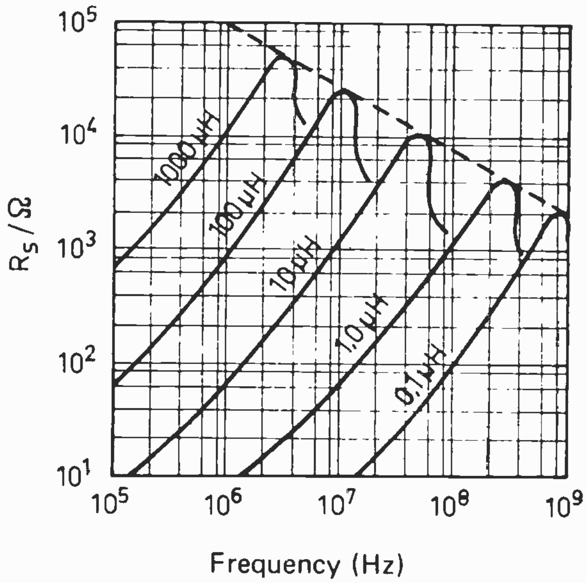


Fig. 6. Typical variation of equivalent serves resistance of a range of RF chokes against frequency.

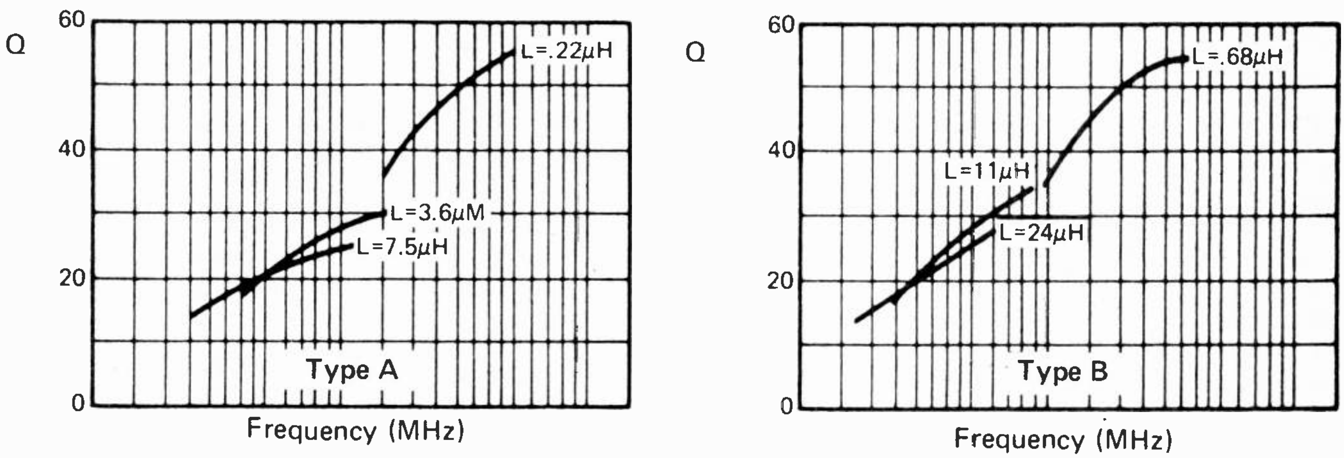


Fig. 7. Typical Q values versus frequency for several values of two different sizes of moulded RF chokes (From IRH).
A = 6.4 mm dia. x 78 mm long.
B = 6.4 mm dia. x 27 mm long.

RF Chokes

Naturally enough, RF chokes have a limit to the amount of dc current they can carry without either overheating or effecting a change in the inductance outside the specified tolerance limits. Manufacturers specify a maximum dc current for their chokes, the figures given in tables 2 and 3 are only a guide. Seek out the manufacturer's data if in any doubt. Special high current chokes are manufactured for specific applications, eg, for RF hash suppression in SCR and Triac ac control circuits, filament chokes for high power RF transmitting tubes, etc.

RF chokes are generally low Q components. The actual Q specified by a manufacturer is generally the minimum Q, measured at a particular frequency, generally in the manner illustrated for several values and two sizes in Figure 7.

MARKINGS

RF chokes are marked with their value and tolerance with the standard colour code or typographic code, in much the same way that resistors and some capacitors are marked.

There are several ways in which the colour code is marked on the body of the choke and these are illustrated in Figures 8, 9, 10, and 11.

The nominal inductance value is always indicated in microhenries (μH).

Where a typographic code is employed it is generally of a quite simple form, similar to that used on resistors. The nominal inductance value, again, is always expressed in microhenries (μH). The value is identified as follows:—

Nominal inductance values less than 100 μH are identified with three (3) numbers representing the significant figures, the letter R being used to designate the decimal point.

eg, 0.68 μH = R680
4.7 μH = 4R70
33 μH = 33R0

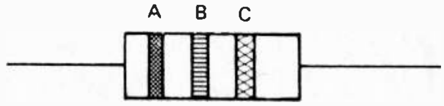
Nominal inductance values of 100 μH and above are identified by a four digit number. The first three (3) digits represent the significant figures of the value and the last digit specifies the number of the following zeroes,

eg, 680 μH = 6800
4700 μH 4701 (4.7 mH)
33000 μH 3302 (33 mH)

In addition, a single letter may be added to indicate the tolerance, as follows:

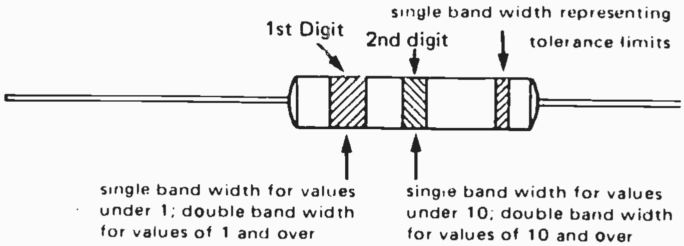
J = ± 5%
K = ± 10%
M = ± 20%

COLOUR	A & B	C
SILVER		10^{-2}
GOLD		10^{-1}
BLACK	0	1
BROWN	1	10^1
RED	2	10^2
ORANGE	3	10^3
YELLOW	4	10^4
GREEN	5	10^5
BLUE	6	10^6
VIOLET	7	10^7
GREY	8	10^8
WHITE	9	10^9



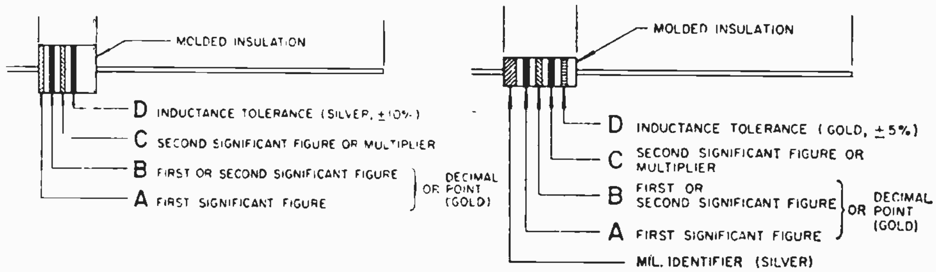
A = First digit
B = Second digit
C = Multiplier

Fig. 8. This colour code for RF chokes follows that for resistors most closely. Principally used by Philips on their 'microchoke' range.



Example: 0 – 0.91 two single bands
1.0 – 9.1 double-single
10.0 – 24.0 double-double

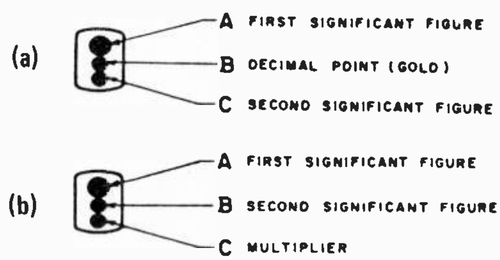
Fig. 9. This code varies the widths of the first two bands to indicate the position of the decimal point in the value. The code is read from left to right, as is conventional.



EXAMPLES

A = GOLD B = ORANGE C = ORANGE D = SILVER	0.33 μH, ±10% A = YELLOW B = GOLD C = VIOLET D = GOLD	4.7 μH, ± 5% A = BROWN B = RED C = ORANGE D = GOLD 15 mH, ± 5%

Fig. 10. This is similar to the code in figure 8 but the decimal point for values under 10µH is indicated by a gold band for bands A or B. A mil-Spec component is identified by broad silver band preceeding the value and tolerance bands. Some manufacturers use a dot to indicate the tolerance value as illustrated here.



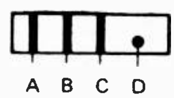


Fig. 11. Miniature radial lead RF chokes for printed circuit mounting may be colour-coded as shown here. The decimal point is indicated by a gold dot at either A or B, the value being read off in the same way as illustrated in figure 10. Note that the value is read commencing at the largest dot.

Write Only Memory

New device from Signetics uses their First In Never Out (FINO) process. Gets rid of all that useless data.

A new WOM from Signetics is described in a recent data sheet for the 25120, a fully encoded 9046 X N, random-access, write-only memory. Signetics points out that this is a final specification — and adds the footnote, "until we get a look at some actual parts".

The product is sufficiently unusual to merit substantial abstracting from the data sheet with only slight modification. It follows:

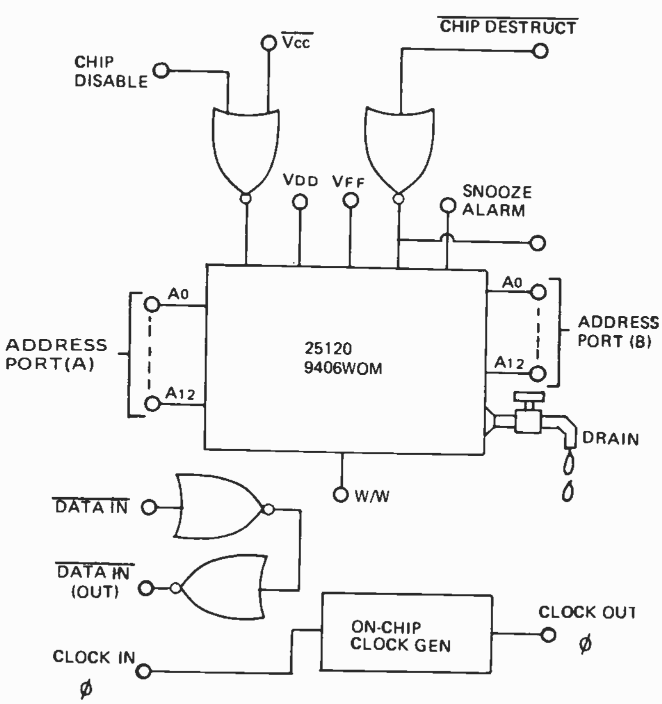
DESCRIPTION

The Signetics 25000 Series 9046 X N Random-Access Write-Only Memory employs both enhancement and depletion mode, p-channel, n-channel and neu[1] channel MOS devices. Although a static device a single TTL-level clock phase is required to drive the onboard multiport clock generator. Data refresh is accomplished during the CB[2] and LH[2] periods. Quadristate outputs (when applicable) allow expansion in many directions, depending on organization.

The static memory cells are operated dynamically to yield extremely low power dissipation. All inputs and outputs are directly TTL compatible when proper interfacing circuitry is employed. Device construction is more or less SOS[3].

FEATURES

- Fully encoded multiport addressing.
- Write cycle time 80 ns (max. typ.)
- Write access time[4].
- Cell refresh time 2 ms (min. typ.)
- TTL/DTL compatible inputs[5]
- Available outputs, n
- Clock capacitance 2 pF max.[6]
- V_{CC} = + 10V
- V_{DD} = 0 V ±2%
- V_{FF} = 6.3 V ac



A0 – A5 COLUMN ADDRESSES A6 – A12 ROW ADDRESSES

APPLICATIONS

Don't care buffer stores

Least-significant control memories.

Post-mortem memories (Weapons systems).

Artificial-memory systems.

Non-intelligent micro controllers.

First-In Never-Out (FINO) asynchronous buffers.

Overflow register (bit bucket).

PROCESS TECHNOLOGY

The use of the unique SEX[7] process yields Vth (var.) and allows the design and production[8] of higher performance than can be obtained with competitors' techniques.

BIPOLAR COMPATIVILITY

All data and clock inputs plus applicable outputs will interface directly or nearly directly with bipolar circuits of suitable characteristics. In any event, use 1-amp fuses in all power-supply and data lines.

INPUT PROTECTION

All terminals are provided with slip-on latex protectors for the prevention of Voltage Destruction. (Pill packaged devices do not require protection.)

SILICONE PACKAGING

Low-cost silicone DIP packaging assures reliability by the use of non-hermetic sealing which prevents entrapment of harmful ions while allowing the free exchange of friendly ions.

SPECIAL FEATURE

Because of the employment of the Signetics proprietary Sanderson-Rabbet Channel, the 25120 will provide 50% higher speed than you will obtain.

COOLING

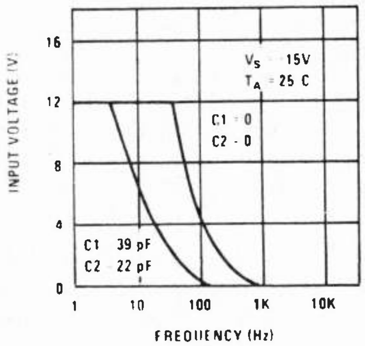
The 25120 is easily cooled by employment of a six-foot fan, 1/2 inch from the package. If the device fails, you have exceeded the ratings. In such cases, more air is recommended.

1. New channel devices enhance or deplete regardless of gate polarity.
2. Coffee Breaks and Lunch Hours.
3. Copywright U.S. Army Commisary, 1940.
4. Not applicable.
5. These inputs can somehow be driven from TTL. The method is obvious.
6. Measured in 1 MHz, 26 mV ac, 1.9 pF in series.
7. Signetics EXtra secret.
8. See "Modern Production Techniques" by T. Arrieta (not yet written).

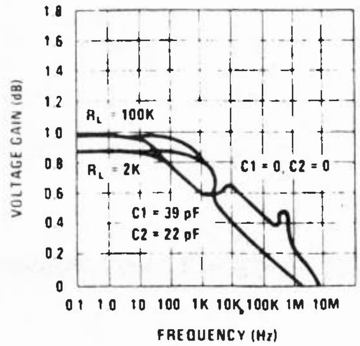
Non-Operational Amp

An ideal amplifier for many worthless applications.

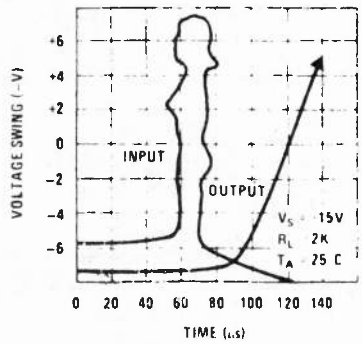
Large Signal Frequency Response



Open Loop Frequency Response



Female Follower Pulse Response



THE LM0901A114109045IC is a macropower, low performance, degraded circuit operational amplifier designed to have a no load power dissipation of less than 0.553 W at $V_s = \pm 1$ pV and less than 200 W at $V_s = \pm 2$ pV. Open loop gain is greater than 0.001 k and input bias current is typically 200 A.

FEATURES

- Typical low upset voltage — 10.13 V
- Typical low upset current — 59 A
- Typical low noise — 30 Vrms
- Simple frequency comprehension
- Marginal bandwidth and slewrate
- Output short circuit susceptible

The LM0901A141109045IC may be substituted directly for paper weights and fish lures. High power consumption, low open loop gain, and excessive input characteristics make this Turkey an ideal amplifier for many worthless applications such as hamster powered instruments or noise amplifiers.

DEFINITION OF TERMS

Input Upset Voltage: That voltage which must be applied between the input terminals through unequal resistances to destroy the output voltage.

Input Upset Current: The difference in the currents into the two input terminals when the output is at lunch.

Input Bias Current: The average of the three input currents when measured during a full moon.

Input Voltage Range: The range of voltages on the input terminals for which the amplifier operates within the city limits of Melbourne.

Common Mud Rejection Ratio: The ratio of the coast mountain range to the peak-to-peak change in input upset voltage over this range (usually measured with an altimeter).

Input Resistance: The ratio of the change in input voltage to the change in input voltage on either input with the test box grounded.

Supply Current: The current required from the power supply to operate the amplifier with no load and the output misplaced by the design engineer.

Output Voltage Swing: The peak output voltage swing, referred to zero, that can be obtained without clipping (which should be avoided since it carries a 15 yard penalty).

Large-Signal Voltage Gone: The ratio of the output voltage swing to the change in input voltage required to drive the output from zero to Wollongong.

Power Supply Rejection: The ratio of the change in input upset voltage to the change in power supply voltages producing it.

Transient Response: The closed-loop step-function response of the amplifier under vague signal conditions.

ABSOLUTE MAXIMUM RATINGS

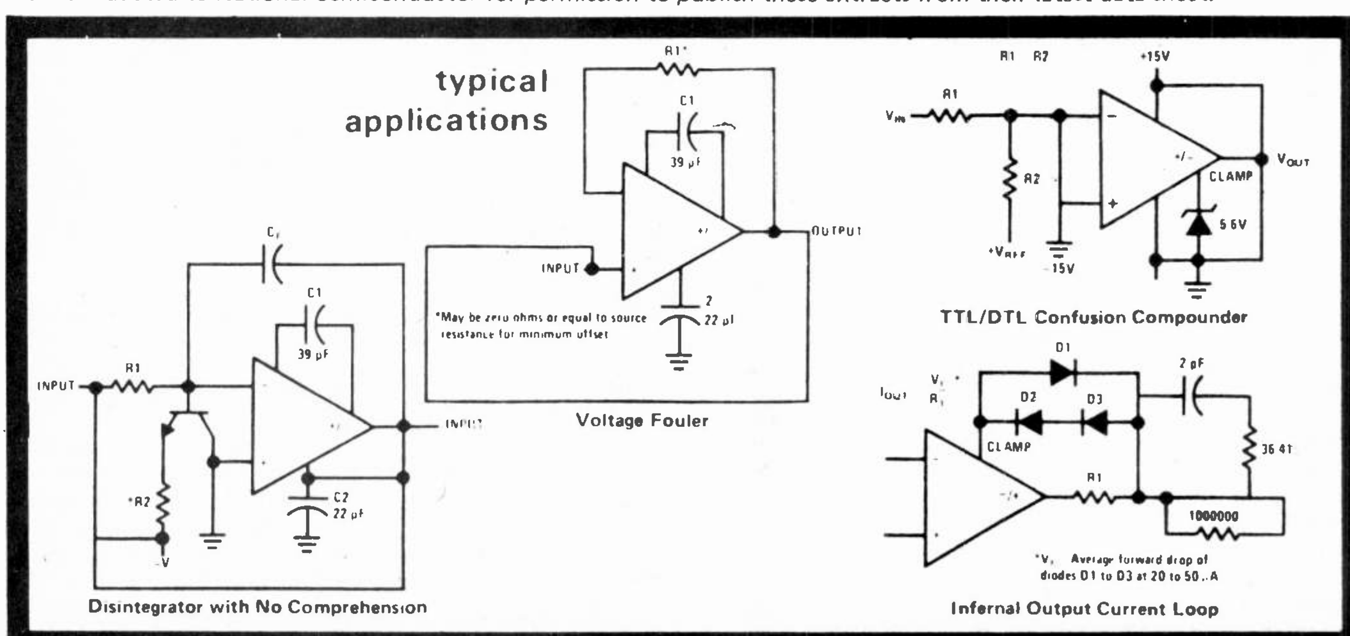
Supply Voltage	±2 pV
Power Dissipation (See Curve)	640 W
Differential Input Voltage	±7 fV
Input Voltage	$\pm V_S$
Short Circuit Duration	11 femtoinches
Long Circuit Duration	27 nanomiles
Operating Temperature Range	22°C to 35°C
Storage Temperature Range	−35°K to −10°K
Lead Temperature (Soldering, 10 seconds)	289°F

ELECTRICAL CHARACTERISTICS (Note 1)

PARAMETERS	CONDITIONS	CRUMMY PART			CRUMMIER PART			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Input Upset Voltage	$R_S \leq 1k$, T_A = 25°C		10.1	12.5 24.0		22.0	25.0 57.0	V V
Input Bias Current	T_A = 25°C		200	100 300		300	200 300	A A
Input Upset Current	T_A = 25°C		59	201 1004		207	360 1009	A A
Sloppy Current	V_S = ±2 pV, T_A = 25°C V_S = ±2 pV		80	425.6 450.3		80	425.3 450.6	μA nA
Voltage Gone	V_S = ±1 pV, V_{OUT} = 10V, R_L = 109k, T_A = 25°C	25	60		25	60		nV/V
	V_S = ±1 pV, V_{OUT} = 10V, R_L = 183k	10	30		10			nV/V
Output Voltage	V_S = ±1 pV, R_L = 12k, T_A = 25°C	10	11.5		10	11.5		V
	V_S = ±1 pV, R_L = 32k	9			9			V
Common Mud Rejection Ratio	V_S = ±1 pV, V_{IN} = 1V, R_S = 1k	70	90		70	90		lb/kton
Power Supply Rejection Ratio	R_S = 1k, V_S = ±1 pV to ±2 pV	0.1	0.2		0.05	0.1		dB
Equivalent Input Noise Voltage	V_S = ±1 pV, R_S = 1k, T_A = 25°C, f = 500 Hz to 500 Hz		30	86.53		30	91.74	Vrms
Average Temperature Coefficient of Upset Voltage	R_S = 310k		3.0			3.0		V/°C
Average Temperature Coefficient of Bias Current			0.3			0.3		A/°C
Rise Time	Monday $\leq T_A \leq$ Friday	6:15		6:45	6:15		6:45	A.M.

Note 1: The specifications apply for ±1 pV $\leq V_S \leq$ ±2 pV, with +input compensation capacitor, C1 = 39 MF, −input compensation capacitor, C2 = 22 MF, 22°C to 35°C, except in January or Belgium. Testing is performed at V_S = ±1.7326 pV, except on Friday when we drink beer instead.

We are indebted to National Semiconductor for permission to publish these extracts from their latest data sheet.



QRM Q

> 1. Section 73.1 of the *General Radio Regulations, Part II* is amended by adding thereto the following subsections:
>
> "(2) No licensee of a radio station performing a General Radio Service shall have in his possession any device capable of boosting the output power of the apparatus of his station.
>
> (3) Subsection (2) does not apply to a licensee of a station performing a General Radio Service if that licensee is also a licensee of a station performing an Amateur Experimental Service."
>
> Ottawa, le 16 octobre 1978

!

Bill Johnson, VE3APZ, this month is annoyed that HE missed out on the free licences, and next month will be organizing bus trips to Buffalo.

HOW OFTEN have you who go on sea cruises wondered why half of the ships making such voyages are registered in such unimpressive-sounding places as Liberia and Greece? In the shipping world it is a well-known fact that the reason for this is that these countries have very low safety standards so the ship owner doesn't have to install as many fire sprinklers, life boats, and other life-saving equipment as he would if he registered the ship under for example the Canadian or American flags. The result is not a heartwarming salute of patriotism towards Greece and Liberia by displaced shipping tycoons but a result of something they all respect and worship — saving money regardless of the expense to other people.

I never thought I would see such a thing happening in amateur radio. Amateur radio is a global fraternity, and as every other fraternity, has its initiation rites. It just so happens that initiation into full membership of our fraternity has been legally formalised by governments, and requires some very serious studying for an examination and the payment of an annual license fee to the amateur's government. The newcomer to the hobby usually gets interested by hearing amateurs and shortwave broadcasters. He sees a magazine such as this one and starts reading the shortwave column and follows advice given there on what to listen for and how to improve his reception and becomes a confirmed candidate for amateurdom. He will occasionally deviate from his perusal of the SWL's column to another one usually found in the same magazine, which is all about a slightly different world called amateur radio. Being an SWL is fun, and in some cases is enough to satisfy one's needs for a hobby, but the SWL cannot help but feel that he is only a spectator — the real participation starts when he receives his amateur ticket and gets his first 'rig' on the air. So he studies for the requirements of the exam set by his country's responsible government, and when he has passed it, he can pat himself on the back and consider himself a full member of the fraternity.

However, just as we find in other areas of life, there are people who are happy with a watered-down version of the original if it gives them something they can brag about and don't have to work for. There are also those who don't care much about being a Canadian "It's a fine place to live but I'd rather pretend to be an American", they think. Last but not least, there are those who don't care if they have to sell their soul to Uncle Sam as long as they don't have to pay their own government for a license.

These are examples of some of the people, all Canadian citizens and living in Canada, who go to the U.S. to write their amateur exams rather than doing it the way everybody else does. They think they are full members of the fraternity but they are really frauds. They stick out like a sore thumb because there is a very easy way to spot them — they all have AMERICAN callsigns, signing portable/VE. The next time you speak to an American portable/VE, ask him where he comes from. It'll probably be Canada and he'll probably give you some lame excuse such as "I just happened to be down there when they had the exam," or "I couldn't be bothered waiting for the D.O.C. to have an exam."

FREE RIDE

Really, they are very smart. You see, a recent count decision in the U.S. found that the license fees for radio stations there were arbitrarily applied and unconstitutional. From that day on, the F.C.C. had no choice but to revoke all license fees. So now any Canadian has the choice of staying Canadian, and going through the process of sitting the exam in Canada and becoming a true-blue Canadian amateur, or just skipping across the border, writing the American exam, and not paying any license fee. I wonder how long it will be before the D.O.C. acts to close this loophole?

QRM LETTERS

The recent article on the RSO repeater, VE3RSO, has sparked a round of letters, all of them from the RSO (see last month's letters also). The editor is doing his best to find space for them in this and future issues.

It seems that I stand accused of impressing on the minds of the many newcomers to the hobby a negative feeling towards the project. I'm also told that I failed to mention the objective of the VE3RSO repeater — that of relaying morse code practise to local repeaters so that student amateurs can easily practise their code to the required standard using cheapie police-band monitors and without the need for an expensive shortwave receiver to listen to WIAW, the American Radio Relay League's headquarters station in Newington, Conn.

My answer to that is twofold—firstly, I agree that such a service does, and will continue to assist would-be amateurs to get their code speed up to that required for the test. (The reason for a repeater is so that every club can originate practise into the system to alleviate the workload of Lloyd, VE3BZF, who must be commended for his stalwart efforts in generating code tapes every night for over three years now). But it is so dangerously close to being too easy. One of the benefits of WIAW's bulletins is that it gets the beginning amateur used to listening to a distant station in a crowded band. It gets him interested in setting up a receiver and a good antenna, and it improves his technique in signal detection. Pretty soon we are going to end up with new amateurs who have never listened to the shortwave bands before the first time they transmit!

Secondly, and this is where the RSO writers completely missed my point, the repeater should not even be in the two metre band. I originally said this because of the cluttering of 2 metre channels around Toronto, and the strong 2 metre signal from the repeater itself both make input on 220 or 450 a much easier task. All present 2 metre repeaters across Canada that have links put them on 220 or 450 MHz. This is not only because it is possible, it makes good sense, and the equipment is available, but the LAW SAYS IT MUST BE DONE THIS WAY. If you look in the D.O.C.'s policy on amateur automatic repeaters, Section 5, subsection 3 clearly states that, "Point-to-point circuits between repeaters shall use the frequency bands 220-225 Mc/s (MHz), 420-450 Mc/s (MHz) or higher frequency bands."

It is clear from the letters received from the RSO that this is what they intend to use VE3RSO for—but why break the rules to acheive their objectives?

Last month we announced the world's highest 2m repeater a-t-t-g-b-a-b, VE3TWR. At 450 MHz it's also the world's highest frequency 2m repeater!

Your Zenith Distributor has the parts and accessories you need in one convenient place — your Zenith One-Stop Shopping Center.

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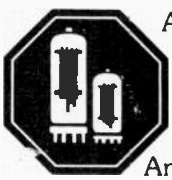
REPLACEMENT RECEIVING TUBES



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Here are just a few! Quad, stereo and monaural headphones. Broadened line of outdoor antennas featuring 13 all-new Super Chromatenna models. Complete new Chromatenna indoor antenna line. Antenna rotors. Three grades of batteries in a wide range of sizes. Electronic chemicals, including tuner degreaser, tuner cleaner, circuit cooler and tape head cleaner. Cassette and 8-track recording tape cartridges and record care products. A full line of test equipment & service aids.

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Service News

MANUFACTURERS. . DISTRIBUTORS . . REPRESENTATIVES . . . . . . SERVICE ORGANISATIONS. . . . Send us your news releases on upcoming seminars, new products, ideas for the successful shop. Address them to Service News, Electronics Today Magazine, Unit 6, 25 Overlea Blvd, Toronto, Ontario, M4H 1B1. Please note that your information must be received at least six weeks before the first of the month of the issue in which it is to appear. Any material published at our discretion.

Dick Cartwright looks into service associations.

A FEW DAYS AGO the boss drifted a memo across to me suggesting that technicians throughout the country might be interested in the various service organizations, who and what they are, their aspirations, etc. The note further suggested that problems past and present in one part of the country and their solutions could be of benefit to groups in other parts. I could only agree that the idea had considerable merit (he is the boss!), and so I started to research the various associations.

ORIGINS OF THE OTEA

Obviously I had to begin with the local chapter of the Ontario Television Electronic Association. This group has been extremely active over the last 7-8 years. It was formed after a very controversial series of articles in the Toronto Telegram under the column "Action Line" edited by Frank Drea, now Ontario's Minister of Consumer and Commercial Relations. This column soundly condemned the TV repair industry of Metropolitan Toronto for malpractice, incompetence and downright dishonesty. At that time Mr. Drea promised a group of extremely concerned technicians that he would do his best to help them form an association, and with the assistance of the Toronto Better Business Bureau the MTTSA was formed.

After nearly 6 years of hard work in which a strong Province-wide organization was always the goal, a charter under the Corporations Act was obtained and the Ontario Television Electronic Association was borne. Both small and large existing groups were incorporated and the Province-wide membership now exceeds 250 companies.

The aims of this quite dedicated association are extremely high, ranging from protection of the general public from unethical practices of domestic electronic service people, to improving the technical skills of all servicing members.

The social possibilities are of course a fine bonus, and from my own experience the get-togethers have always been a source of education as well as relaxation.

A free bi-monthly newsletter is mailed to all members and it provides news releases, technical tips, general information, etc.

I recently had lunch with Mr. Hank Steenhuysen, the President of OETA, and during an extremely frank discussion he pointed out to me that the prime requisite at this time is a larger membership. He further stated that complaints against technicians, members and non-members, have declined rapidly over the last few years, to the extent that the Better Business Bureau has had fewer and fewer complaints requiring serious investigation. Mr. Steenhuysen felt that this was due largely to the efforts of the local association's judicial committee.

Listening to Mr. Steenhuysen, it became obvious that his sights are set even higher than the existing Province-wide association and he is looking forward to the day when associations across the country will combine to form an organization similar to the rapidly growing United States NESDA. We discussed one of the original aims of many of the founding members of MTTSA, namely legislation which would make mandatory the holding of a government certificate of proficiency before any person would be allowed to service domestic electronic appliances. It seemed incomprehensible to us both that a licence is required to do electrical repairs, to be a plumber, or even to cut hair, but any person with absolutely no technical training whatsoever is permitted to set him or herself up as a TV repairer in this province. I have been told that this does not apply in many other parts of this country, but unfortunately I am not in a position to confirm or deny this.

I would be extremely grateful to hear from technicians or associations from across Canada the rules and regulations pertaining to their particular Province (on the other hand, if the editor would like to pay the bills I would gladly travel nationwide and find out for myself). (Ed. note: if someone out east or west will furnish an address, we will mail Dick to you. He will be sent in an unidentified brown paper wrapper. Please allow six weeks for delivery).

COMMENTS

I was somewhat surprised to find out that membership of the Ontario association is now directed primarily to the shop and business owners, as opposed to the practising electronic technicians. Originally the MTTSA was organized with the main objective being to encourage the technicians to obtain the Ontario Government certificate of proficiency, and this was a prime requisite for full membership, and one of the original by-laws was that for full voting rights in the association a member had either to have his own certificate or to employ certified technicians, but this has obviously gone by the board, and I can only surmise that the directors realizing that the shop owners are the company policy makers decided they should be the ones to control the association.

For information regarding the Ontario Television Electronic Association, please address any inquiries to Mr. Hank Steenhuysen, 1245 Ellesmere Road, Scarborough, Ont.

All the best. Richard Cartwright.

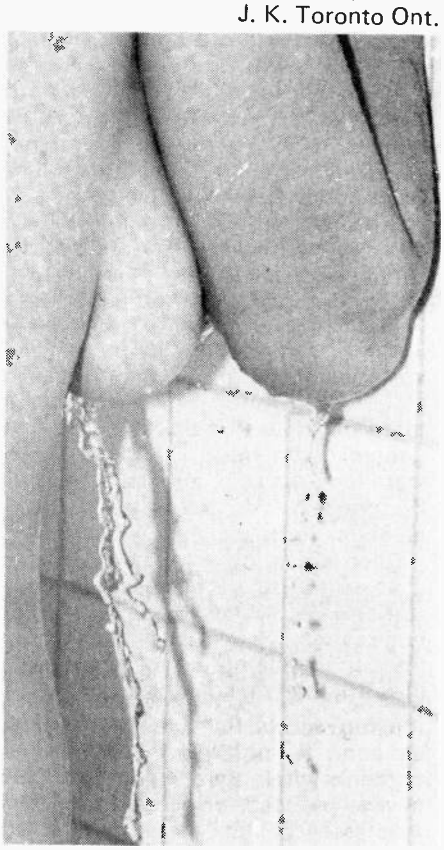
Dear ETI...

STROBE AND PAPER

I was delighted to find an easy to build strobe project in ETI. I purchased the components locally, and did my own pcb to accomodate different transformer etc. A large aluminum baking dish served as a reflector. The stop action effect of dripping water was so fantastic that my girlfriend and I decided to try showering by strobe light. The result was . . .(very interesting) . . . Pictures taken by photographic strobe showing similar effect are enclosed.

I also have a bone to pick with you guys (and gals?). I don't like your paper, because the ink rubs off on your fingers. Could you please switch to glossy, or would that be too expensive?

J. K. Toronto Ont.



Thanks for the pictures, they were very heartwarming, hope you don't mind if we print one.

However, a note to you and other strobe showerers. PLEASE HEED THE CAUTIONARY NOTES regarding the risks with strobe lights. First the electrical shock risk is increased in the bathroom because of the water, and because of the proximity of grounded taps, pipes and bath. IN ADDITION subjecting a person to a strobe lit environment has in some cases been found to induce epileptic seizures, even in those with no history of this trouble. The dangerous flash rate is in the 5 to 12 per second range, so be careful to stay out of this range.

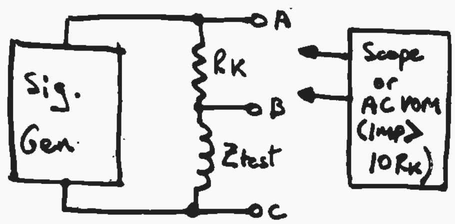
As for the paper, we suggest that you try not reading ETI in the shower.

INDUCTANCE MEASURING

How about an Inductance Measuring circuit? Say 1uH to 100mH.

G. C. Goode, Kelowna BC

Here's how to measure inductance:



Set the signal generator to some frequency, keep trying new values of Rk until voltage between B and C equals voltage between A and B. If R has to be very large, then reduce frequency, if it has to be very small then increase frequency.

Now with the two voltages equal, Ztest = Rk (at the set frequency. Since L=Z/6.28f and we know Z = R thus L = R/6.28f.

Eg. Sig. Gen. f = 10 kHz and Rk = 1k to make the two voltages equal. Thus L = 1k/(6.28 x 10k) = 16 mH.

GENERATOR FREQUENCY

I have a portable 110/220V gasoline generator that I use for power on my farm. I am looking for a digital frequency meter to indicate when the set is operating at 60 cps.

Would it be possible for ETI to publish such a design? It should be able to operate from a 12V battery.

R.G.Mickleborough, Eston Saskatchewan.

We suggest the easiest approach would be to use the Digital Tachometer project which we published in January 1979. You will have to figure out what rpm corresponds to what frequency, according to the particulars of your generator. Then the scaling of the tach can be arranged appropriately.

PCBs AND PAPER

Hi! You may remember I wrote to you about the print rubbing off in ETI? Well, please keep that paper.

I went back to reading a copy of PE and decided I don't like the reflections from the glossy paper. Not only that, but I've found a good use for the rubbing off characteristic. It's a new easy method for transfering the pc board pattern from your pages to the bare copper board. Photos of this method enclosed.

J. K., Toronto, Ont.

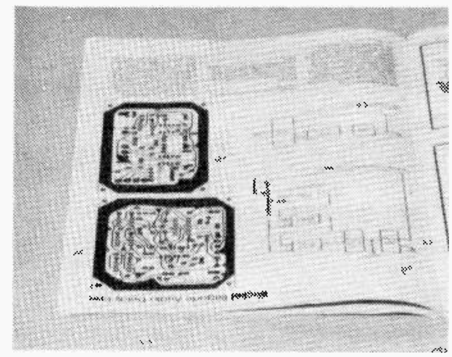


Fig. 1. Lay pattern on flat surface.

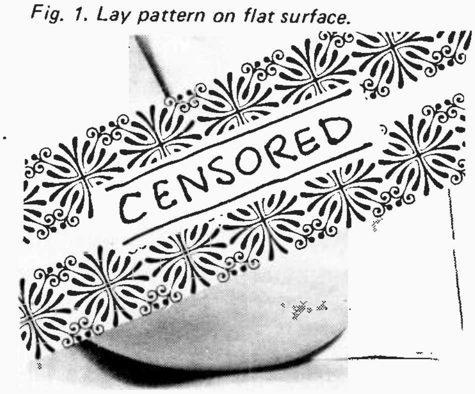


Fig. 2. Apply skin surface (selected for softness and smoothness) to pattern(s). Wriggle for maximum pattern transfer.

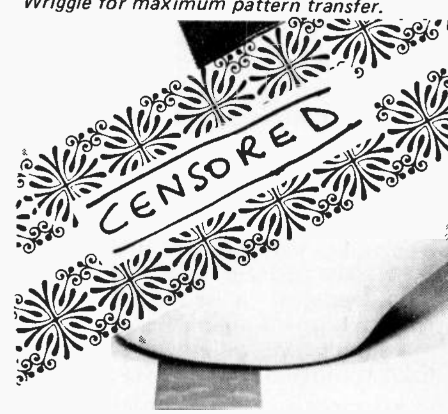


Fig. 3. Apply skin surface to bare copper-clad board. Again, pressure aids transfer process.

This method is ideal for doing two boards at once (as illustrated). Board should be checked for possible breaks before etching.

Mr (?) J. K. — Please send us your pcb transfer unit as soon as possible, as we have a few boards of our own to etch.

Also, how about a few details on the exposure?

More SWLs and QSLs

John Garner continues his discussion on being nice to far-away radio stations, so that they will send you pictures, music, propaganda etc.

ANARC 1979 CONVENTION

Canadian S-W-L International will be handling mail enquiries for the ANARC Convention which will be held in Minneapolis, Minnesota on the weekend of June 22, 23 and 24. For information about the Convention write to Convention '79, P.O. Box 142, Thunder Bay, Ontario, P7C 4V5. Enclose a business size self-addressed stamped envelope for return of the convention information. This convention promises to be one of the best yet so make plans to attend and meet others interested in this same hobby of ours. This convention, the 15th annual ANARC Convention, is being sponsored by the Minnesota DX Club and the Department of Speech-Communication, University of Minnesota. Convention chairman is Kim Andrew Elliot, assisted by Tom Gavaras and Greg Ravenhorst. I attended last year's ANARC Convention in Montreal and enjoyed every minute of it. See you in Minneapolis in June.

RECEPTION REPORTING

Last month we talked about QSLs, what they are, and basically what to tell stations in order to get them.

Program comments: This is one item that often is overlooked by short wave listeners but is very much appreciated by the broadcasters. Producers of short wave programs pay close attention to these program comments so that they can improve their programming and broadcast items that they know their audience want to listen to. In your comments tell the station truthfully what you think of their programs. Let them know what you like and dislike. Tell them how you think they can improve their shows. Some stations now even insist on comments on their programming in order to obtain their QSLs or "audience cards" as Radio Finland now call theirs. Try to avoid praising a station just to obtain a QSL — they would much sooner have you critize them so that they may improve their programming.

Personal data — Most international broadcasters are interested in knowing something about their listeners. This gives them a better idea of what sort of programming would be most enjoyable for their listening audience. Report your age, occupation and other interests that you have. Also let them know what type of programs you like.

After carefully preparing your reception report conclude with a statement such as the following: "If this report agrees with your program log I would appreciate a verification of my reception by QSL card or letter. Thank you very much."

Never demand a QSL!! Remember that this is the station's way of thanking you for reporting on reception in your area. Many stations have professional monitors around the world and they don't need reports on reception but they do appreciate your comments and will QSL out of courtesy to their listeners.

Taped reports: Before sending taped reports check the World Radio and TV Handbook to see if the station accepts tapes and if so what type they prefer. Many stations do appreciate taped reports as this enables them to hear for themselves how they are being heard in distant places. Some stations will record music from their land on your tape and return it to you when they have finished with it. In this case you should, of course, take the time to write to them and thank them for the tape.

When sending tapes state your name and address at the beginning of the tape. Record the program in sections of about one minute duration each, preceded by an announcement of date and time in GMT and the frequency. If you can identify any interfering station(s) mention this also. Two or three such bits are sufficient. Give your general comments on the program and state the type of receiver and antenna that you used. Also tell the station a little bit about yourself.

Recordings of the same program over several days is appreciated by the station as are recordings made of reception of several different frequencies being used in parallel by the particular station.

Mailing reports: Reports should be sent as soon as possible after listening, certainly within a week. Airmail should always be used for overseas stations. Addresses for stations may be obtained from the World Radio and TV Handbook or directly from the stations themselves when they ask for reports over the air. Be sure to affix correct postage to your envelope — don't forget the increase rate set by the Canadian Post Office effective April 1st, 1979. Check with your local post office for correct postage for overseas mail and if your envelope isn't a regular airmail envelope be sure to mark "AIRMAIL" clearly on it or use an airmail sticker from the Post Office.

Many of the major international broadcasters do not require return postage to be sent with your report but the smaller stations and religious broadcasters usually request return postage either in mint stamps of their country or in International Reply Coupons (IRCs). IRCs are obtainable at the Post Office and these are exchanged for postage in any country. IRCs are rather expensive. Mint stamps are available from stamp dealers or from DX Stamp Service, 83 Roder Parkway, Ontario, NY, 14519, USA. You may obtain a list of available stamps (for about 175 countries) by sending a self addressed envelope to the above address. Include an unused stamp!

Now that you have your report sent off all you can do is sit back and wait for your QSL to arrive. This may take from about a month to a year or even more. The Voice of Chile has recently been verifying reports as old as five years. If you belong to a club you can check the QSL column which appears in most club bulletins, to see how long other members have waited for their returns. If you don't receive a reply within a reasonable time then a follow-up report may be sent.

Follow-up reports — Either a copy of your original report may be sent along with a letter notifying the station that you wrote earlier and received no reply, or a new program may be reported. Be polite and do not blame the station for not replying — quite possibly your report was lost in the mail. With some of the more difficult verifiers it is always a good idea to include some small gift, such as stamps from your country, picture post cards, tourist brochures of your area, etc. . .

Tentative reports — If you hear a station but are not 100% sure of the identification but have enough information to be 90% sure then you should send them a tentative report. State clearly that you did not hear a positive identification but you are reasonably sure that the station heard was the one you are reporting to. Give as many details as you can in order to prove that it was indeed their station. Again at the end of your report state that this is a tentative report and you would appreciate verification.

Verification types — Stations may verify by QSL card or letter. The letters "QSL" do not actually stand for anything. In the early days of telegraphy, operators devised a Q Code which is still used today, especially by amateur radio operators. This code consisted of numerous three letter combinations all beginning with the letter Q and were used to replace longer phrases which of course saved a lot of time and telegraph key pounding. QSL was used to mean "I am acknowledging receipt". This came to be used for these cards which are an acknowledgement of your reception report.

QSLs fall into the following categories:

i) Full Data QSL — The date, time and frequency of your reception are included on this type of QSL along with the station's name and possibly call letters. The listener's name and sometimes his address also appears. The card should be signed by an official of the station.

ii) Partial verification — This type has one or more of the above items missing.

iii) No data verification — Sometimes a card will arrive with no data at all other than the name of the station. With this type you must keep track of the data yourself.

Transmitter sites — When writing to stations that transmit from a number of places, such as the Voice of America or Radio Moscow, it is a good idea to request the transmitter site on the card. Some stations will provide this information and others will not.

Storing your QSLs — At first you may wish to display your QSLs on the wall but after a while you will accumulate too many and will want a better method of preserving them. Albums are available in many book stores which are designed to hold post cards. These make very good display albums for those valuable QSLs.

QUICK QSL STORY!

While attending the ANARC Convention last year in Montreal, Larry Shewchuk and I had the good fortune of obtaining probably the quickest QSL reply in history. We were listening to Larry's radio along with Ambrosio Wang An-Po who is the official QSL signer for Radio Exterior de Espana. We tuned into REE and before the program had ended we had our full data QSLs signed by Ambrosio.

Good luck to you in your hunt for those QSLs.

Equipment Review

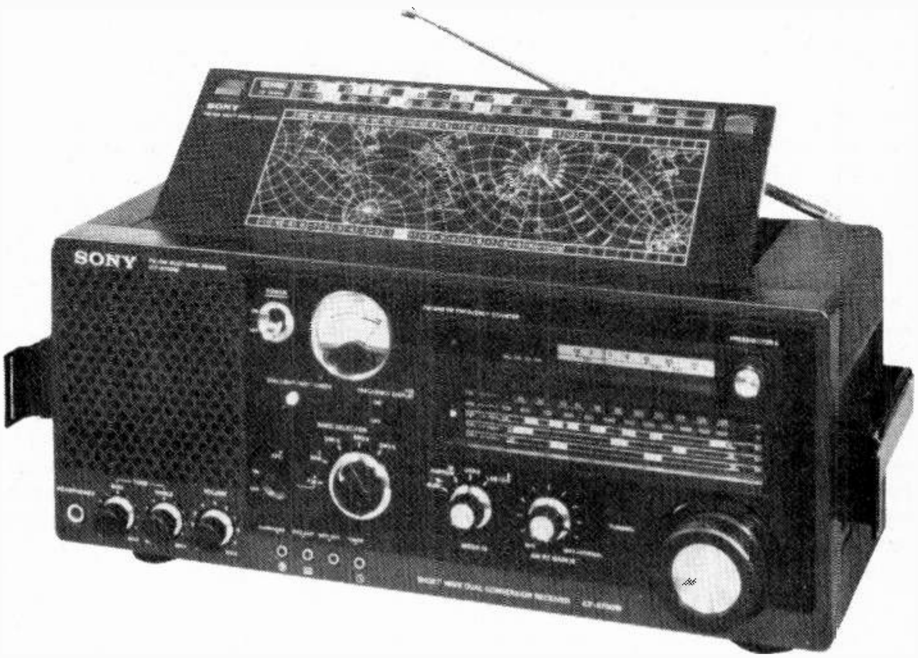
Last month we had a look at Sony's ICF-5800L, TFM-8000W, ICF-5900W, and CRF-5100. This month we look at three more Sony receivers — the ICF-6700W, ICF-6800, and the CRF-320.

ICF-6700W — This is a five band portable featuring AM/FM and three short wave bands covering 1.6 to 10 MHz, 11.5 to 20 MHz and 20 to 30 MHZ. The LED frequency display covers all bands. Tuning stability is assured by the dual conversion superheterodyne circuitry. Other features include SW pretuning for high sensitivity and selectivity; BFO signal generator for upper and lower sidebands and CW reception; FET RF amplifier; RF gain control for low distortion SSB and CW reception; wide and narrow AM mode selection for selectivity in crowded bands; separate bass and treble controls; World map with GMT to local time conversion and azimuthal equidistant projection to help achieve best antenna orientation. The ICF-6700W may be operated on 6 'D' cells or house current, and the weight is 5.5 kilograms. Perhaps a little large for a true portable. The Canadian list price for the ICF-6700W is $599.95.

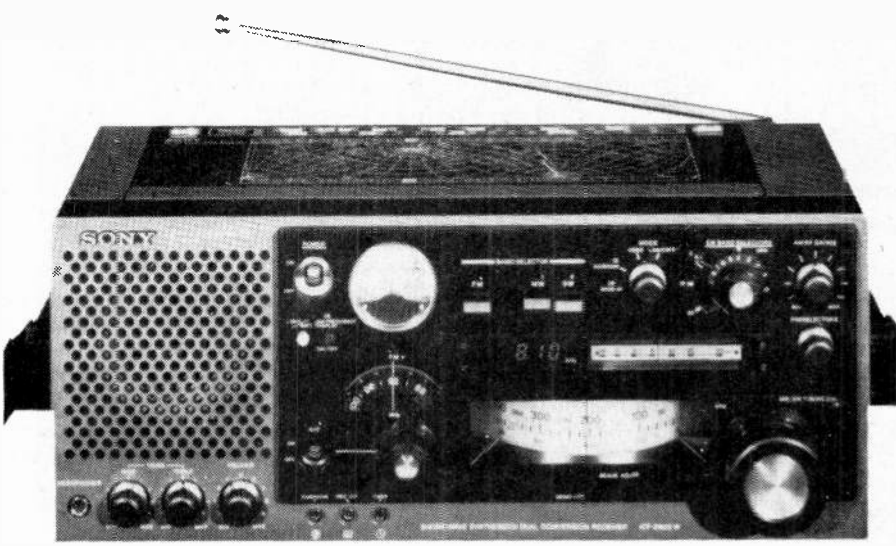
ICF-6800W — This is a fine quality 32 band portable receiver with AM and FM bands as well as 29 shortwave bands covering 1.6 to 30 MHz in 1 MHz wide bands. A longwave (LW) band covers 105 to 400 kHz. The digital display indicates frequencies to 1 kHz accuracy for SW and MW reception. The PLL (Phase Locked Loop) synthesizer tuner assures outstanding stability. Other features of the ICF-6800W include: FET RF amplifier stage; dual conversion crystal controlled; BFO for upper and lower sidebands and CW; RF gain control; antenna input tuning; seperate FM band tuning with AFC; wide-narrow selectivity mode switch; high quality SW preselector; easy to use drum dial; MEMO-LITE lights up desk for note taking even in the dark; separate bass and treble controls; world time zone chart on top for ready reference. The ICF-6800W circuitry consists of 8 ICs, 8 FETs and 53 transistors. Six 'D' size cells or 120 volt house current may be used to power the set. The ICF-6800W weighs 5.8 kilograms with batteries. The Canadian list price is $1,000.

CRF-320 — The Horizon Master also has 32 bands — AM/FM/LW and 29 shortwave bands covering from 1.6 to 30 MHz. This set has a number of unique Sony features including a battery operated quartz crystal clock that will automatically turn the radio on and off. The clock is accurate to within 10 seconds per month. The timer may also be used to turn a tape recorder on at the same time as the receiver. Other features are: dual conversion superheterodyne crystal controlled digital synthesizer with FET RF amplifier; LED frequency display accurate to within 1 KHz on SW bands; upper and lower sideband and CW reception; normal/narrow mode reception control; noise blanker to eliminate noise on SW; muting circuitry eliminates noise between FM stations; separate volume, bass and treble controls; antenna tuning control. The solid state circuitry has 19 ICs, 17 FETs, 80 transistors, 5 crystals (including clock), and 5 LEDs. The receiver may be powered by 120 volt AC house current or eight 'D' size cells. One 'D' cell is also used for the clock. This is another large portable weighing 13 kilograms with batteries. The CRF-320 sells in Canada for $2150.

Next month we will have information on some more receivers. Until then, 73 and good listening.



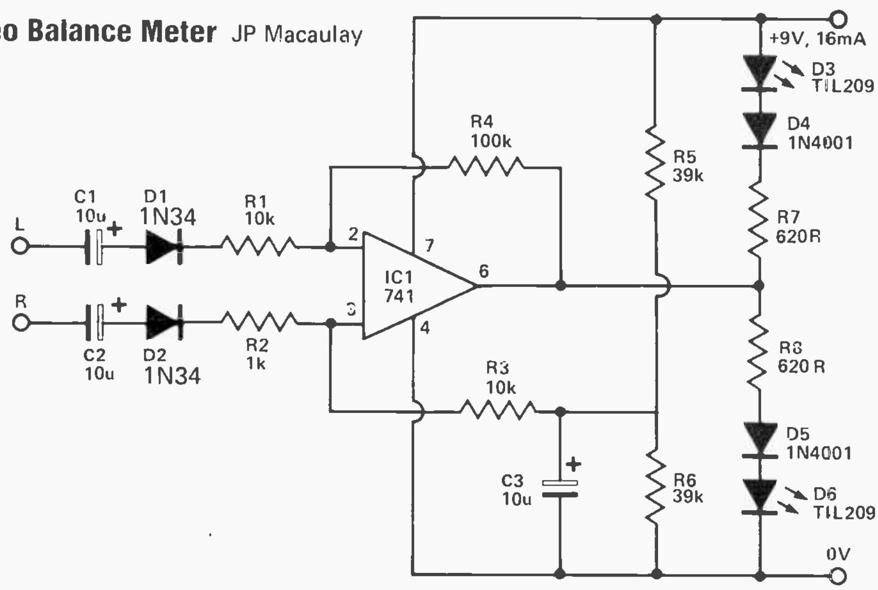
Above and below: the Sony ICF6700W and ICF6800W respectively.



Tech Tips

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

Stereo Balance Meter JP Macaulay



One of the more irritating aspects of owning a stereo system is the need to keep both channels in balance. What often sounds right when adjust--ing the controls turns out wrong when resuming one's normal listening position.

This circuit offers a solution to this problem provided that one's equipment is fitted with a stereo/mono mode switch.

IC1, a 741 op amp, is used as a differential amplifier. L and R signals are taken from across the speaker terminals. D1 and D2 rectify these and the resulting dc voltages are applied to the inputs of the IC.

The output voltage from the IC1 is applied to the LED's D3 and D6 via the current limiting resistors R7 and R8, and the diodes D4 and D5. These latter components allow the LED's to extinguish at extremes of the IC's voltage swings.

To use the indicator, switch the amplifier into the mono mode and adjust the the balance control until both LED's are equally illuminated. The amplifier can now be switched back into stereo mode and will be found to be in perfect balance.

Shifty Phase Adaptor

Q. Rice.

This circuit can be used in conjunction with the Audio Phaser from Canadian Projects Book, or with any phaser for that matter. The circuit provides a complementry (antiphase) shifted waveform which is mixed with the original waveform and amplified.

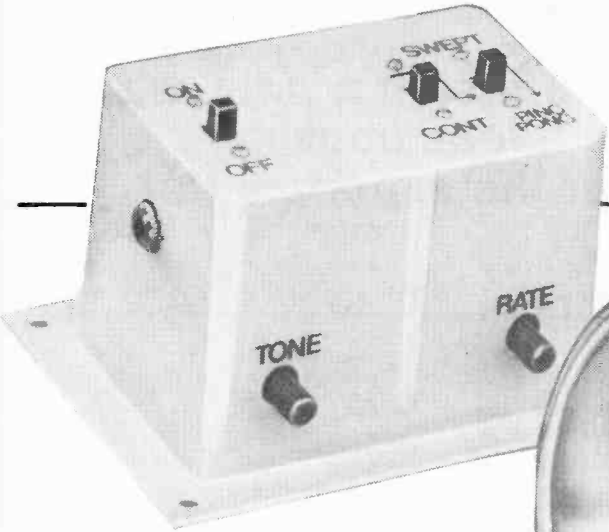
When this is fed through stereo speakers, it provides the ear with some very peculiar sounding phase information.

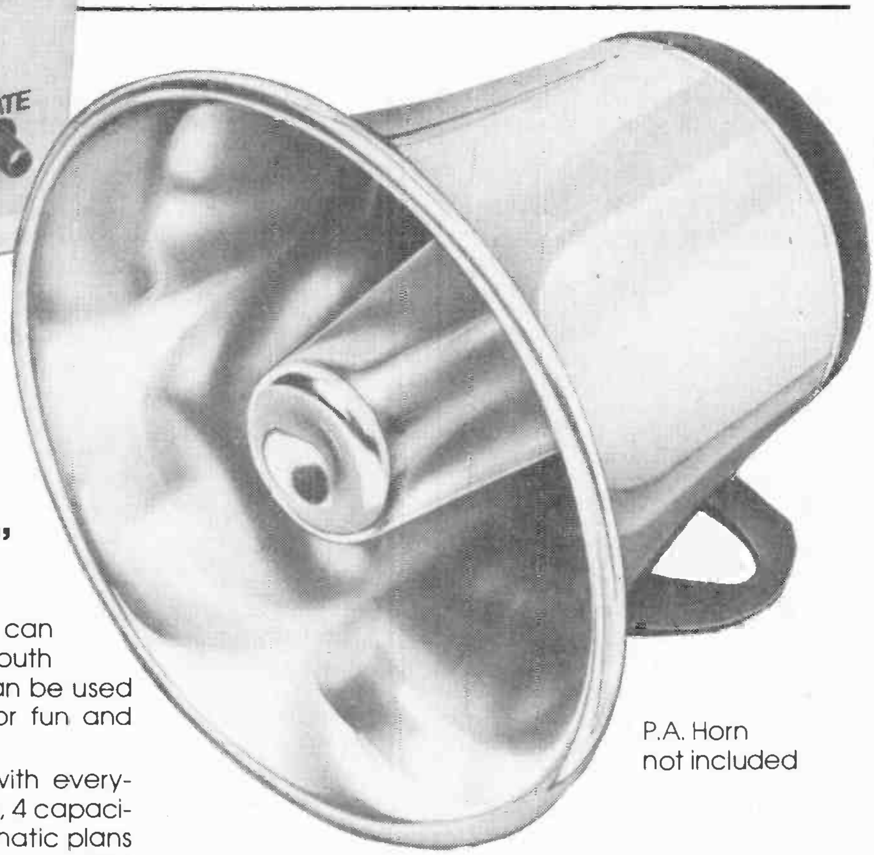
At slow speeds, the effect is very much like panning, except that the image is ambient irrespective of the position of the listener. At higher frequencies, where actual frequency shift occurs, a delayed tremelo effect is obtained.

This phase or frequency shifted panning would be most useful in stereo PA systems where the only place where all of the instruments can be heard is in the middle of the dance floor!

Loudmouth Siren

● Another **jana** Quality KIT





P.A. Horn not included

"Who would have thought the little thing had so much noise in it!"

Anyone with an interest in electronics can assemble an amazingly powerful Loudmouth Siren from this clever Jana Kit. Then it can be used as a burglar alarm, on boats, or just for fun and surprise!

Jana packages this inexpensive kit with everything you need: 2 ICs (chips), 2 transistors, 4 capacitors, 3 diodes, and 10 resistors. Plus schematic plans that guide you in putting it all together accurately. A glass printed circuit board is available separately. The package serves as a case for the finished product.

You add a regular 12v battery, needle nose pliers, a screwdriver, a small soldering iron and some solder, and a horn. If you want a new horn, buy a Jana JJ10706 or JJ10703.

The sound you produce can be as important and compelling as a police siren . . . varying from a steady wail to a swept sound (alternating strong and weak), to the most urgent ping-pong sound. A lot of people will suddenly become aware that you know something about putting electronics to work!

Check out the growing list of useful, educational Jana kits at dealers across Canada.

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3. Bug Shoo
4. Code Oscillator
5. Crystal Radio
7. Curiosity Box II
8. Dally Lighter
9. Decision Maker
10. Fish Caller
11. Hi Power 12V DC Flasher
12. Photo Electric Night Light
13. 6V Power Supply
14. 9V Power Supply
15. 0-20V Power Supply
16. Single Channel Color Organ
17. Electronic Siren
18. Shimmer Strobe Light
19. Tone Generator
20. 5 Transistor 1 Watt Amplifier
21. Tube Continuity Checker
22. Xenon Strobe
23. LJ 12016A Color Organ
24. Loudmouth Siren
25. Roulette Wheel
26. Electronic Skeet Game
27. Electronic Dice
28. Super Roulette
29. FM Mini Broadcaster

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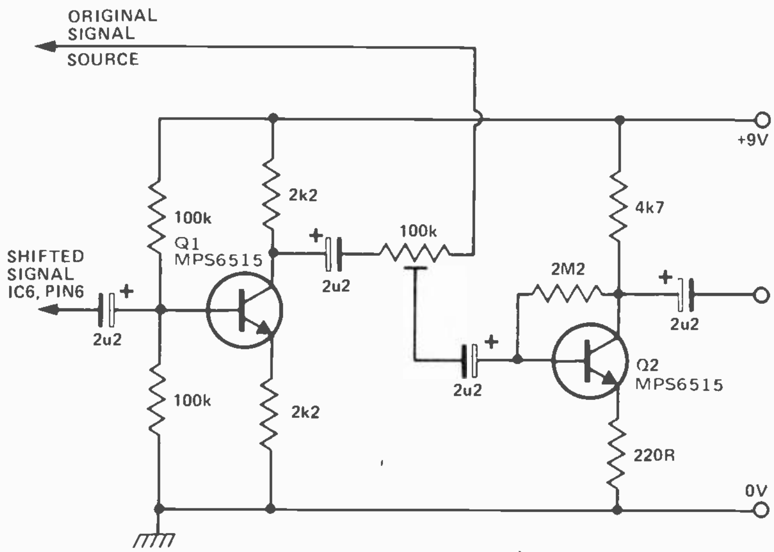
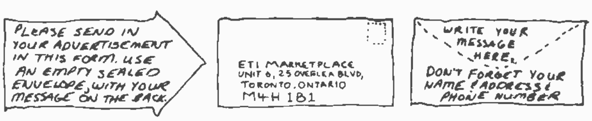
Tech Tips



ETI MARKET PLACE



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FOR SALE: GOOD OLD AC VOLTMETER (HP 400C) 12 RANGES FROM -60 TO +50 dB. ASKING $75.00, O.B.O. MR. C. LIN 59-W60TH AVE. VANCOUVER, B.C. V5X 1Z3.

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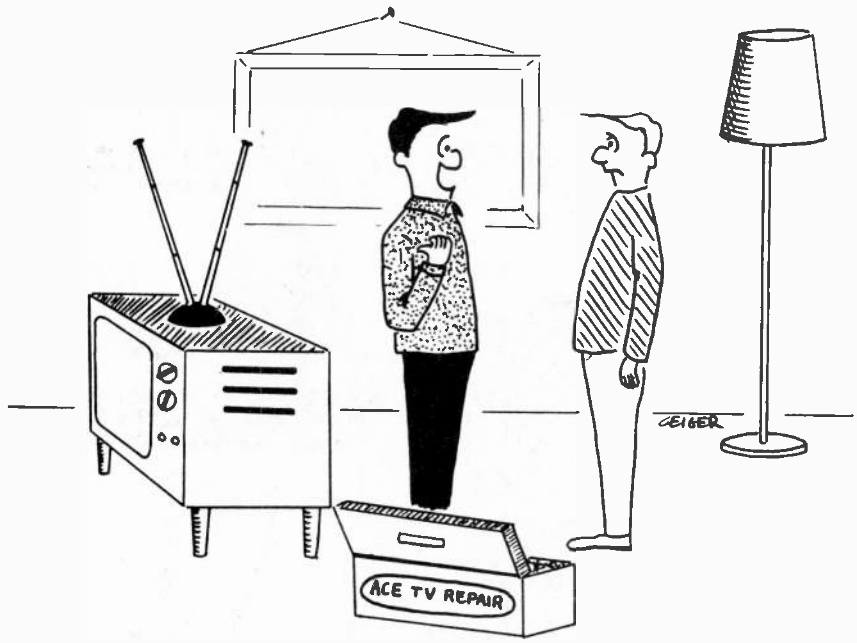
WANTED: APRIL 1978 ISSUE OF ELECTRONICS TODAY, WILL PAY EXCELLENT PRICE. MR. & MRS. R.B. DIXON, 4657 IRMIN STREET, BURNABY, B.C., CANADA V5J 1Y1.

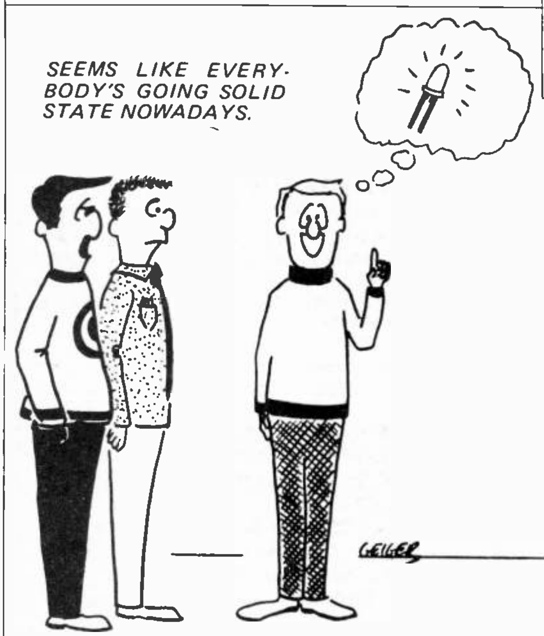
WANTED: SCHEMATIC FOR CLAIRTONE DELUXE AUDIO-VISUAL TRANSLATOR. ALEX HUDSON, 567 MONTGOMERY, ARVIDA. P.Q.

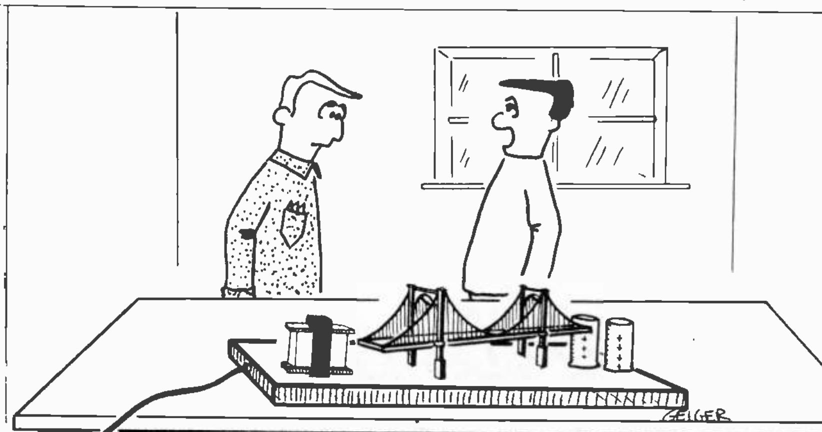
The Fun of Electronics



I JUST MADE AN ESTIMATE ON HOW MUCH IT WILL COST TO REPAIR YOUR SET, MR. CAMPBELL – MAY I USE YOUR PHONE, – I WANT TO TELL MY WIFE THAT WE'LL BE ABLE TO AFFORD THAT NEW CAR AFTER ALL.

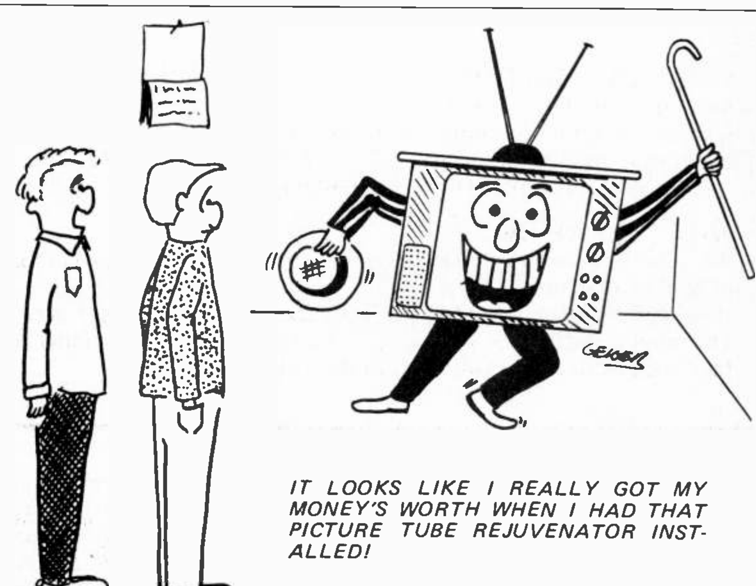
SEEMS LIKE EVERYBODY'S GOING SOLID STATE NOWADAYS.





WHATSA MATTER – HAVEN'T YOU EVER SEEN A BRIDGE RECTIFIER?

YOU'VE GOT TO START WEARING YOUR GLASSES FOR CLOSE-UP WORK JIM – YOU'VE JUST SOLDERED A SPIDER TO THE BOARD IN PLACE OF IC8.



IT LOOKS LIKE I REALLY GOT MY MONEY'S WORTH WHEN I HAD THAT PICTURE TUBE REJUVENATOR INSTALLED!

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WHAT DO WE DO?

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If we get your message by the 14th of the month, it will appear in ETI 1½ months later. For example, if we receive it by November 14th, you (and thousands more) will see it in the January issue.

FORSTER ENTERPRISES Box 371, Winfield B.C. V0H 2C0. Professional tape recorders ¼" – ½" used, 10½" reels. $200 – $600. Wanted: your used audio recorders, mixers, microphones. Send list.

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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.

ISSUE DATE	ARTICLE
Mar 78	Hammer Throw
June 78	Neg.
Feb 79	Note:C,D
Mar 78	True RMS Meter
Apr 78	Neg.
Jan 79	Note:N
Feb 79	Note:N
Mar 78	Home Burglar Alarm
Apr 78	Computer PSU & Neg.
Apr 78	Audio Delay Line & Neg.
Apr 78	Gas Alarm & Neg.
May 78	White Line Follower
June 78	Neg.
Apr 79	Note:C
May 78	Acoustic Feedback Eliminator
June 78	Neg.
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
Apr 79	Note:N
Nov 78	Cap Meter &Neg.
Nov 78	Stars & Dots
Nov 78	CMOS Preamp & Neg.
Dec 78	Digital Anemometer
Feb 79	Neg
Mar 79	Note:C. D
Dec 78	Tape Noise Elim
Feb 79	Neg
Dec 78	EPROM Programmer
Feb 79	Neg
Jan 79	Log Exp Convert.
Feb 79	Neg
Jan 79	Digital Tach.
Feb 79	Neg
Jan 79	FM Transmitter
Feb 79	Neg
Feb 79	Phasemeter & Neg
Feb 79	SW Radio
Feb 79	Light Chaser & Neg
Mar 79	Tape-Slide Synch
Mar 79	Synth. Sequ.
Mar 79	Dual Dice
Apr 79	Solar Control
Apr 79	Audio Compressor
Apr 79	Wheel of Fortune

ETI Project Chart

Canadian Projects Book

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

White Line Follower: May 78

There is some confusion on the component overlay. All the transistors are correctly positioned and their leads correctly labelled. However the physical orientation of the transistors indicated by the flat side does not apply to most models of transistors that might be used in this circuit. In other words, figure out which leads are the emitter, base and collector, and follow the e, b, and c markings.

Easy Strobe: Oct 78

It appears that with a large proportion of samples the neon bulb we recomended is not of high enough rating. Hence a higher power one should be used, such as NE54 (F2A) or NE2H (C2A). Alternatively, a triac circuit may be used.

Digital Tachometer: Jan 79

The one problem with this project is that on the pc foil pattern, the transistor leads are incorrectly lettered. The component positioning diagram and circuit diagram are however correct.

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

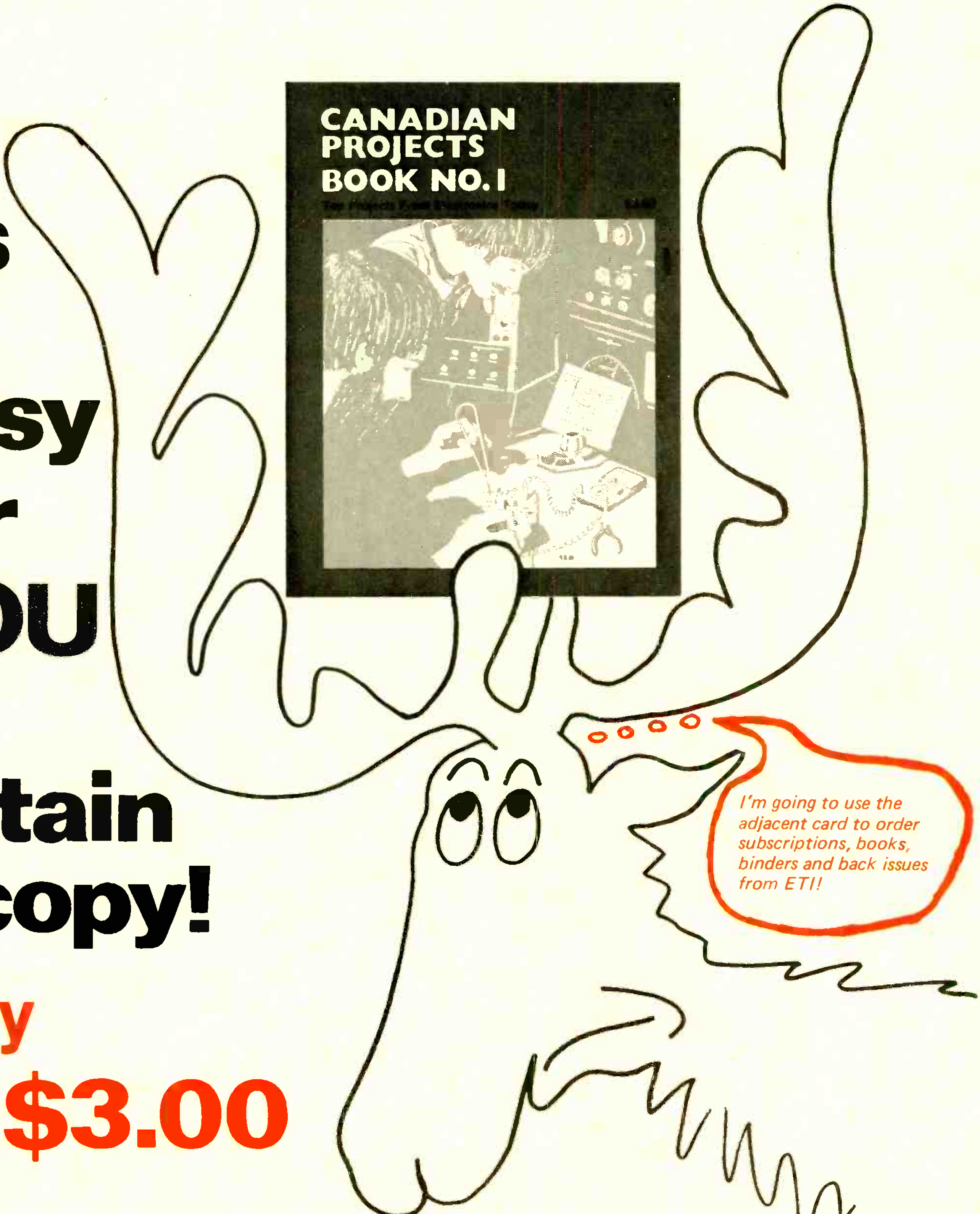
Previous issues of ETI-Canada are available direct from our office for $2.00 each. Please specify issue by the month, not by the features you require. The following back issues are still available for sale.

1977	1978	1979
February	January	January
May	February	February
June	March	March
July	~~April~~	
September	May	
November	June	
	July	
	August	
	September	
	October	
	November	
	December	

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.)

Advertisers' Index

It's so easy for YOU to obtain a copy!



Only $3.00

There's got to be something in this book for all ETI readers. Canadian Projects Book Number One gives you twenty-five projects from issues of ETI sold in Canada. All the projects have been reworked since they were first published to update them with any information we might have received about availability of components, improvements, etc.

To order Canadian Projects Book Number One send $3.00 per copy + 45¢ for postage and handling to: Canadian Projects Book, ETI Magazine, Unit Six, 25 Overlea Blvd., Toronto, Ontario, M4H 1B1.

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